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NUCLEAR ENERGY AGENCY
RADIOACTIVE WASTE MANAGEMENT COMMITTEE

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Forum on Stakeholder Confidence (FSC)

PROCEEDINGS OF THE TOPICAL SESSION OF THE 6TH MEETING OF THE FSC ON "THE LINK BETWEEN RD&D AND STAKEHOLDER CONFIDENCE"

Held on the 9 June 2005
at the OECD HQ in Paris, France

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FOREWORD

Within the Forum for Stakeholder Confidence (FSC) it is agreed that any decision-making process should take place in stages, in order to provide for the flexibility to adapt to contextual changes, including collective learning, new research findings and technological developments. In this process each actor must feel that it can influence the process, including generating complementary investigations on topics of significance in the field of safety and to the long-term impacts. It was recognized as well that the R&D community is also a stakeholder in the radioactive waste management processes, and should play a key role by providing balanced and qualified input, and encouraging informed and judgement. Further, active participation in and/or monitoring of ongoing R&D are viewed, in many countries, as providing important information for decision-making relating to the development of a radioactive waste management strategy.

Moreover, the science involved in radioactive waste management is not fundamental science of the kind that is driven mainly by our curiosity to understand the world around us and ourselves, it is issue-oriented science, as its primary objective is to provide a solution to an actual national problem. The issue at hand combines the complexity of the geophysical systems under consideration and the complexity of the societal framework in which radioactive waste is produced and managed. This complexity implies that science, as well as societal decision making, have to deal with -and live with-, to some extent, with uncertainty, indeterminacy, ambiguity and even ignorance. Another important feature of the scientific enterprise – and even more so for issue-oriented science – is that it is not a value-neutral exercise: the very definition of the problem includes value choices. And so do the choices of boundaries, of important variables, parameters and criteria.

Finally, because, today, the issue is no longer only how to implement an economically-optimal project of waste storage or disposal on a site imposed by the higher authorities, new challenges are posed to the technical community and their roles and the approaches they take. In this new environment, the place of research, development and demonstration (RD&D) in the elaboration of waste management policies and their implementation deserves to be debated.

The topical session convened at the June 9, 2005 Forum for Stakeholder Confidence was very rich in the breadth and depth of the presentations that were received, as well as in the debate that it aroused. A full day of proceedings was devoted to this topic, during which presentations and discussion addressed the following:

- The role of, and relation to, *science* in today's societies, as well the issue of confidence in researchers/institutions;
- The role and behaviour of the *experts* (technicians, engineers, researchers) and how to expose the experts' value system in order to gain stakeholder confidence;
- An *implementer'*s view of how research and research capability are approached in order to gain stakeholder confidence in the implementer fulfilling its mission;
- A *regulator*'s view of how research and research capability are approached in order to gain stakeholder confidence in effective regulation and safety;

- A *policy maker* view of how research and research capability are to be approached in order to have stakeholder confidence in policy and its implementation; and
- The role of RD&D for stakeholder confidence as seen by non-institutional actors: a local community; a mayor; and an academic.

This document provides a summary of the presentations delivered during this topical session. It follows with highlights of some of the areas of discussion that ensued amongst FSC members, and concludes with some broader international reflections on lessons learned.

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SUMMARY OF PRESENTED PAPERS

INTRODUCTION

Mr. Yves Le Bars welcomed the Forum for Stakeholder Confidence (FSC) participants and introduced the day's meetings that would investigate the possible contributions and conditions for RD&D to support stakeholder confidence. In his introductory remarks, Mr. Le Bars reviewed the intent of this topical discussion and its contribution to the Phase 2 Programme of Work for FSC.

Observations were drawn from previous FSC work concerning the evolving requirements for stakeholder involvement that require a new culture within the organizations. It is recognized that each actor must respect certain values and abilities, and have the capacity to communicate, to learn from the public and to adapt. In particular, it was suggested that the role of the expert in the decision-making process has changed, and there is a need to restore credibility to the voice of experts to support the processes relating to radioactive waste management. Mr. Le Bars spoke about the changing role of the "expert" and increasing demands from the public to be informed, active participants in decision-making processes. As societal expectations have evolved over the years, there is less willingness to give the expert the legitimacy to decide, or the expert working solely with the decision-maker. Rather, there are growing demands for public policies to be defined and implemented through decision-making processes that also invite stakeholder participation, as another important category of actors. Thus, the decision-making process can be viewed as now involving three parties: the public, the experts and decision-makers. Research must be positioned in this context.

Research must be part of the process, structure, behaviour and debate. It is meant to be introduced in the process as contributor to the project definition, by providing scientific background. Further, it is best undertaken through an adaptive behaviour, carried out by institutions with a clearly defined and communicated role.

In setting the context for the discussion which followed, Mr. Le Bars posed some interesting questions and challenges relating to the contributions and conditions for research to affect stakeholder confidence:

- What quality can we expect in research?
- How should it be provided in the process?
- Research will inform and identify some areas of certainty and work on uncertainties, accepting doubt. How will residual areas of uncertainty be recognized and exposed?
- How should the fine-tuning between the project design and demonstrations and research and investigation be implemented?
- How can uncertainties be reduced and exposed?
- Recognizing that research is not value free, how can underlying values be identified and exposed?
- How can we succeed in the face of cultural changes, and ensure that researches recognize their contributions and role in the process, accepting that they are not the decision-makers?

STAKEHOLDER CONFIDENCE *VIS-À-VIS* THE ROLE OF SCIENCE, SCIENTIFIC INSTITUTIONS, AND EXPERTS IN TODAY'S SOCIETY

Martin O'Connor, Professor of Economics, Université de Versailles, France, addressed the role of, and relation to, science in today's societies, as well the issue of confidence in researchers/institutions.

Professor O'Connor underscored that social trust and partnership is developed through dialogue of scientists and technical experts with the full range of stakeholders, including policy makers and implementers. Effective dialogue, based on reciprocal learning and capacity building, will further the understanding of the tensions and different viewpoints and values, and reveal areas of uncertainty. This type of dialogue responds to a social demand to reappraise publicly and reflexively. This important process cannot unfold if research is cloistered and kept separate.

It is essential to mobilize knowledge, share it, and allow the process for social evaluation of science. Radioactive waste management is a socially-constructed problem; an acceptable response cannot therefore be separated from the public concerned. Expert evaluations that support regulatory processes are insufficient for strong decision-making where there are issues of high risk and uncertainty. Science must be considered in broader social context. The public is more suspicious of "expert processes" of risk assessment that are non-transparent. Stakeholder confidence requires building relationships of different components of society. Building stakeholder confidence is about hopes to be shared, and must consider relationships between the actors. Research must be sensitive to the social relationships of the problem and respond to areas of public interest.

Trust in process is key. The foundation for a successful dialogue is agreement of the initial hypothesis is that there is a need to address the issue in question. Real dialogue also demands that participants are respectful of others' views and principles. This requires willingness to work on the future together on common problems. There must be a capacity to listen to others, and assimilate different views. This in turn, requires processes and training to allow an effective exchange of views to take place. Participants from specialist communities, and institutional actors, must be willing to listen to other views that matter to the public. Quality issues must also be addressed, recognizing that quality is also shaped by social criteria. Contributions of science and experts must be considered as institutional questions of what is considered "research"? What is "good research"? What constitutes quality?

Sharing of research through stakeholder dialogue provides an important opportunity to build bridges to bring in different disciplines to the discussion. Integral to the process, is the integration of social science expertise which, in addition to offering a broad range of insight, has an important role in assessing and establishing the legitimacy of other streams of science. It was suggested that more significant investments are required to integrate the contributions of social science into projects in the nuclear sector.

There are challenges associated with executing and communicating research. Professor O'Connor addressed the issue of competence required to support effective dialogue, and the reciprocal burden of proof in which all actors are required to be attentive to a spectrum of quality criteria and principles. He emphasized that expertise must be built in a fundamental way, not as a communication strategy. He noted that ambiguities may arise in science and technology, and that challenges are greatest where there are many different social values, remaining areas of uncertainty, risk, and high decision stakes in terms of long- term impacts of decisions taken. It isn't always possible to reconcile multiple principles. Recognition and acceptance of these vulnerabilities assists in building trust.

Professor O'Connor offered a helpful framework for working through challenges - "Ethical Bottom Lines", which offer principles of responsibility for stewardship of radioactive waste:

- Have responsibilities of existing parties been appropriately assigned?
- Have responsibilities 'towards other parties" in the short term been adequately addressed? (e.g. worker health and safety, security)
- Have responsibilities 'towards other parties" in the long term been adequately addressed? (e.g. Long-term stability of knowledge transfer, inter-generational fairness, provision for contingencies)
- Has available technical know-how and systems science been mobilised? (e.g. Adoption of best practices and standards, monitoring)
- Is the solution economically viable?
- Does the solution enhance the prestige of the host communities and other stakeholder groups closely associated with the residual/waste site?

He noted three key components for a viable solution to radioactive waste management:

- Development, application and maintenance of scientific knowledge and technical competency to measure and control the present and eventual exposure of living beings to radioactivity;
- Building societal relationships with the site, envisaging how the community will relate to and interact with the site, the waste, the records, etc; and
- Political and economic partnerships, to enable mobilization of the relevant knowledge and resources for implementation of an agreed societal strategy for stewardship.

Kjell Andersson, Karita Research, discussed the role and behaviour of experts in the context of gaining stakeholder confidence.

Dr. Andersson underscored the many reasons to make explicit experts' values. Complex policy issues often involve many challenges – factual issues with uncertainties, values, emotions and vested interests. All of these factors should be exposed to policy makers and the public before decisions are made. Experts may set the agendas too narrowly, there may be mistrust in expertise and authorities, and there may be low awareness in the political system. Excessively narrow framing of the issues can result in frustration and inability to solve important societal problems. It was noted further, that in a democratic society decisions are based not on expert values, but on citizen values. Democracy implies accountability and requires awareness and transparency. Modern society is demanding higher levels of transparency and public participation dialogue and incorporation of public values.

Dr. Andersson reviewed some of the models which have been advanced for awareness building with transparency and participation within frameworks of representative democracy. The RISKOM model was discussed, as was the VALDOC model, both of which invoke the practice of "stretching" - inviting questions to be raised from new angles through challenges from society. Another key element of the RISCOM model is "intelligence" – understanding future developments and outside forces, as well as studying and planning for the future. Crucial aspects of the VALDOC methodology include the authenticity of the approach itself, its identity in awareness and transparency, fairness in process setting and ensure neutral venues for hearings and transparency arenas. The presentation highlighted some applications of these models in a variety of industries in Sweden.

The presentation reviewed a number of arenas in which experts' value systems may be exposed. Within the expert arena, it was proposed that experts have legitimate roles in providing a scientific basis, but they must be willing to give up control to decision-makers. Experts should not frame the problems and set agendas. Another arena is that of deliberative discourse and participative processes based on procedural legitimacy. It is important that there be a knowledge base underpinning deliberative discourse and societal participation. It is important to ask whether the participative processes create the awareness needed for democratic decisions – will citizens participate? What is the role of elected representatives? How is accountability assured? Where is the stretching? The critical issue when it comes to application is *who* will be trusted to act as the host for the process. Ideally the process host is someone with no other interest than ensuring transparency. The process host must also accept to be stretched.

THE ROLE OF RD&D FOR STAKEHOLDER CONFIDENCE AS SEEN BY INSTITUTIONAL ACTORS

F. Jacq, Director General, Andra, France, offered an institutional perspective, by drawing on the experience of Andra the implementing agency in France.

Mr. Jacq's presentation addressed the role of research. Research is an asset, for policy, but science doesn't necessarily impose "truth" or consensus in society. Research considered as an essential component of RWM projects, it is not with the objective of imposing solutions, but rather to provide quality responses that provide us with flexibility. The example was provided of reversibility, as a feature considered in some repository concepts.

Reflecting on the discussions of the role of R&D in building public confidence, he noted that there is a long-term involvement of science and research in implementation in radioactive waste programs.

The presentation emphasized the need for sharing amongst science and society. A viable and robust system is required to connect science and social environments.

The process through which science and society collaboratively review research is also important. In this regard, adoption of "stretching" to consider issues and research questions from many perspectives is key.

Scientific proof is necessary, but there is also need to question how research is conducted.

The presentation continued with observations from the experience of Andra, regarding the processes followed within the institution for setting directions, organizing and executing research.

Janet Kotra, Senior Regulation and Communication Specialist with the U.S. Nuclear Regulatory Commission (NRC), provided a regulator's view on the role of independent research capability and its relationship to stakeholder confidence.

Ms. Kotra underscored the NRC's commitment to regulatory openness in its Strategic Plan. A number of actions have been adopted to achieve openness: public access to information about risks, safety and

licensee performance that is accurate and timely; enhanced awareness of NRC as an independent regulator; fair and timely process for public involvement in NRC's decision-making; and early public involvement and two-way communication to enhance public confidence in NRC's regulatory process.

The presentation reviewed the ways through which the NRC seeks to inspire confidence in its process as independent regulator and in future decisions concerning whether to authorize the U.S. DOE to construct the proposed repository at Yucca Mountain. Key to this will be reviewing all information objectively, making open decisions based on sound, scientific judgements about the facts; and maintaining an open and fair public process, and accessing independent R&D. It was noted that among the requirements for the safety review for the Yucca Mountain repository will be extensive technical and scientific analyses, evaluation of expert judgement, and long-range modelling assessments of expected repository performance. NRC requires independent scientific and engineering analyses to develop technical bases for regulations and guidance; evaluate adequacy of DOE's safety case for a potential repository; assist preparation of NRC Safety Evaluation Report; provide technical support for NRC testimony during licensing hearing; and develop effective outreach and communication tools.

Confidence in NRC's use of science and engineering will depend upon: competence; independence; open and fair process; regulatory outcomes that are subject to verification and monitoring. To assist, the NRC established the Centre for Nuclear Waste Regulatory Analyses (CNWRA) as a conflict-free body of experts to assist the NRC in making independent judgements about the safety case of the nation's first geological repository for high-level radioactive waste. The CNWRA supports the NRC's regulatory mission with a wide range of independent technical expertise, computers, laboratories and field research. In addition to providing broad technical support to the NRC, CNWRA experts support the NRC's public meetings, open houses and other public outreach activities, assisting with the identification of key technical concepts and plain language communications concerning research findings and limitations.

NRC sought to create a centre that would provide expertise that:

- is competent, employing recognized experts, scientists and engineers, with in-depth knowledge of the scientific and technical issues related to the potential repository at Yucca Mountain;
- is independent of the DOE, free from any potential conflict of interest, or appearance of such conflicts;
- assures long-term continuity of technical support and the maintenance of corporate memory of the evolution of repository safety and regulatory issues; and
- complements NRC's skill sets, avoiding gaps and overlaps in expertise between the NRC and CNWRA.

NRC's reliance on independent expertise will assist in conveying to stakeholders that the NRC is able to challenge DOE assumptions and assertions and arrive at objective conclusions about the safety of the potential repository.

Carmel Létourneau, Senior Policy Advisor with Natural Resources Canada, addressed the topic of government Policy, research and stakeholder Confidence from the perspective of government policy makers in Canada.

The presentation reviewed the question: why carry out more research into methods of long-term management of nuclear fuel waste? In addressing this question, Ms. Létourneau provided some

perspectives that were expressed by the Canadian public, since reflected in the Final Study of management approaches led by the Nuclear Waste Management Organization (NWMO), an organization set up by the nuclear industry to study options for the long-term management of nuclear fuel waste. The Final Study was submitted to the federal Minister of Natural Resources in November 2005 as required under the *Nuclear Fuel Waste Act*.

The NWMO's Final Study emphasized the important role of continuous learning, a key element in the NWMO's recommendation of Adaptive Phased Management. It was reported that the NWMO work had identified many reasons to carry out further research. Regardless of the management approach adopted, activities to manage radioactive waste will continue for a very long time. Any management program could be expected to apply the best practice available at the time. A program that will evolve over a long period of time will have many opportunities for improvements to increase performance, enhance effectiveness, and address rising societal concerns. It was suggested that, to realize these benefits, there needs to be a vibrant and robust research and development effort during management program development and execution, a period that will last many generations, and enable implementers to adapt to a changing environment. Among the reasons put forward for continuing research were, to:

- Embody the principles of continuous learning which encourages standards of excellence and integrity
- Prepare for facility siting, design, licensing, development and operations to improve designs, minimize costs, enhance schedules, and reduce uncertainties
- Assure adequate human capacity to manage the program throughout its existence to maintain competence and credibility
- Enhance scientific understanding to improve confidence in predictions and to evaluate potential program improvements
- Confirm performance or identify anomalies during and after program operations and thereby increase confidence
- Clearly demonstrate to citizens an ongoing capability to manage the enterprise and to respond to their concerns and desires
- Be able to enact mid-course corrections in response to new information or societal decisions by adapting to new designs, new regional, national or international institutional changes, or new international standards
- Be able to adapt to new capabilities developed externally to the program that show promise of improving program success.

Ms. Letourneau addressed the role of the public and private sector in conducting research on RWM in Canada. The Government of Canada has clearly indicated that the responsibility for providing sound scientific data for proposed practices rests with the proponent who is taking action associated with the risk of potential serious harm. Where it is less clear that the proponent should shoulder the entire responsibility for research programs, the Government step in and assist the proponent or the general industry in question. The relationship between research and Government policy focuses on the public good and always aspires to public confidence. It cannot focus only on ideas and technologies with commercial potential. Its top priority must retain the public interest of present and future generations of Canadians. The Government is interested in supporting research which responds to public priorities of the day. The presentation reviewed the functional objectives of government research, and noted that increasingly, the setting of research priorities now involves more intensive and extensive public

consultations. It was noted that allocation of responsibility for research can shift over time, as knowledge grows, and the roles of the public and private sectors evolve.

Reference was made to the "precautionary principle" that has been an important factor in setting priorities in science and technology research and development since the early 1990s. Precautionary decision-making is in keeping with Canadians social, environmental and economic values and priorities. Ms. Létourneau commented that the application of "precaution", the "precautionary principle", the "precautionary approach", also recognizes that the absence of full scientific uncertainty shall not be used as a reason for postponing decisions where there is a risk of serious or irreversible harm. R&D can assist to improve stakeholder confidence and risk management, but should not be used to unnecessarily delay decisions to reach zero risk. When considering public views, governments will need to balance their ability to practice good governance (making decisions) with the thoughtful application of precaution (delaying decisions until more research can be carried out). This approach should lead to increasing public confidence in RWM decisions based on sound R&D.

THE ROLE OF RD&D FOR STAKEHOLDER CONFIDENCE AS SEEN BY NON-INSTITUTIONAL ACTORS

Harold Åhagen, of the Municipality of Oskarshamn in Sweden delivered remarks from the perspective of a local community. His presentation was based on his observations of the Oskarshamn experience with the site selection process in Sweden.

Mr. Åhagen set the context for his presentation by profiling the geographic location and history of Oskarshamn including the feasibility study and the council's 2002 unanimous vote to accept site investigation with 13 conditions and clarifications. Among the conditions were such requirements such as: public guidance on the safety assessments, continuous SSI and SKI oversight and reporting, development of connection between PA, siting criteria and site characterisation and compilation and evaluation of critical research results by SKI and SSI.

The municipality's policy places an emphasis on ensuring safety first, providing information on the table from all parties at all times, and ensuring active engagement and influence. Working groups were established by the municipality to follow the safety issues and ensure that the 13 conditions are fulfilled, require investigations enhance citizens' competence; collect and forward questions and issues; and draw experience from local participation in other national programmes.

The Oskarshamn model has a number of key elements:

- Openness and participation, through which all research results are shared and put on the table.
- Collaborative development of the EIA process.
- The role of Council in serving as the reference group for the voters – competent elected officials are responsible for the voters.
- The public serving as a resource through their contributions. Clearly-defined studies and plans are pre-requisites for public engagement and influence.
- Environmental groups serving as resources also, as their members and experts make valuable contributions.

- Stretching of the implementing agency, SKB (the community must build competence so it can ask difficult questions, until clear answers are provided).
- Competent authorities visible throughout the process, as the "peoples" experts.
- SKI's oversight role, conducting independent R&D; a key process for public confidence. The regulator puts findings into perspective; communicates to municipality its findings.
- Demonstration playing an important role - laboratories which demonstrate the technology found to play key roles in competence building and confidence building.

Reaching "informed consent: in siting depends upon many factors, a key factor of which is RD&D. Mr. Åhagen identified two components that he believes to be key to achieving informed stakeholder consent. To reach an *informed* consent there is first a need to build local competence on local terms, allowing the municipality to have the capacity to independently judge the project. The second challenge is to achieve consent – a conclusion by a majority (qualified majority) that the repository can be accepted and is compatible with the broader visions for the municipality. It was noted that local issues may arise which cannot be resolved. The example of the municipality of Storuman was provided, in which the suggestion of a radioactive waste repository was found to be incompatible with the local focus on wildlife tourism. In Oskarshamn, an industrial municipality familiar with nuclear plants, the same image dilemma did not arise.

R&D, together with parameters from site investigations form the basic safety case for repository siting. It was noted that evaluations of safety also are based on assumptions and value judgements. Mr. Åhagen underscored that the public has a much better understanding of R&D than most experts are aware of, and that implementers should have faith in the public and trust the public's ability to absorb the facts and follow the issues. Citizens understand the quality aspects of R&D, including the role for peer reviews. The public is also aware that facts change over time and that scientists may hold different opinions.

The presentation emphasized the importance of capacity-building at the local level. Stable local support can only be sustained if there is a high degree of competence established about the project. It is key to be mindful that it will take time to bridge that gap between the nuclear waste management experts and the local community. It takes a long period of time for a local community to develop its capacity to participate in decision-making in a way that will support implementation that can take decades to complete. Building true competence takes a long time and it must be undertaken on the terms of the public and the local decision makers. Lack of patience or tight schedules adopted by the implementing agencies can pose threats to the maturing of this process. It requires participation and influence, and cannot be forced by education and information. The challenge and time required to build this local capacity is even greater within non-nuclear municipalities. An ongoing process of revitalisation of the local platform is required, as individuals involved at the local level will change over the years. The experience of Finland and Sweden suggests that access to a local veto has been an important aspect of local acceptance. With a local veto, there is reduced risk for local decision-makers to engage in a siting effort. In Oskarshamn, this local power has been used to engage in the competence building and to ensure that there is informed consent for participation in site investigations and possibly hosting of the repository in future.

There was discussion of the types of research most likely to engage local publics. In terms of focus, participation of the local community will likely begin with a focus on the safety case, and then shift to environmental impacts, societal issues and socio-economic issues. The municipality can have more influence in the social science area, in light of their already established competences on socio-economic matters. In these areas, the municipality will want to have more direct influence in

identifying the need for R&D and investigations, following R&D progress and understanding the results in more detail. It is not the task of the local community to define the program of natural science R&D. This is largely the domain of the regulators and implementing agencies. The local level can influence R&D in an indirect way through the identification of questions, a commitment to competence building and continuous follow-up on identified issues. Local influence on R&D in Oskarshamn is described as aggressive competence building through questioning (stretching) of the experts of implementing agency and regulators.

Modern siting processes present new challenges. Experts are asked to be more open to dialogue and to sharing of findings as they emerge, including areas of incomplete knowledge and plans. Citizens must be willing to take on more active roles and invest in capacity building to gain competence to engage in this new active citizenship. To allow for local influence, the dialogue must start before the solutions are set and final designs confirmed. The role of the regulator was of fundamental importance in Oskarshamn. The openness of SKB's experts, their willingness to share plans and preliminary results, and active participation by the regulatory experts has resulted in a solid platform for local participation and influence over the work. Clear definition of roles and responsibilities of implementing agencies, the regulators, government and the municipality, early in the process, was found to be fundamental to the process.

It was suggested that demonstration plays quite a different role in local confidence building than does R&D. Demonstration is seen to be more effective in explaining to the public how a repository is intended to work and how it is intended to isolate the waste from the biosphere. In the case of Oskarshamn, hosing CLAB, the Äspö Hard Rock Laboratory and the encapsulation laboratory has been found to play a significant role in the competence building and in building local acceptance.

Josep Castellnou Barceló, Mayor of Vandellòs and L'Hospitalet de L'Infant in Spain, addressed the linkages of R&D and stakeholder confidence from the perspective of a mayor. His presentation drew on his experience as mayor of nuclear community in Vandellòs and Hospitalet, Spain.

Mr. Castellnou began by reviewing the economic profile of his community and the chronology of the nuclear program in that area. In discussing factors influencing trust and confidence at the local level, it was noted that safety and security were key, (not negotiable). Economic development and prospects for the future were also seen as important pillars for building public confidence. Cutting across these areas, was a role for R&D and information.

It was important to provide information to the public, and to communicate effectively around issues of risk and security. R&D plays a role in supporting these activities to generate confidence. There were active training and education initiatives for elected officials and citizens and other stakeholders, which included local participation in site visits. Education on matters of nuclear energy was provided, seminars and technical visits. The community participated in the COWAM project, to benefit from the exchange of information internationally. In addition, local information committees were created that play an important role in ensuring a flow of information to the general public. The local level has access to experts to support their activities. The presentation profiled the ways in which the municipality retains an active role in overseeing the decommissioning of the local nuclear plant.

The presentation reviewed areas in which R&D provided linkages to future well-being of the municipality, through professional training, linkages with universities, promotion of culture and business and economic diversification. Research in social disciplines is found to be important in building confidence of the public.

Ghislain de Marsily of the University de Paris VI and French Academy of Sciences contributed to the discussion by providing a presentation from the perspective of an academic.

In reviewing the role of science, Professor de Marsily focused on the important roles of science and R&D following a siting process. Science and R&D is essential for understanding the physical systems, displaying and demonstrating processes involved, measuring key parameters, and assessing areas of residual uncertainty. He outlined a number of factors that are key to making a strong case to stakeholders, to demonstrate that the system is well understood:

- explaining the past history of the site;
- explaining unexpected features or occurrences (such as seismic anomalies);
- ensuring the capacity to observe and note unexpected features;
- having the capacity to introduce new measurements that can inform the system;
- deriving scientific validation of theory (noting the example of WIPP);
- maintaining the capacity to be at the frontier of science; and
- having the ability to answer unexpected questions from any party.

It was suggested that credibility and stakeholder confidence is linked, in part, to credibility of the research in the eyes of the scientific community. The scientific community must be engaged to address questions of interest to the public. The role of peer review is essential in establishing the credibility of researchers, and within academic circles, publications in the scientific literature is highly valued. It is important for both implementers and regulators to retain their own capabilities and competence to be credible in the eyes of stakeholders. The experience of Andra was noted, in underscoring the importance of having high-level scientists internal to the implementing organization to ensure momentum and institutional knowledge. Thesis students also offer ways of promoting science in areas of interest concerning radioactive waste management.

Demonstration plays an essential and distinct role from R&D. It offers tangible insight to stakeholders. At the same time, it may reveal unexpected features and can be a catalyst for triggering yet further R&D. Demonstration carries more relevance for engineering knowledge. The presentation concluded with the example of CLIS, a forum which is interested in the results of research.

SUMMARY OF DISCUSSIONS

Sybille van den Hove, of the Autonomous University of Barcelona in Spain, contributed context roundtable discussion amongst FSC members and guest presenters, by discussing some general observations and key issues that surfaced during the day's discussions. In her stocktaking, Professor van den Hove reviewed highlights from the discussion and presented her own reflections on the role of science and the inter-disciplinary aspects of research discussed. She noted the themes arising from the presentations concerning transparency, openness, accountability, as well as the emphasis placed on "stretching" in framing research programs, and the importance of recognizing and managing residual uncertainty.

In commenting on the role of science, Professor van den Hove observed that science is important in framing issues, but it does not provide truth. Science deals with incomplete explanations of the world; uncertainty and ignorance are parts of science; and yet we tend to still operate as if science brings the absolute truth.

- Science does participate in the definition of problems, but it is not alone in this role.
- We must consider the role of established knowledge vs. "destabilised" knowledge (research).
- Translation is required: need translations from science to society and from society to science.
- There are cultural differences in understanding the role of science – we have heard very different approaches in terms of role of science.
- *What is science*? This is an on-going research question. It is definitely a human process. Has there ever been such a thing as a pure scientist?
- Too often science processes are black-boxed in our institutions.
- (Power) asymmetry between science/expertise and the public, is still very present, even in discursive processes, but processes can be designed to address this.
- There are many different types of expertise, knowledge, intelligence.
- Science is not neutral and not always independent, nevertheless it does maintain ideals of neutrality and independence in scientific methods.

Roundtable discussion ensued in an exchange of comments and observations amongst FSC members and guest presenters, covering a range of topics:

Discussion continued on the role of RD&D

- Participants discussed the ways in which research and society may be linked. One individual suggested that until the actors are brought together, it will not be possible to build a vision of a socially acceptable future. In that case the research has to be "stretched" in a way that responds to the task of partnership-building. Expertise must be built up in the spirit of partnership building. As part of this, it is important to open up the question of "what is the future"?

- There was discussion from the perspective of different agencies on how decisions are taken regarding the amount of research required. The case of Canada was noted, in which the Seaborn Panel found that, notwithstanding the millions of dollars directed to years of technical research, safety had not been demonstrated from a social perspective. The Panel's finding was instructive in encouraging new thinking on decision- making processes.
- There was discussion on the role of demonstration; recognizing it has a very different role from R&D, but an essential role.

Roles and responsibilities were considered

- Participants discussed "w*ho should conduct research"?* It was recognized that there are many possible approaches, and each actor has associated with it its own scientific network.
- Some suggested that, to some extent, implementers and regulators may be competing technically. Consideration should be given to how many researchers are required, the required functions of the various technical committees, and the role for stakeholders in national programmes.
- The question of who undertakes social science was addressed. It was noted that there are different ways of involving social scientists in the process.
- The role for public guidance in safety assessments was discussed. Some proposed that this is the same notion as stretching - that by asking questions and understanding the answers, we can understand the maturity of the work. Implementers should not be afraid of questions raised by the host municipality or potential host communities - this questioning should be seen as helpful to the process.
- It was suggested that the significance and the acceptability - to an individual, to members of a community, and to a society - of exposure to risk depends on perceptions about how, by whom and why the risk is produced. When talking of risk, there are many dimensions, beyond the purely technical ones. A participant suggested that risk is not just a scientific concept; it is value laden. Some proposed that many aspects of radioactive waste management are *socially constructed.*
- There was discussion of the roles of the public, the authorities, inter-disciplinary peer reviewers and other actors in ensuring quality of science and expertise.
- There was discussion of the merit of allowing scientists to proceed independently, outside of the implementing or regulatory organization (i.e. not "in-house" scientists) for special projects. Some suggested that if science was left only to outside labs, the result may not be helpful. Yet, it was recognized that one can't expect to micro-manage the research internally. It is important to find a balance, with sufficient independent scientific contribution while maintaining at each point a dialogue so work does not diverge too far from the objectives of the organization.
- The potential for self-interested behaviour of researchers was acknowledged. It was noted that many make livelihoods out of ongoing research, and it is therefore in their interest to keep identifying problems to investigate. It was suggested that it is important that the leadership of implementing and regulatory organizations to include strong scientific capabilities to help the organization make important judgments concerning the extent and areas of research needs.
- Reference was made to the French law of 1991 which enforced a new model for scientific and technical development. In contrast with the previous rationale based on large organisations, the creation of Andra as a programme organisation, not entrusted with a mission to carry out and to concentrate all investigations within its own structure, but to federate other scientific resources sharing a common objective, constituted a major innovation. A new working method was created based on a new scientific organisation, guaranteeing openness, a finer and more relevant account

of the issues at stake by the scientific community, a sharper critical outlook over the entire work, or in brief, some of the specific virtues ascribed to scientific investigations.

Funding of research was raised as an issue that perhaps should receive more attention.

- One member suggested that there are a number of financial questions that may warrant more in-depth consideration in relation to stakeholder confidence:
  - Who should pay for research: the public or the waste producer?
  - Is research funded by public monies found to be more credible? The case could be made it is in the public interest.
  - The counter argument is that polluters should pay. Is industry-funded research seen as less credible than research funded by public monies?
  - Does the issue of who finances significantly affect the credibility issue? Is this expected to vary by country?

Participants exchanged views on the role of civil society.

- Participants shared perspectives on whether the public should be viewed as being "expert". Some argued that this should be the case and that lay persons can understand complex risk assessment.
- The question was asked, if we acknowledge that there is expertise in civil society, then what is its responsibility in the process? It was proposed that views on whether or not civil society ought to play a prominent role must be situated in a cultural setting. The cultural framing is key where different values exist.
- It was remarked that, as higher education and R&D play a much larger role in almost all aspects of our modern western society, there is generally a much better understanding spread among the public on what R&D constitutes. It was suggested that the public appreciates that what constitutes "facts" will change over time, and that scientists have different opinions about the same matter. It was proposed that that evolution is not unique to matters of nuclear waste; rather these are developments and features that permeate our society generally.
- A participant observed, with reference to a nuclear community, that those citizens, through their life experiences, have shown to have very sophisticated knowledge about the presence and effect of radioactivity.
- A participant suggested that there is a need to rebuild relationships among the actors, but that in so doing, we should not go back to old models.
- There was some exploration of the practical possibilities of truly engaging the general public that may have a low level of awareness or interest in the topic. Discussion ensued around the issue that some countries require consultation at the national level. The work of the UK CoRWM was noted, in bringing together a wide range of experts. Trends to move toward more pluralistic models of advisory committees to government were noted. In France, it was noted that the CNE has 12 members appointed by the Parliament, safety authorities and others, which are not exclusively scientists.

There was considerable discussion on quality and stakeholder perceptions of competence and credibility of researchers.

- Some commented that the recent breakdown of the credibility of science and engineering is primarily a *social* phenomenon. At a time when many actors are experiencing low public confidence, the level of trust that the public has in institutions undertaking the research becomes important. It was noted that quality considerations vary with different sets of people. In order to assess and foster acceptability of a given strategy for waste management, it was suggested that it is necessary also to consider the *meanings and relationships* that alternative strategies might establish among the people implicated in the waste management process. Trust must be built amongst these constituencies.
- Important questions emerging are:
  - What should be the role of science in, and the contribution of expertise to, decision-making processes?
  - What constitutes quality in scientific research?
  - Which are issues experts need to be aware of so credibility is not impaired?
  - What is the role for peer review processes?
- A participant suggested that the credibility of technical experts and institutions depends on the issue at hand, and that the issue is more about the "credibility of applied science".
- Participants considered the question, of "credibility to whom?", and how credibility is meant to be defined. It was suggested by some that there is no higher credibility than that brought by the peer-review process, and that to maintain currency, researchers must be published and recognized within their own communities. The challenge is how to navigate between interests – independent scientists won't have credibility if they are not current.
- The experience of the U.S. NRC was noted, in which the peer review process tries to be current, to reach out and be visible.
- Participants acknowledged the role for mutual questioning, which must be allowed. The peer review – including the extended peer review – is also important. Some stressed the need to open up all contributions to debate - to scientists, society and implementers - so that there can be mutual questioning, understanding and stretching.
- The Eurobarometer survey and the findings presented in Mr. Le Bars' presentation on "being told the truth" and "competence" were discussed, as participants reflected on what might be deeper implications underlying these findings.

Transparency and accountability were much discussed.

Transparency and openness around science and expertise in supporting decision-making processes was considered in terms of the implications for scientists, experts, decision-makers and institutions.

- There was discussion on the background context. It was suggested that the strong belief in a scientific and technological revolution as a source of progress has weakened. The public is demanding greater levels of transparency in processes, including a sharing of research programs and findings. Citizens wish to have access to information and findings of specialists.
- The public is more suspicious of "expert processes" of risk assessment that are non-transparent. Challenges appear to be greatest on issues in which there are many different social values,

remaining areas of uncertainty, risk, and high decision stakes in terms of long- term impacts of decisions taken.

- Complex policy issues often involve many challenges – factual issues with uncertainties, values, emotions and vested interests. All of these factors should be exposed to policy makers and the public before decisions are made. There should be transparency about the assumptions, values and interests of experts. Participatory processes may help to clarify these assumptions. A range of questions emerge in considering the issue of transparency and accountability.
  - Does a less formal process lead to less accountability?
  - What does accountability mean in a very long term framework?
  - Is partiality acceptable, provided that it is declared?
  - How can consistency between discourse and behaviour (authenticity) be ensured?

Other process challenges emerged in the discussion.

- Some noted the difficulty for many researchers to stay within their own fields, focused on their mandates. Others noted that researchers can become enamoured with their respective fields in ways that pose challenges to the process.
- Some emphasized the importance of having a process host that has a strong vested interest in the value of the process. All actors carry competences and values and we need to build the bridges for these competences to be exchanged.
- Participants considered the challenge of working with experts who hold different points of view.
  - Some observed that experts have not been trained to work with dilemmas. Situations may arise with a majority viewpoint, and minority outliers. It was suggested that the RISCOM model is able to test the authenticity of these viewpoints.
  - Others suggested the importance of demonstrating competence vis-à-vis certain levels of duty and criteria. Demonstrating integrity and authenticity in a structured way will allow a player to build space for compromise. E.g. "I must demonstrate attention to "your concern"".
- There was recognition of the importance of effectively communicating research findings**.** A participant noted the experience of their organization, in which the direction to the technical staff is that "research results that we do or sponsor have to be explainable in the plainest language".
- Participants questioned whether these challenges are problems exclusive to radioactive waste management, or whether they are features of the realm of science more generally. Some maintained that these challenges are evident more broadly across sectors. For example, issues of mistrust are of a generic nature in large part, which also originate with other issues, such as the GMO issue.

Concluding comments and preliminary thoughts on possible ways forward were invited by the FSC secretariat.

- A participant remarked that national differences were more pronounced than had been expected. In light of these differences, it was suggested that it may be useful to undertake further work in this area, by framing the issue more precisely to understand national and cultural differences and uncover areas of common ground. If this is of interest to FSC members, consideration might be given how best to collect relevant information from members.

- An individual suggested that it may be interesting to review selected processes through a case study format, to compare a radioactive waste management process to another case in another sector, to explore whether the challenges and issues are topic-specific or whether they apply more generally across other sectors.
- Another idea tabled was that the FSC might reach out to people affected at the local level, to explore areas of satisfaction and dissatisfaction concerning their role in interacting with other players and RD&D.
- Participants raised the question, *where do we go from here*? *How do we change/build institutions for* interfacing science and society in practice?
- One individual suggested areas for further exploration might include:
  - Ways of training scientists
  - How to ensure transparency
  - Approaches to engaging stakeholders vs. the general public in the process
  - Articulation of different forms of participation.

In concluding discussion of a way forward, it was agreed that the next step would involve a summary and distillation of the key themes and lessons learned from this topical session. The Core Group would then consider an appropriate course forward on this item.

As the discussion concluded, FSC members expressed appreciation to the guest presenters. Members acknowledged the extensive ground covered by the presentations. The topical session highlighted a number of key issues, opportunities and challenges regarding the linkages of science and research to stakeholder confidence.

SOME INTERNATIONAL PERSPECTIVES OF LESSONS LEARNED

The topical session provided a forum in which FSC members could explore the relationship of RD&D to stakeholder confidence, reflecting on their own experiences and learning from a rich discussion provided through presentations offering a multiple of perspectives – implementing agencies, regulators, governments, local communities and academia – as well as their own experiences.

This section draws on the FSC presentations and discussion which followed presentations, the stocktaking of Sybille van den hove, and the NEA Secretariat's observations of international experiences and lessons learned.

Throughout the discussion, it emerged that there are very notable differences across jurisdictions in terms of how RD&D has been integrated in radioactive waste management programs. While it is not possible to draw broad generalizations across countries, it is possible to note a number of the themes discussed.

Confirmation of the important linkages of science and research to stakeholder confidence – RD&D -- the nature and robustness of the work which is conducted, the manner in which it is conducted and the effectiveness of its communication -- is acknowledged to be a critical contributor to stakeholder confidence in nuclear waste management approaches. RD&D has a role in both meeting regulatory requirements, and also in seeking broader social understanding and confidence in decisions taken.

Among the factors considered key to building confidence among stakeholders are: demonstration that the system is well understood; explaining the past history of the site; explaining unexpected features or occurrences; ensuring the capacity to observe and note unexpected features; having the capacity to introduce new measurements that can inform the system; deriving scientific validation of theory; maintaining the capacity to be at the frontier of science; and having the ability to answer unexpected questions from any party. Residual areas of uncertainty must be acknowledged, and continuous learning should guide decision-making. *Social sciences* play an important role in establishing the legitimacy of societal, scientific and expert processes, and furthering understanding of social issues that are essential components of integrated risk assessment. Implemented well, science and research programs help to build stakeholder confidence to facilitate and sustain momentum for decisions and implementation.

The essential and distinct role of demonstration – Demonstration is highly valued in offering tangible insight to stakeholders, particularly concerning engineering knowledge. Observations from demonstration projects may, in turn, be a catalyst for further R&D.

> Examples: Effectiveness of CLAB, Äspö Hard Rock Laboratory was noted in building local confidence. Experience of CLIS was discussed.

The need to consider science and research in the broader social context of decision-making – Modern society is demanding greater public participation and incorporation of citizen values in

decision-making. Processes and systems must be in place to connect science with society, to ensure research reflects the public's priorities, visions and concerns. Experts are important actors but do not hold the exclusive right to influence over decision-making – they contribute alongside citizens, regulators, governments and implementers. The scientific community needs to engage and respond to the interrogations raised by citizens since quality of science and expertise will ultimately be assessed against criteria established by society.

Importance of clarifying roles, responsibilities and relationships early in the process - Experience to date highlights the importance of establishing, early in the process, roles and responsibilities of different actors, including their roles in influencing and discussing science and research investigations. Different approaches are adopted across jurisdictions with regard to who are considered to be "experts" in the decision-making process – e.g. can range from regulators, NGO's, implementers or others. However, it is important for both implementers and regulators to retain their own capabilities and competence to themselves be credible in the eyes of stakeholders. Some jurisdictions are adopting the terminology of "specialists" (rather than "experts") to cover the full range of contributors – including civil society, which is increasingly accepted as being "specialist" in its own right.

Inclusion – making space for multi-disciplinary contributions – Society now expects that a broad range of considerations and expertise will be brought to the waste management project, and in an integrated way that bridges and builds accountability across disciplines. Citizens expect holistic decision-making on complex issues to be well informed by specialists from many disciplines and a variety of institutions or sources. The public views decisions as strongest and most trustworthy when informed by many objective sources. Inviting multiple perspectives within a discipline adds further rigor. In this context, social science research is widely acknowledged as having an important role to play alongside technical and scientific investigation. While social science may not be considered as a formal domain of expertise in many institutional designs, it is seen as essential in considering the human dimensions of integrated risk assessments and in guiding the design of sound process and stakeholder involvement.

A more active role for citizens – There are rising demands from the public to be active informed participants with opportunities to influence decisions that affect them. The public is asking implementers to both assist and trust the public's ability to absorb information, understand research processes and follow issues. Guidance in identifying and managing potential socio-economic effects from interests that may potentially be affected, as well as from experts in the field, is essential to providing socio-economic-related insight concerning the area hosting the facility. This guidance is also an important focus for ongoing socio-economic and cultural-related work as implementation proceeds.

Affected communities may exert influence by asking questions, identifying new areas of research, reviewing progress and understanding results. In asking questions, local communities can exert influence directly or indirectly on the research program. This influence can be important in "stretching" the experts from implementing and regulatory institutions, however it necessarily requires the community to invest in capacity-building.

Changing roles for experts – Although a very critical partner in waste management decision making, the time has past when experts can make decisions on behalf of society in this area without its direct involvement. Scientists offer confidence to society about the sound quality of its activities. Moreover, applying rigour in the implementation of scientific projects ensures the reliability and relevance of the proposed suggestions.

However, it is becoming increasingly recognized that research is not value-free: stakeholder confidence requires that researchers declare their interests and expose their value frameworks. Experts are being asked to be more open to dialogue – sharing findings as they emerge, including residual areas of uncertainty and incomplete knowledge. In framing the issues and research questions, experts must be open to listening to citizen concerns, agree to be "stretched" as questions are posed from new angles, ensure their questions are addressed and agree to be open to changes in direction.

It is understood that a broad range of knowledge is required to fully understand the issues. The inclusion of a multiplicity of diverse perspectives helps ensure the entrance of additional information, values and concerns within the project dialogue and debate. Provided early in the process, consideration of this diverse perspective can reduce the risk of mistrust that tends to emerge from overly narrow framing of research programs and questions. The "stretching" of expertise in both process and substance aspects of research, which results from consideration of this diverse perspective, is important in opening up the dialogue and ensuring partnership building.

Sharing of knowledge and reciprocal learning is key for relationship building – Dissemination of research findings and provision for real dialogue about these findings are key to building public confidence -- it is important to avoid sequestered learning. Social trust is enhanced through the broad sharing of knowledge and providing opportunities for all interested stakeholders to ask questions and share perspectives. Processes of collaboration that bring together specialists and communities for two-way conversation and earnest exchange of views can assist in building trust amongst different constituencies. Such processes offer the opportunity for inter-disciplinary aspects of the project to be discussed, and provides bridging opportunities for multiple areas of specialist knowledge and competencies. Effective reciprocal learning requires responsiveness to citizens, so that expertise and specialist information includes areas of interest and inquiries of potentially affected communities. A variety of mechanisms have been employed to encourage expression of a wide range of stakeholder perspectives.

> Examples: In Vandellòs, Spain, reciprocal learning was facilitated by municipalities' active involvement in training, education and participation in international projects (COWAM), a well as through local information committees established to ensure ongoing flow of information to the public.
>
> In Oskarshamn, Sweden, sharing is facilitated through working groups set up by the municipality to follow safety issues and site investigation process.
>
> In Canada, the NWMO study process was driven by societal direction. Through a collaborative process, the NWMO process created an open forum which brought specialists and citizens together - information was widely distributed, findings discussed, multiple perspectives welcomed, and direction on research questions invited. Dialogues were designed, conducted and reported on by third parties to ensure accuracy and transparency.

Importance of capacity-building – In voluntary siting processes, it is important that the local community has the capacity to participate in decision-making in an informed and active manner. Sustained, stable local support also requires a high degree of competence at the local level. It is therefore essential to recognize the potential for the existence of a large knowledge gap, initially, between affected communities and implementers and the importance of community capacity-building to bridge this gap. Experience indicates that *building capacity takes significant periods of time*. Lack of patience and tight implementation schedules can pose significant threats to the maturing of this process. Experience also indicates that participation and influence cannot be forced by education and information; it must unfold on the terms of the public and local decision makers.

In order to support effective participation, it is important to ensure that the citizens and communities impacted by the selection of a site for the management facility are sufficiently resourced and informed to fully participate in discussions and decision-making which affects them. Their participation must be based on an understanding of potential risks and the means to manage them. There must be opportunities for genuine involvement in decision-making concerning the future facility. Communities need to be informed and have the capacity to, should they wish, participate in monitoring as well as decision-making. Experience indicates that effective engagement is based on principles of openness, transparency, integrity and mutual respect, which imply a shared responsibility.

RD&D a key feature embedded in some management approaches – There are a number of ways in which a new relationship between science and society is being recognized and encouraged in waste management programs. Recently, explicit inclusion of RD&D in the implementation plans for management approaches by some implementers and/or authorities are examples of current thinking about how the relationship between science and society might be formalized to facilitate decision-making in to the future. For instance, RD&D is an explicit feature of adaptive/phased management approaches which embody continuous learning. As an explicit part of an implementation plan, RD&D becomes part of the process established to respond to societal expectations for: continuous learning; incorporation of scientific advancement; sequential decision-making informed by most recent international understandings; reduced uncertainty; and flexibility to adjust course, in response to new technology or shifting societal priorities and values. Inclusion of RD&D in this way explicitly lays out a course by which science and society will jointly consider and make the decisions necessary to explore and capitalize on opportunities to improve system design and effectiveness, advance understanding, reduce uncertainties, assure regulatory requirements and respond to societal concerns over the generations required for implementation.

Waste management approaches which include continuous learning as a component, more so than other approaches, require longer term thinking about how the relationship between science and society will evolve over time. Continuous learning demands research and development to help assure focus on areas that warrant attention, and the improvement and adoption of evolving best practices and, should they become available, new technologies. Since program requirements are set not at minimally acceptable performance and regulatory compliance, but at meeting societal expectations to continually improve upon best practices and adapt to unfolding advances in related fields as the program progresses, it is important that mechanisms to identify these societal expectations and factor them into decision-making are established.

Programs involving sequential decision-making can be informed and enriched by new learning from RD&D *provided that* such knowledge, skills and capability are effectively sustained over the long-time horizon associated with implementation. RD&D would ensure that institutions retain the flexibility and capability to adapt to changing circumstances and adjust direction as appropriate. This in turn may help ensure that responsible organizations maintain skills and knowledge required to oversee and manage facilities, and address emerging issues long into the future, thereby sustaining public confidence. Within affected communities, an ongoing process of capacity building and revitalization would be required to retain competence, as individuals involved at the local level change over the years. Vibrant and well-directed research programs would be required to sustain this capacity over time and ensure the availability of well-trained, experienced personnel focused on solving emerging issues throughout the duration of the program. Ongoing collaborative research with local communities can serve to build and maintain important long-term relationships with local stakeholders.

Examples: Provision for retrievability featured in some repository programs to accommodate new learning. Reversibility options ensure renewed interrogation in RWM, and provide flexibility to allow for collective aspirations for continuous learning to be reflected in sound social and technical practices.

In Canada, the societal emphasis placed on continuous learning and R&D as a public good required to inform decisions - now featured in Adaptive Phased Management proposed by Canada's NWMO.

France's Andra underscored the importance of having high-level scientists internal to the implementing organization to ensure momentum and institutional knowledge.

In the U.S., the CNWRA established by the NRC will help to assures long-term continuity of focused support in technical areas, and maintenance of "corporate memory" of the evolution of repository safety and regulatory issues.

Transparency and accountability key to earning trust— Indications are that the public has come to feel that the scientific and technical system is too opaque and expect greater openness and transparency in the sharing of research findings, areas of uncertainty and in decision-making. In this environment, transparency and accountability are key to building and retaining trust. The public wants to know and better understand why decisions are being made, how they are being implemented, and the extent to which standards are being met.

Experience indicates that transparent and accountable reporting needs to include explicit public recognition of the limits to the current state of knowledge, areas of uncertainty and the areas of continued scientific debate. Experience also indicates that scientific openness does not constitute a goal in itself. Rather, its importance lies in its contribution to broadening the public debate, giving rise to new questions, and structuring scientific investigation in accordance with both the standard requirements of the scientific world as well as societal expectations. A transparent and accountable process contributes to building a sense of public trust in that process and greater stakeholder confidence. Quality of research, fairness of process, transparency in values frameworks and interests of participating experts, and willingness to be "stretched" all contribute to stakeholder confidence. It is understood that complex policy issues, such as the long term management of nuclear waste, often involve many challenges – factual issues with uncertainties, values, emotions and vested interests. All of these factors need to be exposed to policy makers and the public before decisions are made.

Examples: The openness of SKB's experts, their willingness to share plans and preliminary results, along with active participation of regulatory experts, has resulted in a solid platform for local participation and influence.

U.S. NRC commitment to reviewing information objectively, making open decisions, running open and fair public process, ensuring availability of documents.

In Canada, throughout its study the NWMO publicly reported on points of convergence between experts and citizens, and the broad diversity of view including debates among experts.

Quality as a condition of credibility – The issue of quality of science and expertise must be considered and built into the research process. Experience indicates it is important to question *how* research is conducted. Applying rigour in execution of science and research enhances relevancy and public acceptance of ultimate decisions taken. In this regard, stakeholder confidence is linked to the

perceived credibility of the scientific community and the role of peer review is essential in establishing the credibility of researchers. Within academic circles, publication in the scientific literature is highly valued. Peer reviews may take many forms, such as written reviews, advisory committees or other screening processes. "Extended peer reviews" open up the peer community to other forms of knowledge to allow debate beyond narrow scientific circles, amongst the public, implementers, regulators and scientists, for mutual questioning and confirmation of the problem definitions, stretching and understanding. Experts must agree to be evaluated in their own right and their mandates and constraints made clear.

> Examples: To enhance the public confidence of its regulatory processes and decisions, the U.S. NRC recognizes the importance of open and fair processes, independence and verification and monitoring. The NRC established the Center for Nuclear Waste Regulatory Analyses (CNWRA) in 1987, employing experts on scientific and technical issues, to assist NRC in making independent judgments about the safety of the nation's first geological repository for high-level radioactive waste.
> Canada's NWMO adopts the practice of peer reviewing its research and using third-party facilitators and reporters for transparency and independence.

Integration of RD&D in ongoing process of dialogue and decision-making – Public demands are likely to continue to increase for real engagement with experts and other stakeholders as decisions are taken. Many of the challenges associated with strengthening linkages between RD&D and stakeholder confidence in the RWM sector are also encountered in other sectors as part of evolving societal expectations more generally. There is a growing body of experience from which lessons can be learned associated with siting large projects in RWM, as well as in other sectors, which offer insights and innovation in bringing together affected organisations and individuals into decision-making processes. As well, through collaborative processes which bring experts and citizens together, experience is being gained with addressing socio-economic and cultural affects to ensure alignment between projects and citizen values and priorities leading to greater stakeholder confidence. Agencies responsible for implementation will need to stay abreast of emerging societal expectations, and look to innovation across sectors for new and evolving approaches and practices in strengthening the relationship between science and society.

> Examples: Models such as VALDOC and RISCOM offer new ways of approaching process, challenging participants to embrace transparency and "stretch", to consider issues from new perspectives.
> In France, Andra has sought to diversify its partnerships on a constant basis.

Shared challenges – National differences exist in terms of the way in which science and RD&D contribute to stakeholder confidence and decision-making, and the way in which roles and responsibilities have been assigned. The balance struck between science driven decision-making and broader societally-directed decision-making, and methods for achieving this balance, are at the heart of achieving stakeholder confidence. The range of approaches used by different waste management programs reflects the historical and cultural context in which a new relationship between science and society is being built in various national contexts.

It is expected that jurisdictions will continue to share a number of interests and challenges as they seek to develop and refine decision-making and implementation processes. Within each country's own societal and cultural context a number of questions will continue to pose challenges:

- How to improve the interaction of science and society, to enhance confidence in RWM decision-making processes?
- How to encourage cross-fertilization of specialist knowledge in informing decisions on RWM?
- How to ensure opportunities for societal direction of RD&D, to enhance confidence in the process?
- How to clearly and effectively communicate scientific findings and uncertainties? And address contradictory views of process participants?
- How to anticipate, and provide for, rising societal expectations for active citizen engagement in design and review of science and research?
- How to encourage further "stretching" of specialists for disclosure of interests, greater transparency, broader dialogue and ensured rigour of research programs?
- How to design and execute effective collaborative processes that engage all affected parties in the broad direction of the consideration of risk and the safety case?
- How to build local capacity and competence for active roles in RD&D and decision-making?

COMPILATION OF PAPERS

AGENDA OF THE TOPICAL SESSION OF THE 6TH MEETING OF THE FSC

12. **THE LINK BETWEEN RD&D AND STAKEHOLDER CONFIDENCE**

Co-Chairs: Y. Le Bars, K. Shaver
Rapporteur: S. van den Hove

12.a Introduction
Y. Le Bars

PART-1: STAKEHOLDER CONFIDENCE VIS-À-VIS THE ROLE OF SCIENCE, SCIENTIFIC INSTITUTIONS, AND EXPERTS IN TODAY'S SOCIETY

12.b Role of, and relation to, science in today's societies, as well the issue of confidence in researchers/institutions.
M. O'Connor

12.c The role and behaviour of the experts (technicians, engineers, researchers) and how to expose the experts' value system in order to gain stakeholder confidence.
K. Andersson

Discussion of Items 12.a, 12.b, 12.c

PART-2: THE ROLE OF RD&D FOR STAKEHOLDER CONFIDENCE AS SEEN BY INSTITUTIONAL ACTORS

12.d An implementer's view of how research and research capability are approached in order to gain stakeholder confidence in the implementer fulfilling its mission
F. Jacq

12.e A regulator's view of how research and research capability are approached in order to gain stakeholder confidence in effective regulation and safety
J. Kotra

12.f A policy maker view of how research and research capability are to be approached in order to have stakeholder confidence in policy and its implementation
C. Létourneau

12.g Discussion of Items 12.d, 12.e, 12.f

PART-3: THE ROLE OF RD&D FOR STAKEHOLDER CONFIDENCE AS SEEN BY NON-INSTITUTIONAL ACTORS

12.h The perspective of a local community
H. Åhagen

12.i The perspective of a mayor
J. Castellnou

12.j The perspective of an academic
G. De Marsily

PART-4: LESSONS TO BE LEARNT

12.k Discussion of Part-3, plus overall discussion, including suggestions for way forward
K. Shaver

12.l Stocktaking from the topical session on the Link Between RD&D and Stakeholder Confidence held at the 6th Meeting of the RWMC held at the 6th meeting of the RWMC forum on stakeholder confidence
S. van den Hove

FORUM OF STAKEHOLDER CONFIDENCE - PHASE II OF PROGRAM OF WORK

Yves LE BARS
IGGREF, France

Extended Aims to Six Major Areas

- The role of RD&D for stakeholder confidence.
- Cultural and organizational changes for credibility of RWM institutions and experts.
- Different actors and stakeholder values, perspectives and needs.
- Involving and interacting with the media.
- Means to help society make decisions through stakeholder involvement.
- Help create a relationship between a community and the local waste facility.

Some key conclusion from the FSC

Stakeholder involvement requires a new culture in the organisation:

- Each actor must respect certain values and abilities; capacity to communicate, to learn form the public and to adapt.
- A need to restore credibility to the voice of experts.

1. The role of the expert has changed:

- After the 2nd World War: shortages and cold war gave the expert the legitimacy to decide: legitimacy given to one.
- Some difficulties, and recognition that alternatives are possible, led to share the "expert" role, with this of the "decision maker": legitimacy given to two.
- But crisis in health and environment, and number of independent actors involved ask for "public policies" defined and implemented through "decision making processes", with stakeholders participation.

  Complexity of issues, complexity of the social system have led to: An interplay among three types of actors.

2. Competence and credibility: Could research play a role?

- Trust in the actors and confidence in the way they manage are rather low in the nuclear field.

  Independent research organistions resist more than others.

3. FSC Programme of Work: The links between research and stakeholders confidence

We suppose research to be part of our "process, structure, behaviour and debate":

- To be introduced in the process, as contributor to the project definition, providing scientific background.
- To be carried out by institutions, with a clear role.
- To adopt an adapted behaviour.

  The thematic session is supposed to investigate contribution and conditions for research to Stakeholder confidence

Research contributions to stakeholders confidence; some questions

Research, certainties and uncertainties:

- Research provides evidences, certainties.
- But in environmental issues, and RW LT management, project managers have to recognize that uncertainties will remain.
- It's one of the research tasks to provide qualified certainties, and to work on uncertainties, accepting doubt.

  Which quality we can expect from research?
  How to implement it in the process?

Research contribution to stakeholders confidence

Research and the project: an organization is needed:

- Project managers have to design and demonstrate.
- Researchers have to investigate, and to work on uncertainties, to expose, to reduce them.
- Each of the two has its own evaluation.

  How to implement a "fine tuning" between project and research?

Research contribution to stakeholders confidence

Researchers, project managers and the debate; a cultural and personal "conversion"

- "Speaking to a journalist, a researcher quite always go out of his field of expertise" (H. Curien).
- Experts and researchers often "fall in love" with their research topic.
- Researchers have to accept, and to demonstrate they accept, not to be the decision maker; values out of sciences are part of the decision.

  How to succeed in these cultural changes?

ROLE OF, AND RELATION TO, SCIENCE IN TODAY'S SOCIETIES, AS WELL THE ISSUE OF CONFIDENCE IN RESEARCHERS/INSTITUTIONS.

Outline based on the presentation of Professor Martin O'Connor

The recent breakdown of the credibility of science and engineering is primarily a social phenomenon. This problem cannot be solved merely by science, but it should also be addressed by social science research. Especially important questions are, for example: What constitutes quality in scientific research? What should be the role of science in, and the contribution of expertise to, decision making processes?

Problems of social acceptance are also pertinent to the radioactive waste problem. However, in the nuclear waste management field there are major differences between investments in technical and social science research. Large efforts need to be made in the latter area, because many aspects of radioactive waste management are *socially constructed.* In general terms, social construction of a risk means that the significance and the acceptability - to an individual, to members of a community, and to a society - of exposure to a dose depends on perceptions about how, by whom and why the dose has been produced. Correspondingly, in order to assess to what extent or on what basis the members of a society will judge acceptable a given strategy for waste management, it is necessary also to consider the *meanings and relationships* that alternative strategies might establish between the people implicated in the waste management process.

The key issue is to build an appropriate relationship between the key components of the waste management process, i.e., the host community, the science community, the waste generators and the policy makers. *Trust* is an important component of this relationship. In general, trust can be characterised as the willingness of a person, group or community, to make itself vulnerable in the hope of a benefit coming from association with others that would not otherwise be forthcoming. Therefore, the building of the trust of stakeholders means building a shared hope[1].

In addition to hopes for shared benefits, another condition of trust is the confidence in the capacity and will of institutional actors to assure the sharing of the benefits. Due to the above mentioned breakdown of the credibility of science and engineering, technocratic approaches (where the locus of making decisions is at science and engineering organisations), or administrative approaches (where decisions are made by policy makers with the aid of technical experts, but without involving other stakeholders), are not appropriate for building up such confidence any more. Chances of building up confidence are improved by a *dialogue* between policy makers, technical experts and other stakeholders.

Participants in a dialogue should recognise that there are many different (and equally legitimate) principles and quality criteria to be considered, the importance of which can be very different for the various stakeholder groups. In policy debates parties should understand and address all principles and

1. It can be stated that one of FSC's objectives is exploring the hopes that can be shared by stakeholders of the RWM problem.

quality criteria that are deemed significant by any of the stakeholder groups, rather than using arguments which relate only to their own principles and criteria. This means *a reciprocal burden of proof,* in contrast to traditional approaches where the burden of proof lies with only one of the parties.

For example, a dialogue can improve the prospects of reaching agreement about satisfactory stewardship strategies for radioactive waste sites. To address this problem, a *multi-stakeholder multi-criteria deliberation process* has been developed, which starts with identifying a set of alternative stewardship strategies (scenarios). This is followed by the definition of the evaluation criteria to be used for comparing the scenarios. To help the development of criteria, six fundamental principles ("ethical bottom lines") have been elaborated (see box)[2]. In the following step, a comparative evaluation of alternative stewardship scenarios takes place. By assigning different weights to the quality criteria, each stakeholder group will bring a different balance of preoccupations to the evaluation process. Also, different stakeholder groups may evaluate the same scenarios in terms of the same quality criteria differently. Where dissent emerges between stakeholders, divergent views and the underlying arguments should be documented. The reasons for dissent (e.g., conflicting interests, differences in knowledge or values) should be discussed in a transparent way, which may lead to an agreement or opens up prospects for novel scenarios.

A set of "ethical bottom lines" (Principles of responsibility) for the radioactivity stewardship domain[3]

PR.1 Have the responsibilities of existing parties been appropriately assigned?

- Application of a principle of national autonomy/responsibility ("take care of your own wastes" at national scale).
- Application of the principle that "the polluter pays".
- Clear expression of, and respect for, local, national and international regulatory conditions.

PR.2 Have responsibilities 'towards other parties' in the short term been adequately addressed?

- Health security to workers and the public on or close to the site.
- Security against attack in the face of external or internal sources of aggression.

PR.3 Have responsibilities 'towards other parties' in the longer term been adequately addressed?

- A "sustainability" principle of inter-generational responsibility (don't pass on problems to others that you cannot cope with yourself).
- A thorough characterisation of risks/uncertainties/future contingencies (with reference to: the dangerous substances, the engineering works, the living environment, and future societal evolutions).
- An application of some version of the principle of precaution.
- Is there likely long term stability of the necessary knowledge base (e.g. transmission of records, specialised know-how, local knowledge) for competent stewardship?

2. It is noteworthy that quality criteria relevant for science constitute only one (PR.4) of these principles.
3. Under each principle, examples for evaluation criteria are provided.

PR. 4 Has available technical know-how and systems science been mobilised?

- Rigorous profiling (in technical, medical and sociological terms) of the exposure risks.
- Standards of best practice (technical reliability, simplicity...).
- Monitoring procedures attentive to the full spectrum of identified risks/uncertainties/future contingencies.

PR. 5 Is the solution economically viable?

- Are the immediate costs of stewardship affordable with the available resources?
- Clear picture of the trade-offs and relationship between clean-up and stewardship.
- Are the solutions cost-effective for the identified risk reduction results?
- Are the major financial costs shifted into the future?
- Reasonable prospects of mobilising resources for the forecast stewardship costs in the longer term?

PR.6 Does the solution enhance the prestige of the host communities and other stakeholder groups closely associated with the residual/waste site?

- Viable partnership between local and national stakeholders (e.g. agreed distribution of responsibilities; legal mandate for stewardship activity; agreement on bases for financing of different cost components, etc.)
- Site specificities clearly in evidence?
- Local competencies clearly in evidence?
- Well defined framework for ongoing involvement of stakeholders in stewardship oversight and review.
- Links to educational and training activities at local and wider scales.

Finally, it needs to be emphasised that, at present, scientific experts are not prepared for the above type of dialogue. In general, they are trained only about the principles and quality criteria of their own profession. It is recommended that their expertise be expanded, for example, developing a capacity for listening to others would be crucial. Understanding the multiplicity of quality considerations and being reciprocal in the burden of proof should become also key components of their expertise. It is also recommended that such expertise should be built in a fundamental way and not as a communication strategy.

THE ROLE AND BEHAVIOUR OF THE EXPERTS AND HOW TO EXPOSE THE EXPERTS' VALUE SYSTEM IN ORDER TO GAIN STAKEHOLDER CONFIDENCE

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In policy issues with a high technological and scientific content it is common that experts set the agendas too narrowly, there is mistrust in expertise and authorities, fragmentation by interest groups and low awareness level in the political system. Often, early narrow framing leads to a decision-making basis not sufficient, or even relevant, for the political decisions, resulting in frustration and inability to solve important societal problems.

A structured framework for awareness building

These deficiencies are recognized to a certain extent by policy makers and more dialogue is proposed both at the highest EU level as well as in many individual countries. In spite of this recognition of the need for citizen participation in general terms, experts and policy makers often show quite another attitude to the role of lay people. The point of departure is still often that new technologies should be "accepted" by the public, and that there are "barriers" against acceptance. Still it is clear that most policy issues with some complexity involve not only factual issues with uncertainties, but also values, emotions and vested interest. All these factors should be exposed to policy makers and the general public before decisions are made.

Current societal structures thus need to be strengthened for the propose of providing a practical framework for decisions with high awareness in highly complex areas. Moreover, the need for more transparency and public participation must be seen within the broad framework of current developments and democratic problems in modern society. The initially promising ideas of participative and deliberative democracy have their limitations with respect to transparency and accountability.

A new approach with a structured framework for awareness building with transparency and participation taking place within the framework of representative democracy has been developed and tested in three example areas. The VALDOC approach contains four principles: 1) A multi-perspective starting point, 2) Stretching capacity, 3) Impartiality and fairness, and 4) Publicity. The concept of "stretching" is a key element in the RISCOM model, which gives structure and a deeper meaning to the concept of "transparency", and what is needed for its realization. The VALDOC approach has a firm theoretical base and it contains practical methods for its implementation.

Applications

The RISCOM Model has emerged as a result of efforts in the area of nuclear waste management to make decision processes for e.g. the selection of sites for final disposal transparent. This is also the

area where the model was first applied when hearings were designed for the Swedish site selection process. However, the model is generally applicable to decision processes on technically complex issues with large benefits but with uncertain and potentially very unfavourable consequences. Now the model is becoming more widely appreciated and also used in other areas.

One current area of application is the introduction of the third generation (3G) of cellular phones which has caused much discussion in Sweden. The time table and the level of ambition in terms of access to the system all over the country was early set at the highest political level. The development of 3G has, however, caused opposition and controversy in a number of municipalities. There are concerns over radiation risks from the masts, which are built with much higher density than for the previous GSM system, although the authorities assure that there are no such risks. Resistance groups have emerged, and there are municipalities wanting to establish zones free from masts. Now industry, authorities, municipalities and critical groups have agreed to form a joint Transparency Forum using the VALDOC approach with the RISCOM Model through an initiative taken by the Swedish Radiation Protection Authority.

Another area of application is contaminated waste landfills and sediments. As the awareness about the existence of waste landfills, contaminated sites and contaminated sediments, and their risks for humans and the environment, has gradually increased world-wide - so has the need for assessing and managing them in the best possible way. The technical complexity and potentially high costs associated with remediation projects require efficient, reasonable and democratic risk reduction policies and strategies. In a recent project the RISCOM Model has been used to diagnose the Swedish national programme for cleaning-up and remediation, and recommendations were made for measures to improve transparency and awareness before decisions are made. As a result, a pilot project is to be launched to support municipalities with in a few selected projects.

Discussion

Crucial aspects of the VALDOC methodology are the authenticity of the approach itself, its identity in awareness and transparency, fairness in process setting and neutral venues for hearings and transparency arenas. The critical issue when it comes to application is who will be trusted to act as the host for the process leading to awareness. Ideally, the process host should be someone with no other interest than the transparency itself and with no other vested interest. If the process host is in fact a stakeholder with its own interest in the outcome, an agreement must be signed with the other participating stakeholders about process format and content. The parties need to look up for manipulation since the RISCOM Model can be a sophisticated instrument if someone wants to misuse it. Finally the process host must also accept to be stretched.

Doubtless, journalistic skills will be needed to stretch stakeholders and interest groups, and to make issues and their value-ladenness transparent in the public domain. However, these skills must be combined with the analytic skills of natural scientists, the contextual understanding of social scientists and the human knowledge of behavioural scientists. Structured ways of cooperation between these groups need to be worked out, and new forms of citizen participation need to be developed, tested and applied to practical problems.

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THE ROLE OF RESEARCH IN THE RADIOACTIVE WASTE MANAGEMENT POLICY

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Nowadays, growing emphasis is made on the essential role of research in developing sound radioactive-waste management policies. Research has constituted a reliable component for a very long time in that field. The reason why research is now making the headlines is less due to the fact that its rightful significance has been finally recognised than to the change operated in the approach. In the past, research was synonym with technical rationality and was expected to provide "the" most efficient solution by the sheer virtue of its intrinsic logic. Broadly speaking, science was entrusted with the responsibility to resolve the issues raised by the presence of radioactive waste. Gradually, however, research certainly appeared as a requirement, but proved insufficient. Moreover, the conduct of research policies also became a theme for debate: how are scientific issues identified? What guarantees exist for scientific openness? How do final programmes on radioactive waste studies meet the requirements for good scientific practice? Are scientific investigations paying sufficient attention to the questions raised by stakeholders?, etc., etc. All those questions succeeded progressively in transforming the scientific policy and practices. In my presentation today, I would like to illustrate that evolution based on Andra's experience in the framework of the French research programme.

The new role of research

The major orientations guiding the research systems of the Western world, particularly up to 1980s, were outlined back during the Second World War. One of the options selected by France was to rely on large specialised research organisations, such as the CEA (Atomic Energy Commission). Obviously, the first investigations on nuclear energy, and later on radioactive waste, were conducted in this framework.

Since the waste issue was entrusted to those organisations and their associated programmes, the work performed remained practically unknown to the non-specialists. Over the years, a small group of engineers and scientists gradually developed a sorting and selection process that materialised in a programme focusing mainly on the disposal of radioactive waste in a deep geological formation. Presented to the public, to politicians and to the larger circle of all stakeholders involved, this solution was not unanimously approved as it had been by the scientific community. Far from it. Hence, the consensus reached behind closed doors in the 1970s was suddenly broken and opened the way to a new approach.

The situation is also linked to the fact that, since the 1980s, the model derived from the Second World War and the Cold War has been drastically destabilised. The strong belief in a scientific and technological revolution as a source of progress has weakened. Lastly, citizens feel that the scientific and technical system is too opaque and they call for more democracy and transparency. All those elements joined together imposed a revision of the post-war systems and an attempt to develop new approaches.

Towards a more open and shared scientific policy

In France, the evolution I just mentioned was reflected in a law adopted by Parliament in December 1991. Among its prescriptions, the Law requires that the waste issue be considered from a new perspective. In other words, it organises the scientific and technical controversy by implementing a research programme based on three different options.

Most of all, it enforces a new model for scientific and technical development. In contrast with the previous rationale based on large organisations, the creation of Andra as a programme organisation, not entrusted with a mission to carry out and to concentrate all investigations within its own structure, but to federate other scientific resources sharing a common objective, constitutes a major innovation.

In practical terms, the Law resulted in a scientific diversification. The mandate of a programme agency is to mobilise those skills when they exist, to create them among the most relevant stakeholders when they are lacking, to organise the scientific debate, as well as to share and compare existing knowledge. It also has to find a balance between scientific investigations and development of a project.

Such an approach gave rise to a new working method based on a new scientific organisation, guaranteeing openness, a finer and more relevant account of the issues at stake by the scientific community, a sharper critical outlook over the entire work, or in brief, some of the specific virtues ascribed to scientific investigations. That comment is valid not only for studies on waste disposal, but also for other research areas.

The main orientations may be briefly summarised as follows:

- First and foremost, considering scientific and technical activities as a useful tool in the development of the waste-management public policy implies two conditions: observing the specific rules of the scientific world and taking seriously the practice of science as it is generally understood at the international scale. The first step consists therefore in formulating a clear-cut scientific policy allowing the scientific community and the various teams concerned to have at hand a non-equivocal definition of its leading orientations or topics. This policy constitutes an indispensable tool to open up the scientific programme and to welcome all the required skills. By its very nature, such an openness is synonym with confrontation, enrichment and cross-fertilisation of knowledge.
- Formulating a policy is the first step, but that would be far from sufficient to attract the scientific community and to mobilise it around a common issue. In order to fulfil that goal during a second step. One must develop specific tools in the form of multiyear partnerships, but also encourage young researchers in order to promote innovative research projects with a view to allow laboratories meet the general objective and to further their own research field. Those principles have become conventional components in the management of any scientific activity, but require a permanent mobilisation and effort. In France, the grouping of nearly 100 university laboratories around Andra's programme is the result of 10 years of patient labour and constitutes one of the major achievements of the Law of 30 December 1991.
- The programme must meet the standard rules governing data acquisition and validation. Scientific openness does not constitute a goal in itself. It aims rather at broadening the debate, sharing and comparing views, giving rise to new questions and structuring the scientific controversy in order to ensure that all possible solutions have been explored. Downstream, the purpose is to certify that any relevant knowledge was actually acquired in accordance with the standard requirements of the scientific world and meets all accepted rules. Hence, the capability to publish the results and the development of international scientific events represent significant indicators. Once again, nothing

is new is that approach, but the endeavour has contributed to the implementation of new practices in a field such as radioactive-waste management. After five years of efforts, the French research programme on waste disposal may be considered to be in line with the international standards as shown by the recent conferences organised by Andra in Reims and Tours.

- Lastly, scientific openness implies also rigour and renewal. Any programme must demonstrate its capability to create and maintain efficient research networks. Those networks must absolutely avoid to rehash the same schemes and to call over and over again upon the same partners who would gradually become regular customers of the agency managing the research programmes. Andra's concern is therefore to diversify its partnerships on a constant basis.

Those elements constitute an essential contribution, but would not be complete without the existence of an array of assessment tools, such as advisory committees, individual experts and peer reviews. In that field, the efforts made since the 1990s in France have started to bear fruit.

The items mentioned above constitute a base in order to guarantee the quality of the investigations under way. This involves two major features:

- Firstly, without being capable entirely on its own to win any form of approval, this approach protects against a certain type of intellectual and scientific short-sightedness. Gone is the time when an expert was still able to impose his decisions or to see his views greeted with unadulterated confidence. Nowadays, by clarifying their own work methods, scientists offer an additional guarantee to the public about the sound quality of their activities. Moreover, applying rigour in the implementation of scientific projects ensures the reliability and relevancy of the proposed suggestions;
- Secondly, the scientific debate helps to envision future scientific and technical development scenarios and allows for hypotheses, once tested, to become precious assets in responding to the interrogations of the public at large.

A rigorous research capable of dealing with stakeholders' interrogations

In the previous section, I emphasised the significance of a rigorous scientific approach capable of explaining to the various stakeholders which tools or mechanisms were used to acquire knowledge. As mentioned earlier, such a concern constitutes a prerequisite for the development of any public policy, but is far from being sufficient. From a no less significant point of view, the selected scientific policy must be able to deal with the interrogations raised by citizens, especially since the objective is not to prescribe a single solution based on the sole weight of an obvious rationale, but rather to instil some kind of hybrid system integrating both social logic and scientific rationality.

The example of reversibility may help to illustrate the nature of the work around the scientific policy relating to waste management, since it pertains typically to the issues raised by the scientific and political debate on waste.

In the 1960s, a repository for radioactive waste was supposed to be as irreversible as possible, by definition. However, citizens found that notion objectionable, because they were confronted with a technical project that scientists guaranteed safe for one million years, although such a long timescale is normally hard to foresee. Moreover, citizens were not offered any alternative solution in order to maintain a certain form of flexibility.

Gradually, public demands converged towards a requirement for reversibility, a general concept that remained quite vague during the initial reflections on the subject. However, the process initiated by the Law of 30 December 1991 formally incorporated reversibility in the research programme.

The first signs appeared in the 1990s when it was suggested to study reversibility, although it seemed difficult to deal with its underlying motivations. In other words, the situation was boiling down to recognising a social need without reflecting in more detail on the appropriate means to materialise it in technical terms.

In fact, paying serious attention to the notion of reversibility also meant recognising that it involved very complex expectations. Consequently, it also implied that the technical stakeholder was responsible for proposing technical options, even if it meant that those options might be rejected or require changes.

From then on, it is easy to show how the situation evolved and oriented research on the geological disposal of radioactive waste. The idea suggested by Andra in response to the reversibility requirement was to propose a stepwise approach consisting of successive reversibility levels within the potential repository.

The ruling principle is to be in a position to react upon the evolution of a potential repository by maintaining the possibility of choices over time. Any transition from one phase of the repository to the next is not permanent and "no page is turned forever". Every decision is based on a rational choice and is taken with full knowledge of the facts, including any changes in the scientific, technical, economic, social and environmental parameters that may be induced by the transition to a new phase of the laboratory.

Nevertheless, there are significant consequences on the type of research to be carried out:

- Any phenomenon occurring in the lifetime of the facility must be very clearly understood;
- Observation and monitoring programmes, as well as corresponding sensors, must be developed;
- Suitable modelling and simulations resources must be available.

In brief, the objective is to change the "reversibility" concept from an empty shell to a research prospect in order to develop in turn a technical proposal for which only the future will tell how it was received, understood or modified.

The various reversibility options for the management of radioactive waste then becomes a means to materialise collective aspirations into a sound social and technical practice. Reversibility renews interrogations on radioactive waste by dealing with the issue from a pragmatic standpoint and by seeking to develop and negotiate the possible conditions for waste management. Reversibility imposes a new research plan that needs to be taken into account. A well thought research policy enables more easily to take those demands into account.

Conclusion

Research has become an essential component in support of public policies for the management of radioactive waste. The objective is not to impose any scientific truth, but to provide all relevant tools in order to introduce the most open and serene approach possible in response to interrogations. Such a goal implies the existence of a formal scientific policy, relying on the best modern management tools and practices in order to guarantee the exemplariness of the implemented methods. Without being a convincing tool per se, the approach should contribute to implement suitable conditions for a sound debate and to develop gradually appropriate solutions that will clarify and recognise the expectations of the various stakeholders.

STAKEHOLDER CONFIDENCE IN EFFECTIVE SAFETY REGULATION – A REGULATOR'S VIEW ON THE ROLE OF INDEPENDENT RESEARCH CAPABILITY

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Outline

- NRC's openness goal.
- Openness in HLW regulation.
- Role of independent scientific and engineering analyses.
- The Center for Nuclear Waste Regulatory Analyses (CNWRA).
- Conclusions.

Openness: Part f NRC's Strategic Plan

Mission:	License and regulate radioactive materials to protect public health and safety, promote security, and protect the environment.
Vision:	Excellence in regulating safe and secure use of radioactive materials for the public good.
Strategic objective:	Realise this vision using regulatory actions that are open, effective, efficient, realistic and timely.

Strategies for Achieving Openness

- Public access to information about risks, safety and licensee performance that is accurate and timely.
- Enhanced awareness of NRC as an independent regulator.
- Fair and timely process for public involvement in NRC's decision-making.
- Early public involvement and tow-way communication to enhance public confidence in NRC's regulatory process.

NRC's Role at Yucca Mountain

- Independent regulator
- Primary mission is to protect public health and safety and the environment

- Must decide whether to authorize U.S. Department of Energy (DOE) to construct the proposed repository.
- If authorization is granted, must assure DOE complies with NRC regulations.

To do so in a way that inspires confidence, NRC must…

- Review all information objectively.
- Make open decisions based on sound, scientific judgments about the facts.
- Maintain an open and fair public process.
- Ensure availability of documents.
- Keep State, Counties, Tribes and public informed.

On what basis will NRC decide?

Any NRC decision on a potential license application for a repository will:

- Be based on NRC staff's comprehensive, independent safety review
- Include a full and fair public hearing that follows formal, well-established rules to ensure, and document, an open, objective decision.

NRC Staff Safety Review

- Review license application.
- Request more information from DOE, if needed.
- Conduct independent confirmatory analyses.
- Document results in a Safety Evaluation Report.

Public Licensing Hearing

If DOE submits a license application …

- Any NRC decision will be based on a full and fair public hearing before an independent panel of judges.
- Hearing will follow formal, well-established rules, and will result in findings of fact and conclusions of law that are based on the record of the proceeding.

Formal Evidentiary Hearing

- DOE has burden of proof.
- State, Counties, Tribes, and other parties must present evidence to support their issues or contentions.
- NRC staff will testify on the basis and conclusions of its independent safety evaluation report.

Openness Challenges at Yucca Mountain

- Highly controversial, licensing decision for a first-of-its-kind facility.
- Safety review will require extensive technical and scientific analyses, evaluation of expert judgment, and long-range modeling assessments of expected repository performance.
- Formal, trial-type proceeding.
- Law provides limited time to decide.

NRC needs Independent Scientific and Engineering Analyses to:

- Develop technical bases for regulations and guidance
- Evaluate adequacy of DOE's safety case for a potential repository at Yucca Mountain.
- Assist preparation of NRC Safety Evaluation Report.
- Provide technical support for NRC testimony during the licensing hearing.
- Develop effective outreach and communication tools.

Confidence in a Regulatory uses of Science and Engineering

- Confidence in NRA's use of science and engineering to formulate realistic regulatory requirements and make sound regulatory judgments depends on:
  - Competence.
  - Independent.
  - Open and fair process.
  - Regulatory outcomes that are subject of verification and monitoring.

Formation of the CNWRA

- NRC established the Center for Nuclear Waste Regulatory Analyses (CNWRA), in 1987, to assist NRC in making independent judgments about the safety of the nation's first geological repository for high-level radioactive waste.
- Creation of the CNWRA resulted from NRC's long-term, strategic preparation for the review of a license application for a potential license application for the proposed HLW repository at Yucca Mountain.
- CNWRA was chartered with clear goals and guidelines consistent with U.S. low governing Federally-Funded Research and Development Corporations.
- NRC sought to create a research and development center to provide expertise that;
  - Is competent- employing recognized experts, scientists and engineers, with in-depth knowledge of the scientific and technical issues related to the potential repository at Yucca Mountain.
  - Is independent of DOE - free from any potential conflict of interest, or the appearance of such conflicts.
  - Assures long-term continuity of focused support in technical areas, and maintenance of "corporate memory" of the evolution of repository safety and regulatory issues.
  - Complements NRC's skill set - avoiding gaps and overlaps in expertise between NRC and CNWRA.

Center for Nuclear Waste Regulatory Analyses

- Supports NRC's regulatory mission with expertise, computers, laboratories, and field research.
- 66 technical and 20 support staff members.
- Part of Southwest Research Institute (SWRI), San Antonio, Texas.
- SWRI is an independent, nonprofit, applied engineering and physical sciences research and development organisation.
- SWRI occupies, 1,200 acres, with ~2,000,000 ft^2 of laboratories, test facilities, workshops, and offices for more than 2,900 employees.

Roles and Responsibilities of CNWRA

- Research and technical assistance.
- Technical bases for regulations and guidance.
- Assist review of license application.
- Hearing support of NRC staff.
- Support NRC outreach and communications.

CNWRA Technical Expertise

- Hydrology/Climatology
- Material Sciences
- Mechanical Engineering
- Geochemistry/Radiochemistry
- Rock Mechanics
- Mining Engineering
- Structural Geology
- Health Physics
- Nuclear Engineering
- Volcanology
- Computer Sciences
- Performance Assessment

Joint NRC and CNWRA Analyses

- Comprehensive understanding of repository system.
- Independent performance assessment model and codes.
- Evaluation of technical uncertainties.
- Risk significance of repository safety issues.
- Documented bases for regulatory decisions.

CNWRA provides a wide range of independent technical support to NRC

- Technical experts.
- Computer Modeling.

- Laboratory investigation.
- Field studies.
- Safety Assessment.

NRC relies on CNWRA for broad technical support

- Primary area of support is to NRC's high-level waste repository safety program.
- CNWRA also performs scientific and engineering analyses for other NRC regulatory application.
  - Uranium mining and mill tailings.
  - Waste reprocessing.
  - Site decommissioning.
  - Spent fuel storage.
- Examples; Aircraft crash probability.
  - Issues of contention in hearing for an interim storage facility.
  - Independent CNWRA analyses used to support NRC testimony.

Technical Support for Public Outreach

- CNWRA experts support NRC public meetings, open houses and conference exhibits
- Help NRC staff identify key technical concepts and defining science-based messages.
- Aid NRC in translating key messages into plain language.
- CNWRA and NRC Staff strive to publish research findings and limitations in plain language.
- CNWRA is working to develop physical models, computer visualization, and animations to illustrate regulatory requirements for repository performance.

Conclusions

- NRC is committed to regulatory openness.
- Independent research and development is necessary to support NRC regulatory actions and decisions regarding a proposed HLW repository at Yucca Mountain.
- NRC established the CNWRA as a conflict-free body of experts to support NRC's HLW regulatory programme.
- NRC's reliance on independent expertise conveys to stakeholders that NRC is able to challenge DOE's assumptions, and assertions and arrive at objective conclusions about the safety of the potential repository.

GOVERNMENT POLICY, RESEARCH AND STAKEHOLDER CONFIDENCE

- Current Trends in Canada -

Carmel LETOURNEAU
Natural Resources Canada

An issue which has been recently expressed by the public in Canada is whether there is a need to carry out more research into methods of long-term management of nuclear fuel waste. Public comments on this issue were formally reported on May 25, 2005, when the Nuclear Waste Management Organization (NWMO), an organization set up by the nuclear industry, published its draft Study of options for the long-term management of nuclear fuel waste. The NWMO will continue to consult with the public and all other interested parties on the draft Study so that it may take further views into account during the development of the final Study to be submitted to the federal Minister of Natural Resources by November 15, 2005 as required under the *Nuclear Fuel Waste Act*. Of note for this paper, at issue is whether further research is needed and if so who would carry it out and fund it.

Why carry out research?

In the draft Study, the NWMO makes the case that, while current waste management technologies are deemed to be safe, there are many reasons to carry out further research. The Box below reports the reasoning of the NWMO in this regard.

THE CASE FOR MORE RESEARCH AS ARGUED BY
THE NUCLEAR WASTE MANAGEMENT ORGANIZATION

Regardless of the approach taken, activities to manage radioactive waste will continue for a very long time. Any management program could be expected to apply the best practice available at the time. There is confidence in present best practices for safely handling the waste and that such waste can be properly managed in the future. However, a program that will evolve over a long period of time will have many opportunities for improvements to increase performance, enhance effectiveness, and address rising societal concerns. To realize these benefits, there needs to be a vibrant and robust research and development effort during management program development and execution, a period that will last many generations.

Therefore there are many reasons to pursue research:

1. to embody the principles of continuous learning which encourages standards of excellence and integrity;
2. to prepare for facility siting, design, licensing, development, and operations to improve designs, minimize costs, enhance schedules, and reduce uncertainties;

3. to assure adequate human capacity to manage the program throughout its existence to maintain competence and credibility;
4. to enhance scientific understanding to improve confidence in predictions and to evaluate potential program improvements;
5. to confirm performance or identify anomalies during and after program operations and thereby increase confidence;
6. to clearly demonstrate to citizens an ongoing capability to manage the enterprise and to respond to their concerns and desires;
7. to be able to enact mid-course corrections in response to new information or societal decisions by adapting to new designs, new regional, national or international institutional changes, or new international standards;
8. to be able to adapt to new capabilities developed externally to the program that show promise of improving program success.

The reasons given by the NWMO are all compassing and respond to either private and public interests, to either technical considerations or stakeholder confidence.

Who is responsible for carrying out and funding research?

Government policies on research either deal with providing funds to conduct research or directing others to carry out necessary research. In this case, the NWMO indicate that the responsibility, financial or otherwise for carrying out additional research, resides with the nuclear industry. It is clear that the proponent intends to be responsible for the research it deems necessary. The Government of Canada has yet no immediate plans to direct the NWMO in its research undertakings.

Where it is less clear that the proponent should shoulder the entire responsibility for research programs, the Government may decide to step in and assist the proponent or the general industry in question. The relationship between research and Government policy focuses on the public good and always aspires to public confidence. It cannot focus only on ideas and technologies with commercial potential. Its top priority must retain the public interest of present and future generations of Canadians. The Government is interested in supporting research which responds to public priorities of the day: within recent years, those priorities were usually related to sustainable development activities.

The Government has clearly indicated that the responsibility for providing sound scientific data for proposed practices rests with the proponent who is taking an action associated with the risk of potential serious harm. Nevertheless, responsibility for research can shift as knowledge grows, and roles of the public and private sectors evolve.

The Government can either act as a contractor or as the performer of research, independently or in association with other partners. The research may involve revenue generation over the short-term with specific clients or lead over the long term to non revenue-generating results for the public good with no specific client targeted. The latter reflects the majority of government research. Considering the limited amount of funds from taxpayers and the many demands, considerable amount of time and effort is spent in setting research priorities which moreover may vary over time. Increasingly within the last few years, the setting of research priorities now involves more intensive and extensive public consultations.

In setting priorities, not only thematic public priorities are to be considered but the function to be supported by research needs to be considered. These functions include:

- to provide and disseminate information;
- to support laws and regulations;
- to promote competitiveness of the private sector;
- to assist international cooperation on global issues;
- to carry out basic research without obvious short-term gains;
- to conduct national monitoring and data and inventory base management;
- to carry out pre-competitive research and development;
- to assist in new technology deployment;
- to support the mandate of government departments; and,
- to support universities, and other educational establishments.

Research, the Precautionary Approach and Stakeholder Confidence

Since the early 1990s, one important factor in setting priorities in science and technology research and development has been the precautionary principle**.**

Precautionary decision-making is in keeping with Canadians social, environmental and economic values and priorities. The challenge for governments is to balance its ability to practice good governance with the various views of the precautionary principle expressed by a wide-section of Canadians.

Although the principle has now been adopted nationally and internationally, it is sometimes misinterpreted into as a "prevention principle". Nevertheless, as developed, the application of "precaution", the "precautionary principle", the "precautionary approach", also recognizes that the absence of full scientific uncertainty shall not be used as a reason for postponing decisions where there is a risk of serious or irreversible harm. The application of precaution is distinctive within science-based risk management and is characterized by four basic tenets: the need for a decision, a risk of serious or irreversible harm, a lack of full scientific certainty and, cost-effectiveness.

The need for a decision

Living in a society implies carrying out communal activities which all have some degree of risk. In making decisions, in order to proceed with practices that may involve some risks and where the extent of these risks cannot either be accurately determined or countered with absolute scientific uncertainty, the need for the practice needs first to be clearly justified in a transparent way. The application of precaution here entails a clear and credible explanation why a certain practice needs to be carried out now. Would postponing a decision to carry out more research be prudent, not necessary or dangerous? Should the decision and actions be taken by this generation and should they be postponed to future ones? In any democratic society, the answers to these questions may vary between groups of citizens and it will be up to governments to develop fair decision-making processes ultimately culminating in fully justified decisions made in the best interests of all citizens.

A risk of serious or irreversible harm

The application of precaution by governments is guided by society's chosen level of protection against risk. The Government must analyze and understand the public's tolerance of risks based on knowledge and values. Scientific data relevant to the risk must conclude on the possibility of the occurrence of the harm and the magnitude of that harm, including the extent of possible damage, persistency, reversibility, reversibility and delayed effects. Reports should summarize the existing state of knowledge, provide scientific views on the reliability of the assessment, and address remaining uncertainties and areas for further scientific research and monitoring.

A lack of full scientific certainty

Governments can rarely act on the basis of full scientific certainty and cannot guarantee zero risk. It is neither justifiable to postpone a pressing decision in order to achieve full scientific uncertainty, nor prevent a practice because there is no full scientific certainty. Faced with a lack of full scientific certainty where a decision needs to be taken and where risks are tolerable, there are nevertheless measures that governments can take to increase confidence in their decisions. The application of precaution would include: the establishment of advisory bodies, ongoing public consultations, funding additional research to reduce uncertainties if resources permit, national or international peer reviews of components leading to the decision, including adaptive flexibility to decisions or orders, third-party monitoring of risks from the practice carried out after the decision, reporting requirements, and encouraging international information exchanges.

Cost-effectiveness

As science evolves, it is inherently appropriate that the cost-effectiveness of decisions and associated measures be assessed on an ongoing basis, i.e. taken into account initially, in the mid, and possibly the long term. For some issues, a net benefit may not be realized for a long period of time. However, the emphasis should always be on ensuring that ongoing costs are assessed and minimized so that new scientific data which alter cost-effectiveness considerations can be incorporated (including performance monitoring results) while maintaining the reduction of risks and, where appropriate, maximizing the benefits (e.g. from innovation).

Conclusion

- A fundamental government policy is that the proponent has the primary responsibility for research, as mandated by governments if necessary. This is the basic premise unless special circumstances put governments in a better position to carry out the required research;

- Under such special circumstances, the trend is to carry out more intensive and extensive consultations with the public on research initiatives;

- When considering public views, governments will need to balance their ability to practice good governance with the thoughtful application of precaution;

- This approach should lead to increasing public confidence in RWM decisions based on sound R&D.

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THE ROLE OF RD&D FOR STAKEHOLDER CONFIDENCE AS SEEN BY NON-INSTITUTIONAL ACTORS

The Perspective of a Municipality

Harald Åhagen,
Municipality of Oskarshamn, Sweden

Introduction

Stakeholder confidence is difficult to define. There are no criteria for when stakeholder confidence has been reached and it is difficult to measure a level of confidence e.g. in opinion polls. Implicit in the institutional look at stakeholder confidence is a stage where the proposed project – in this forum a repository – is accepted. The theory is that initially concerned stakeholders have reached confidence and with confidence comes acceptance. There are however examples where this acceptance or confidence has not been reached. It seems in some cases that it may not be a viable goal to be reached. A waste disposal is in general terms defined very different by e.g. an implementer – who has the task to find a solution and a site where this solution can be realised. If this task can not be solved there is a level of failure. For a local community – where a majority may well agree to that the problem should be solved - the decision-makers and the public may disagree that a repository should be sited in their community. They may see a stopped repository as a victory. I argue that this is not just to be discarded as a NIMBY syndrome. It may from a local perspective be completely logical and based on sensible arguments such as for example incompatible image, lack of trust in the safety case, diverging values or some other reasons.

I see two components that are key to local stakeholder confidence summarised in the term – *Informed Consent*. To reach an informed consent there is first a need for competence building – to get informed. To judge the repository the public and the local decision makers must first understand what they are to judge. Here lies the first challenge in repository siting – building true competence takes a long time and it must be done on the terms of the public and the local decision makers. It is not something that in my mind can be done by forced information or education it requires participation and influence. Lack of patience and tight schedules by the implementor is the largest threat for this process to mature. The second challenge - an informed public and decision makers does not automatically give their consent. There are true local issues that may not be resolvable. One example is the incompatible images of "Europe's last wilderness" with a radioactive waste repository - as was found to be two incompatible images by many in the municipality of Storuman in Sweden. Storuman has wildlife tourism as a large part of the local economy. In the Storuman case the rejection has little to do with what the local public and local decision makers believe it is more related to how the outside world will view a repository in this wilderness. For Oskarshamn - an industrial municipality already with a nuclear power plants there is no such image dilemma.

To reach the situation of an informed consent depends on many factors and RD&D is certainly one of the key factors. I will elaborate on some of the aspects of the RD&D efforts from a local perspective. I treat R&D separate from demonstration as I think they play quite different roles in local confidence building.

RD&D – Safety and Site Selection

Research & Development R&D was historically not something the general public could easily relate to. As higher education and R&D plays a much larger role in almost all aspects of our modern western society there is generally a much better understanding spread among the public what R&D constitutes. I actually feel that there is a far better understanding then most experts seem to be aware of. People are generally aware of the quality aspects of R&D, the system for publication and review and also the scientific dialogue about what facts are and what are not. The public is also aware about that facts change over time, that scientists have different opinions about the same matter and that this is nothing particular just for nuclear waste. Nuclear waste experts and managers however often seem to believe that nuclear waste is a special case. 3G and GM food debates are examples where R&D issues are in focus in the debate and where experts draw completely different conclusions on the same research results.

In repository siting the paramount issue is safety. R&D is there to demonstrate safety. R&D together with parameters from site investigations form the basic safety case but evaluation is also based on assumptions and value judgements – something I hope Kjell Andersson will talk about at this FSC meeting

A local view on uncertainty, indeterminacy, ambiguity and ignorance

In the expert world and in particular in the waste managers world there is a clear vision of a technically solved problem. R&D and safety assessments over decades have proven to this community that there is a safe and viable solution. This solution however requires access to a site – a site that people live on and around. People that has not taken any part in the decades of R&D as it has not been any of their concern. This site is located in e.g. a municipality with autonomy of some kind. Sometimes this autonomy has a strong legal base with a local veto sometimes not. By looking at the experience in Finland and Sweden the access to a local veto seem to be an important aspect of local acceptance. There is no risk for local decision makers to engage in a siting effort with a local veto. In Oskarshamn this local power has been used to engage in the competence building and make sure that there is an informed consent to participation in the site investigations and in becoming a possible host municipality for a repository.

A repository siting effort is an undertaking that takes a decade or more. Local participation in a siting effort requires long term public support. In the case of Oskarshamn there is an opinion among the local politicians that a qualified majority of the public need to agree with the site investigations. Such a stable local support can probably only be reached if there is a large degree of competence about the repository project. Initially the contacts between the implementor and the local community is very fragile. The implementor has a safe solution that he has worked on for decades but for the local community this is a completely new project and the local community has the right to be sceptical and to take the time to find out, from various sources, if they can be comfortable with the project.

Local demands on the technical community

Modern open siting efforts where local participation and influence are components puts new demands both on the citizen – to engage, to build up competence and to offer questions and advice to the experts. Dialogue, participation and local influence also puts new demands on the experts to share also uncertainties and decision power. Experts are not only required to have communicative skills they are also requested to talk about their work before they have final answers and present plans in a draft form. In order to allow for local influence the dialogue must start before the solutions are set, drawings

are made and results are final. This engagement with people before the expert has a solution to present has for many experts been difficult. One category experts - the regulators are seen by decision makers and the public as the "peoples experts". The role of the regulator has been of fundamental importance in Oskarshamn. In the initial stage SKI and SSI where reluctant to participate in the siting programme a position that was not accepted by the municipality. Currently the party roles are well defined and working practices for the participation of the regulatory experts work well.

The openness by SKBs experts, their willingness to share plans and preliminary results, and the active participation by the regulatory experts has resulted in a solid platform for local participation and influence over the work. This working model is probably one of the key explanations to that the public in Oskarshamn increasingly supports the site investigations for the spent fuel repository – currently this support around 80% as measured by opinion polls this April.

The role of demonstration

Demonstration, prototyping and large scale experiments has several purposes but I like to focus on the role of demonstration in communicating waste repository solutions to the public and decision makers. Complicated analysis, laboratory experiments and complex mathematical models are things difficult to make transparent to the public, many small pieces in a large scientific puzzle is only interesting to a few. Demonstration has thus turned out to be more effective to explain to the public how a repository is intended to work and how this practically is designed. Demonstrating the technology and the barrier functions in large scale tests, eg such as disposal prototype tests, has proven to be very effective to make the public understand the basic concept of a repository and how it is intended to function to isolate the waste from the biosphere.

The fact that Oskarshamn is hosting CLAB, the Äspö Hard Rock Laboratory and the Encapsulation Laboratory plays a significant role in the competence building and in building acceptance. I would argue that the value of the two laboratories - locally and nationally - by itself is justifying the investment in these facilities.

Local influence on RD&D

Who determines R&D needs? Who judges when there is enough R&D? Who determines acceptable uncertainties?

From our work in Oskarshamn a clear definition of party roles has been fundamental to the process. SKB – the industry, responsible according to the law to develop, investigate and propose a final disposal (a final disposal is determined as the national solution in the Nuclear Act in Sweden). The regulators – SKI and SSI are assigned to set standards and criteria for the repository, to review SKBs programme and to advice the municipality on the quality, the soundness of the work and the validity of the results. Later SKI and SSI will review the license application and determine if it proves the safety case and the suitability of the site. The government is setting national policy, gives general direction to the programme and takes the final political decision on approval or disapproval of the license application. The municipality will have to live with the facility for generations if located there and needs to give their informed consent. The municipality and its citizens also know the local conditions best and how they would like to form their future. The municipality can veto the repository.

To say yes or no to a repository is first and foremost based on if it is proven to be safe. After safety comes many issues on non nuclear environmental impacts, societal issues and socio-economical issues. It is not only the natural science areas that require R&D and investigations. A final repository

is a large industrial establishment, it will be a large workplace, it will have effects on the local image, it requires various goods and services and it will be around for longer time than any other industry.

Siting of a repository includes many aspects where R&D is required or requested. Repository R&D traditionally referred to as R&D in natural sciences and for the safety case this is also the fundamental work required. The local influence on this R&D in Oskarshamn can be described as aggressive competence building through questioning (or stretching according to the RISCOM model) of SKBs, SKIs and SSIs experts. If we get clear, convincing and understandable answers we are mostly satisfied if not we continue to ask. If we find that SKB on one hand and SKI and SSI on the other hand disagree on the answers we identify this as an issue to follow up, we try to learn more and we try to understand why there are different opinions. It is not the role of the municipality to decide on R&D in natural sciences this is mainly the task of SKB and the regulators. Through our identification of questions, competence building and continuos follow up on identified issues we certainly influence the R&D but in a secondary way. Through our international contacts we have seen examples of more direct local activities in R&D and investigations e.g. the boreholes drilled by Nye County in Nevada - we don't find such activities compatible with our party role.

Other R&D related to other environmental issues for the EIA, on social aspects and socio economical aspects the municipality wants to have a more direct influence in identifying the need for R&D and investigations, to follow the R&D progress and to understand the results in more detail. This is also how the site investigation phase is organised in Oskarshamn. Examples on this working method can be seen in the work of the safety group that mainly follows the work by SKB, SKI and SSI in contrast to the social science R&D where the assigned local working groups participate in developing the plans, follows actively each project through delegations and review draft reports for possible clarifications and complementary R&D. In the social science areas the local influence is more direct and more fundamental and this is motivated by that in these areas the municipality has direct competence about what is required in order to form basis for decision making should the application come to Oskarshamn.

R+D Vs CONFIANCE EN UN TERRITOIRE PRODUCTEUR D'ÉNERGIE NUCLÉAIRE

Josep CASTELLNOU BARCELÓ
Maire de Vandellòs et l'Hospitalet de l'Infant

La municipalité

- Municipalité agricole.
- Tourisme naissant.

Changement économique
- Disparition système agricole.
- Consolidation du secteur industriel énergétique.
- Cohabitation secteur Touristique et de services.

Chronogramme I

- Année 1965 - Début construction central nucléaire Vandellòs I (HIFRENSA).
- Année 1970 - Mise en service CNVI.
- Année 1975 - Début construction centrale nucléaire Vandellòs II.
- Année 198 - Mise en service CNVII.
- Année 1989-1990 - Incident à CNVI et fermeture.
- Année 1997 - Début désassemblage.

Chronogramme II

- Année 2002 - Proposition d'installation ITER
- Année 2002 - Début démarches construction Centrale de Cycle combiné.
- Année 2004 - Centre Technologique Mestral.

Monde Local

- Piliers de base pour la confiance :
  - Sécurité. Bien non négociable.
  - Information. Facteur nécessaire.
  - Développement économique.
  - Garantie de futur.

R+D en Information

- Générer confiance à travers une correcte perception de la sécurité.
- Activités formatives destinées aux élus et aux citoyens (stakeholder).
- Experts de support pour activités et politique local.

Expériences ; R+D en Information

- Formation en énergie nucléaire
  - Séminaires et visites techniques. (Population, élus et autres représentants locaux.
  - Participation à des programmes européens (COWAM). Connaissances d'expériences internationales.
  - Création de Commissions locales d'information. Outil pour l'information et participation publique.

Commission de Suivi Municipal Désassemblage CNVI

Membres :

- Mairies : Vandellòs et l'Hospitalet de l'Infant, Pratdip, Montroig del Camp ; L'Ametlla de Mar y Tivissa (9 personnes).
- Conseil Comarcal du Baix Camp (1 personne).
- Délégation Territoriale d'Industrie (1 personne).
- Délégation Territoriale de l'Environnement (1 personne).
- Univeristé Rovira i Virgili (1 personne).
- Directeur du désassemblage de la CN (1 personne).
- Directeur Technique de la CN (1 personne).
- Secrétaire.

Commission de Suivi Municipal Désassemblage CNVI

Thèmes :

- Suivi des travaux.
- Personnel engagé.
- Contrôle de matériels.
- Gestion de résidus conventionnels et radioactifs ou contaminés.
- Effluents (liquides et gazeux).
- Sécurité (liquides et gazeux).
- Vigilance (radiologique et environnemental : poussières, bruit).
- Incidences.
- Respect des conditions.

Commission de Suivi Municipal Désassemblage CNVI

Information publique :

- Réunions informatives générales.
- Centre d'information ; Unité mobile dans les propres installations de la CN.
- Magazine municipal ; information périodique à la population sur le désassemblage.
- Station émettrice municipale.
- Un ou deux rendez-vous annuels avec la presse locale et de l'état.

R+D en Développement et Futur

- Formation professionnelle et technique.
- Lien avec les universités.
- Promotion de la culture des entreprises.
- Investissement en R+D énergétique sur le territoire.
- R+D = + Valeur ajoutée.
- R+D = Consolidation activité économique.

Expériences : R+D en Développement et Futur

- Syndicat de communes de municipalités limitrophes. Promotion économie sociale.
- Zone industrielle. Diversification économique.
  - Inauguration 1995 ; 99% lotissements vendus et 40 entreprises situées.
- Pépinière d'entreprises. Promotion culture de entreprises.

Le R+D en thèmes sociaux entraînera la confiance de nos voisins.

THE LINK BETWEEN RESEARCH, DEVELOPMENT AND DEMONSTRATION AND STAKEHOLDER CONFIDENCE: THE PERSPECTIVE OF AN ACADEMIC

Ghislain de MARSILY
University Paris VI & French Academy of Sciences, France

In this paper, we will examine the potential role of science (as seen by an academic) for nuclear waste disposal projects, for the stage of site selection, site reconnaissance, and implementation, by the use of research, development and demonstration operations (RD&D) and how they may influence the stakeholders' confidence.

Science plays an obvious role

The *obvious* role of science in nuclear waste disposal projects can be seen as:

- Use of science and R&D to try to understand the physical system and its behaviour, both in space and through time (past and future).
- Design experiments to display the physical-chemical-biological processes at hand, both now and after waste emplacement.
- Measure the relevant parameters.
- Assess the residual uncertainty in both conceptual model and parameter values.

To convince stakeholders, its is necessary to show that the system is well understood:

- Explain the past geologic history of a site.
- Explain unexpected features (e.g. seismic anomalies, abnormal pressures,…).
- Show the capacity to observe and notice unexpected features.
- Show the capacity to imagine new measurements that can learn something on the system.
- Derive an experiment to scientifically validate a theory.
- Show the capacity to be at the frontier of science.
- Show the capacity to answer unexpected questions from any party.

Some particular examples may be brought here to illustrate the relevance of the above desired actions. During a briefing previous to the visit of the Bure site in clay (France), the public was informed that the clay layer was almost "completely impervious", which in many cases was mistakenly interpreted as implying the "absence of water", with the subsequent surprise when visiting the underground facility. The physical explanation of why there is so much water in the clay (porosity of about 10%), but that this water has a very low mobility requires explanations, and scientific evidence that this water is non-mobile (e.g. with water molecule isotopes).

Another example of unexpected results was the ^{36}Cl measurements at Yucca Mountain. At the time of the measurements, the current theory was that the water in the volcanic tuff was almost immobile. Therefore the ^{36}Cl tracer (coming form the atmospheric bomb tests in the Nevada Test Site in the 1950's) should not be present at depth. But some scientist of the National Labs decided to sample the water in the unsaturated zone and to measure ^{36}Cl. And there it was ! This example shows that allowing scientists to perform experiments that are initially considered as unjustified, just to test hypotheses, or invalidate the current model, is of major importance to understand the system and gain confidence. The same happened concerning migration of Pu in the aquifers, from the underground nuclear tests in the Nevada test site.

A third example at the WIPP site concerns the mechanical behaviour of salt. Initially, the R&D programme very ambitiously decided that the mechanical parameters characterizing the behaviour of salt would be measured from core samples, and then the prediction of the mechanical evolution of the *in situ* excavations would be made before construction by modelling, and then compared with the observations. If the two matched, this would have been a strong demonstration of understanding and of being able to predict. In practice, this was too ambitious, and the match was not perfect, inducing the revision of the mechanical model. But the scientific merit of this protocol in terms of confidence building remains clear.

In summary, for science to perform successfully its fundamental understanding role, two actions are called for:

- The continuous exercise in-the-field of the scientific enquiry process, notably of the capacity for observing and noticing unexpected features and validating theoretical predictions.
- To increase the awareness of the scientific community towards the special nature of the societal decision to be taken, and the level of information and questioning required by the public.

Role of the academic circle in the R&D programmes

In the above, the role of science was emphasized independently of the positions of the scientists involved. Let us now consider the potential role of the academic circle (universities, independent research organisations …) to address the credibility issue. This role can be:

- Increase the credibility of the outcome of R&D first to the rest of the scientific community, and then to the stakeholders, by independently validating the scientific quality of the work performed by the implementer.
- Increase the credibility by acting as peer reviewers, e.g. through publications in the scientific literature by the scientists of the implementers, in the Journal having the highest possible impact.
- Increase the credibility within the implementers-regulators own institutions by helping them attract and keep high calibre scientists, and have them do good work.
- Be the source of interesting problems suitable for training brilliant young Ph.D. students.

With this pre-requisite of acceptance by the scientific community, the credibility by the stakeholders may be addressed, although it is by no means granted. A particular note concerns the need for regulators to carry out a scientific exercise of the same scientific quality than the implementers. Both types of organizations need to attract and maintain the best scientific personnel and the latter cannot be achieved without challenging research and development programmes. They thus need to maintain strong links with the academic circle.

Why should science also develop somehow independently of the project?

Developing a nuclear waste repository project should also include a scientific component that is neither necessarily directly applicable nor useful to the project. Reasons for this can be:

- Potential benefit of R&D to scientific knowledge in general; for instance, if a project is abandoned before its conclusion, for any reason, the only benefit left to society will be the increase in scientific knowledge.
- Purely scientific R&D activity can also be recommended when a project is put on hold, pending political decisions; rather than having the staff kept without prescribed goals, the time may be better spent pursuing scientific objectives.
- Pure scientific R&D activity can also be pursued for the benefit of the convincing power of enthusiasm.
- Pure scientific R&D can be a valid objective, with waste disposal as a means to finance pure research; society is ready to finance research with no direct application, such as astronomy, or archaeology, etc. Why would fundamental research not be financed partly with funds dedicated to an applied objective? In France, for example, there is a small percentage of the costs of building a construction (road, building, train track, …) which should be made available for archaeological research, if initial findings justify it.

Demonstration phases may feedback into R&D (and science)

Demonstration phases are primarily a requirement to show the practical feasibility of a project (e.g. waste emplacement techniques, reversibility…) and will satisfy stakeholders as a part of the credibility (e.g. in France, the reversibility issue is not considered credible by the public, and only a trick to make the project more acceptable; a demonstration would possibly change this). Although demonstration may feedback to R&D programmes by showing unexpected difficulties or features (and inevitably they will), they are more likely to contribute to engineering knowledge.

Conclusion

The above discussion only relates to “hard” sciences. However, social sciences are also concerned by issues of decision making, discussion, acceptance or rejection, with stakeholders and the public. These should not be considered as applied research on the best means to make a given project acceptable, but also as pure research on major societal decision making and governance.

The direct involvement of the physical scientists on the discussion with the stakeholders and the public is also an important issue.

STOCKTAKING FROM THE TOPICAL SESSION STOCKTAKING ON THE LINK BETWEEN RD&D AND STAKEHOLDER CONFIDENCE HELD AT THE 6TH MEETING OF THE RWMC FORUM ON STAKEHOLDER CONFIDENCE

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Introduction

The topical session on "The Link between R&D and Stakeholder Confidence" held on the occasion of the 6th Meeting of the RWMC Forum on Stakeholder Confidence addressed the roles of science, scientific institutions and experts in waste management and decision-making. The topical session focussed more specifically on the relation to stakeholder confidence.

The aim of the present text is not to provide a summary of the discussions held; rather, it extracts some of the key issues and ideas that emerged from the presentations and subsequent discussions, and proposes some background and framing elements or references.

Interface between science, policy and society

One can distinguish three models for the relation between scientific knowledge and political practice (Habermas 1971 [1968]). In the decisionistic model of Max Weber, technical (scientific) knowledge is present but the political choice based on values and beliefs is prevalent. In the technocratic model, this dependency between knowledge and politics is inverted and political practice is relegated to the role of executive arm of a scientific intelligentsia. Optimal solutions emerge from science and political choice becomes fictive. The pragmatic model recognises that there is an interdependence between values and facts: "For there is obviously an interdependence between values that proceed from interest situations and techniques that can be utilised for the satisfaction of value-oriented needs." (ibid.: 66) In this model, "the strict separation between the functions of the expert and the politician is replaced by a critical inter-relation." (ibid.: 66) This inter-relation can be understood as an interface between science and policy. In today's policy and societal processes addressing high risk, complex, uncertain and irreversible issues this interface tends to be opened-up to other actors, namely stakeholders and the public, which defines a wider interface between science and society. (Guimaraes Pereira *et al*., forthcoming)

Nature and role(s) of science

The role of science hit as an important element in the discussions. Sometimes decision processes are operating based on a misconception of the role of science. Science does not provide truth, science (by definition) deals with incomplete explanations of the world. Uncertainty and ignorance are parts of science but, notwithstanding, much too often when dealing with high risk, high uncertainty and

irreversible issues, we still make decisions and operate as if science was (or would soon be) bringing the "absolute truth" or something relatively close to it.

Science has multiple roles and the scientific endeavour multiple drivers. Some science is driven mainly by our curiosity to understand and explain the world around us and ourselves, it is curiosity-driven or fundamental science, while other is issue-driven as its primary objective is to solve a societal problem, it is science oriented towards action. (Funtowicz and Ravetz 1993) Obviously, these are not absolute categories. Clearly, the science at play in radioactive waste management falls in the second category, although, like any science, it strongly builds on results and efforts in fundamental science. Now science itself is constituted of, and produces, various types of knowledge that have different roles in the decision-making processes. A question that needs deepening is to consider the role of established knowledge vs. that of "not-yet-stable" knowledge, i.e. on-going research knowledge. Moreover there are many different types of expertise, knowledge, understanding, not all belonging to the realm of science, but which can be relevant to the management of high risk, high uncertainty issues. In other words, in facing complex situations we must accept that science alone will not provide the solution.

Among its key roles, science contributes to the definition of problems, just as it strives to contribute to the design and choice of solutions. But in all these roles, science is not alone in the game, which may lead to conflicting situations within the science-policy and science-society interfaces, as actors might be fighting for the power of defining problems. Another important role for science is a translation role, as there is a need for translations of knowledge from science to policy and society. This role is often downplayed or undervalued in the scientific world.[1]2 Incidentally, the other way around is equally important as there is also a need for translations from society to science. Finally, it is important to bear in mind that there are important cultural differences in the very understanding of the role of science. This can impact the various interfacing processes and the confidence of actors.

The nature of science is another background element to the discussions that were held during the session. The question "What is science?" is an on-going research question which has no simple or unique answer. Science has fuzzy border and a not so obvious identity. (van den Hove 2005) It is a human process carried forward by actors with multiple values and identities. There is no such thing as a pure, neutral, and independent scientist and this bears on the relations between science and actors. But although science is not neutral and not always independent, it does maintain ideals of neutrality and independence in scientific methods, which contributes to the very definition of science as opposed to other types of processes or knowledges and which are the backbone of the high level of quality and success encountered in science. Notwithstanding, the processes of science – and more generally all processes of knowledge acquisition – are too often black-boxed in our institutions and the knowledge itself is too often safe-vaulted. This does not contribute to trust-building. While black-boxing of the results of science for the sake of translation and simplification of scientific knowledge might be the only viable option (people cannot be experts in everything) the transparency of the knowledge acquisition process and the accessibility of knowledge are key to confidence.

There exists a (power) asymmetry between science/expertise and the public, which stems from the nature and roles of science. This asymmetry is still very present, even in participatory decision

1. Although with the rising trend towards research programmes which call for immediate return on investment – i.e. for "useful" science, whatever that may mean – translation becomes a strategic must in the competition for funding. But this is not necessarily the type of translation needed in science-policy and science-society interfaces

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processes. But such processes can be designed to address this, in particular building on Habermas's discursive ethics (Habermas 1986 [1983]) one would aim for processes allowing (i) a free speech situation devoid of external constraint and of strategic behaviour and accessible to all; (ii) consistency between discourse and beliefs as well as consistency between discourse and behaviour; (iii) transparency, in particular of values and references; and (iv) a focus on the common interest. (van den Hove 2004)

Scientific quality and interdisciplinarity

Of uttermost importance to the relation between science and society and to the link between R&D and stakeholder confidence is the question of quality of scientific knowledge and of expertise. In particular, quality can be used to build credibility. Scientific quality processes are built-in as key elements of the research and expertise processes. For high risk, high uncertainty, high irreversibility issues, traditional scientific quality processes need to be enlarged. This involves interdisciplinary peer-reviews as well as opening up the traditional quality processes of science by creating so-called "extended peer communities" in which the scientific peer community is opened to other forms of knowledge and critiques (lay people, stakeholders,…) (Funtowicz & Ravetz 1993; Funtowicz 2001) As argued by Martin O'Connor during the session, there is a need for building a dialectical framework of dialogue in which all actors must be attentive to a spectrum of quality criteria and principles, even if some of those are not within their concern. The challenge being the design of institutions which allow such "reciprocal burden of proof" processes, where one needs to find good arguments in relation to another's reasons.

These considerations on quality raise questions about the role of authorities and other actors in ensuring quality of expertise as well as the role of the public and stakeholders in science policy. Also, as stressed by François Jacq, finding the right balance between the autonomy and independence of science on the one hand and accountability and the maintenance of a dialogue between science and policy on the other hand remains a challenge.

Interdisciplinarity is another key issue, strongly related to quality. There is a need to acknowledge the diversity of expertise, to articulate different knowledges, and to ensure a transboundary mobilisation of knowledge. Does this in particular mean that decision processes should rely on more than one scientific institution for the provision of scientific knowledge? Discussions showed different approaches in different countries, e.g. in France, "scientific diversification" is the objective, where different scientific research institutions participate to a research programme driven by a programme organisation (ANDRA) which federates other scientific resources, while in the USA NRC has created a specific and independent research and development centre: (CNWRA).

Since multiple scientific disciplines are brought to bear on the issue, there is a need to bridge between different disciplines and competencies and to build accountability between disciplines. As radioactive waste management is a societal problem, bridging with social sciences is important. However, social science is de facto not considered as a relevant domain of expertise in many institutional designs (e.g. ANDRA or CNWRA). But then the question is: how do you make an integrated risk assessment without considering the human dimensions? As shown by the Swedish example in Oskarshamn presented by Harald Åhagen, local communities can act as drivers of social science research. Discussions also stressed that, if they are included, social sciences may be as difficult to grasp by non-expert as natural sciences, hence the same translation problem as mentioned above.

Finally, at another level, social sciences can assess the legitimacy of societal processes, including the scientific and expertise processes, and they can contribute to institutional design.

Transparency, openness and accountability

Several presentations and discussions stressed that transparency, openness and accountability of the scientific and expertise processes are key ingredient for building – and maintaining – confidence, just as is the transparency, openness and accountability of decision processes. In particular, transparency is needed about where the scientist or expert speaks from, that is about his assumptions, values, and interests. Partiality is unavoidable, for scientists as for any other person. It is acceptable to the extent that it is not hidden. As we have seen above, participatory processes, if well designed, can help to clarify assumptions and make them explicit. Consistency between discourse and behaviour on the part of all actors, including scientists and experts – or in other words a commitment to authenticity and integrity – is equally key to confidence building.

Openness and transparency relates to the idea of stretching which was presented by Kjell Andersson and further discussed during the session. Stretching allows for the possibility of questions being raised from new angles. It is needed because there may be different views within one single area of expertise (e.g. geology). It is further needed because of the various expertises that can legitimately bring insight on the radioactive waste issue. Stretching helps to ensure that entrance of other information, values and concerns in the debate is not ex-post to the scientific/expert debate. Moreover, expertise can be enlarged – stretched – beyond substance to the knowledge provision process and to partnership building. That is there is the possibility to open-up the realm of expertise to process design, an area where social science may play an important role.

Several issues regarding accountability were raised. It was recalled by Kjell Andersson that accountability is part of democracy. Beyond the accountability of decision-makers and institutions, reflections are needed on what is – what should be – the accountability of scientists and experts. The question of whether less formal processes lead to less accountability, and of how to ensure accountability with less formality was raised and deserves to be addressed when decision processes – not just science-society interfaces – are designed. Finally also deserving attention is the question of the meaning of accountability in a very long term framework.

As for uncertainty, indeterminacy, ambiguity and ignorance, decision processes on high risk, high irreversibility issues need to recognise that they are facts of life. Not even scientists know about the unknown unknowns. This is another reason to keep processes open. Time and innovation are important here, as is the capacity of adaptation to a changing environment (societal or natural) and to changing knowledge. Openness in this light also means maintaining open the possibility for making corrections in the future or for changing one's mind. Hence the importance of reversible decisions (e.g. retrievability) and of "maintaining of institutional, technological and policy diversity as a means of conferring resilience in the face of ignorance and ambiguity" (Stirling 2004, p. 60) that is, decision-making which leaves open the possibility to abandon some paths if they later prove unsatisfactory.

Conclusions

Many other issues and questions were raised during the session and would deserve further attention, including in no particular order: the difference between scientists and experts, and that between stakeholders and the public; the articulation of different forms of participation; the fact that consent does not necessarily come with competence; and the question of possible "overconfidence" of experts in their work.

It stems from the issues addressed during the session that the practical challenge relating to the link between R&D and the building of stakeholder and public confidence lies in institutional innovation. A

change in our institutions is required to strengthen the interface between science and policy in particular, and science and society more generally. Some suggestions for actions in that direction include: (i) training of scientists in communication, interdisciplinary dialogue, and in working with dilemmas; (ii) opening up the scientific process; (iii) reinforcing its transparency; and (iv) stretching the scientific quality process.

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