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Review of initiatives addressing socio-technical challenges of RWM & geological disposal in international programmes

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Preface on InSOTEC

InSOTEC is a three-year collaborative social sciences research project funded under the European Atomic Energy Community's 7th Framework Programme FP7/2007-2011, under grant agreement n°2699009.[1] The project aims to generate a better understanding of the complex interplay between the technical and the social in radioactive waste management (RWM) and, in particular, in the context of the design and implementation of geological disposal (GD).

In doing so, InSOTEC wants to move beyond the social and technical division by treating RWM and GD as 'socio-technical' challenges.

ON THE INTERTWINEMENT BETWEEN THE SOCIAL AND THE TECHNICAL

As of the 1980's, a new strand of social scientific research emerged, which considered the social world to be shaped or influenced just as much by the technology it uses, as that technology itself is shaped by its social environment (e.g. Bijker et al., 1987; Callon et al., 1986; Elliot, 1987; Latour, 1986; Law, 1986; MacKenzie and Wajcman, 1985). From a Science and Technology Studies (STS) perspective, actions and decisions take place within hybrid collectives, that is, combinations of what we usually call the social (human actors, relationships, norms, groups, values, etc.) and things deemed technical (technical equipment, measures, calculations, tools, texts, etc.) (Callon and Law, 1989: 78). When we look at the making and design of aircrafts, bicycles, ships, buildings, nuclear reactors, light bulbs, diesel motors, or bridges, what we see is that beyond what might look like mere technical questions lie assemblages of humans and non-humans, subjects and objects, the social and the technical. In this sense, "artifacts have politics" (Winner, 1986): artifacts embody political visions of society and, at the same time, they have consequences upon the ways in which humans relate to each other and to their environment. Consequently, when actors modify and translate their interests they simultaneously modify and translate the knowledge and technological artifacts they use, develop and believe in, as well as their identities as actors. This is a reason to talk about socio-technical combinations instead of technical aspects on the one side and social aspects on the other, or about a technical 'content' surrounded by a social 'context'. What goes on in an innovation process is mutual adaptation between many factors gathered together in one and the same process, where involved actors - whether engineers, politicians or engaged citizens - do not separate between what is usually defined as technical and social factors. On the contrary, they know that they have to include both technical and social aspects in order to be successful. For many technologies, the relationship between social and the technical indeed has become stable, relatively unambiguous and not open to fundamental controversy. Today it would be hard to imagine a world without cars, microwaves or the internet, while less than 150 years ago, bicycles were considered a controversial

[1] InSOTEC partners are: University of Antwerp (Belgium), University of East Anglia (UK), OEKO Institute (Germany), Göteborg University (Sweden), CNRS – Ecole des Mines de Paris (France), MTA TK (Hungary), GMF (Spain), University of Tampere (Finland), University of Jyvaskylan (Finland), University of Ljubljana (Slovenia), Charles University (Czech Republic), Merience Strategic Thinking (Spain), University of Oslo (Norway).

technology and several different models competed for social approval (Pinch and Bijker, 1989). Conversely, technologies disappear (e.g. steam engines, cassette recorders, VCRs, or the Concorde airplane), and this for a host of different reasons. For geological disposal, although commonly presented by the expert community as the best available technology today to deal with the long term management of high-level waste and spent nuclear fuel, such stability is clearly not present. In fact, deep geological disposal remains today in many respects a hypothesis, of which the functionality has not been empirically demonstrated for actual long term safety.

ON SOCIO-TECHNICAL CHALLENGES FOR GEOLOGICAL DISPOSAL

Geological disposal is a particular technical concept to deal with the problem of radioactive waste; a technology that is considered by the expert community as the best available: *"The prevailing view of technical experts, as well as of many members of the general public that have been familiar with the work relating to geological disposal, is that geological disposal is a safe and technically achievable solution."* (NEA, 2008a: 14). In 2011, the European Council adopted a new Directive "Establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste" [2], which takes this technical consensus as a basis: *"It is broadly accepted at the technical level that, at this time, deep geological disposal represents the safest and most sustainable option as the end point of the management of high-level waste and spend fuel considered as waste"* (consideration (23) framing the Directive). As a consequence it urges Member States to develop and implement national programmes for the management of all spent fuel and radioactive waste under their jurisdiction, including disposal as the final stage in the management of radioactive materials (article 11 - §1). This suggests that today also a political consensus exists at the European level that GD is the technology of the future, where high level waste and spent fuel are concerned.

However, this does not mean that this technical concept is no longer controversial. Many of the general public, as well as many environmental groups and scientists from other disciplinary backgrounds, are still not convinced. The last Eurobarometer survey on attitudes towards radioactive waste for example showed that despite 43% of the Europeans polled thinking deep underground disposal to be the most appropriate solution for the long term management of high-level radioactive waste, still more than 70% of all respondents did not believe that there actually is a safe way of getting rid of it (TNS, 2008: 23-24). This may or may not have to do with the fact that few people are familiar with the concept of GD and the potential attributed to it by the research done so far in that field, as the above quote from the NEA - RWMC statement suggests. Still doubt remains even among those more familiar with the work on GD. In a review of scientific papers on the subject, commissioned by Greenpeace, Wallace (2010) stresses the remaining uncertainties and gaps in knowledge, for example on corrosion and chemical effects. While the RWM community acknowledges the existence of these uncertainties, they are not considered problematic. It is argued

[2] Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations [OJ L 172, 02/07/2009, p. 18–22].

that they are treated in the so called 'safety cases'[3], focussing on the question of long-term safety (i.e. after closure of a GD facility), and thus taken into account. However, a safety case is a very technical concept, based on modelling, mathematical analyses and performance calculation. It is a complex given that is not widely known outside the RWM community, and controversy does remain concerning methodology, as critics such as Wallace (2010) have expressed concerns regarding the reliability of models predicting long term repository safety.

What is also clear, is that the concept of GD has developed, and will continue to do so, not only because of evolutions in scientific knowledge, but also as a consequence of debates on how to integrate this technology into society. A clear example of this, is the introduction, by legal obligation, of the seemingly contradictory notion of retrievability into the concept of GD in Switzerland[4] and that of reversibility in France[5]. The adapted concept of GD that is being developed in these and other countries today (see for example the NEA's R&R project: NEA, 2011; NEA 2012) still has to prove its capacity for resolving competing values with regard to the safe disposal of radioactive waste. But it does show that we need to think about GD (or more generally any technique to provide in the long term management of high level waste or spent fuel) not as a technology designed by scientists and experts, but as a socio-technical concept of which the meaning and characteristics are negotiated and value laden.

InSOTEC METHODOLOGY AND STRUCTURE

InSOTEC focuses on situations and issues where the relationship between the technical and social components of RWM and GD in particular is still unstable, ambiguous and controversial, and where negotiations are taking place in terms of problem definitions and preferred solutions. Such negotiations can vary from relatively minor contestations, over mild commotion, to strong and open conflicts. Some concrete examples of socio-technical challenges are the question of siting and, as already suggested, of introducing the notion of reversibility and retrievability (R&R) or long term repository monitoring into the concept of GD. These examples show that the concept of GD develops over time, not only because of evolutions in scientific knowledge, but also as a consequence of debates on how to integrate this technology into society.

Whether in a pre-siting, siting or more advanced stage of the implementation of GD, implementers all over the world are looking for ways of addressing stakeholder concerns regarding how to integrate societal 'boundary conditions' (including concerns about safety, but also for example political and economic constraints) with the environmental, technical and regulatory 'boundary conditions' for disposal facility design. Such integration and attuning is needed to determine the

[3] A safety case in the context of geological disposal can be described as "a synthesis of evidence, analyses and arguments to quantify and substantiate that a repository will be safe after closure and beyond the time when active control of the facility can be relied upon" (NEA, 2008b).
[4] Kernergiegesetz, vom 21. März 2003 (*Nuclear Energy Act* - 21 March 2003)
[5] Loi n°2006-739 du 28 juin 2006 de programme relative à la gestion durable de matières et déchets radioactifs (*Radioactive Materials and Waste Planing Act* - 28 June 2006). On the notion of reversibility In France, see also Aparicio (2010).

social feasibility of technology, at a certain point in time. It is also needed to sound the technical viability of specific socio-political expectations and demands (think for example about the issue of R&R). InSOTEC aims to provide a valuable contribution to this challenge by developing a fine-grained understanding of how the technical and the social influence, shape and build upon each other in the case of RWM and the design and implementation of GD. How are socio-technical combinations in this field translated and materialized into the solutions finally adopted? With what kinds of tools and instruments are they being integrated? A better understanding of RWM in terms of socio-technical challenges and combinations allows the concept of GD to be seen not merely as a technical artefact to be introduced in a not necessarily receptive social environment, but as part of that social environment and therefore partially shaping it and being partially shaped by it. GD is in this respect viewed as a possible means to attain a long term management of radioactive waste, rather than as a goal in itself. The socio-technical challenges for implementing GD will therefore be looked at within the broader context of how RWM strategies are defined (by 'technical' and 'social' stakeholders) and how GD fits into these strategies.

The work in the InSOTEC project is structured into seven work packages (WPs). Three of those are supportive WPs dedicated to communication and dissemination activity, the organisation of seminars, and project management. The four research oriented WPs are organised as follows:

WP1 provides a review of national and international RWM focusing on the correlation of socio-political and techno-scientific challenges and whether or not they are acknowledged and dealt with as such.

WP2 consists of an assessment of mechanisms regarding the interaction of social and technical challenges through a number of case studies. These are: siting; technology transfer and transfer of socio-technical innovations; the issue of R&R; and the demonstration of safety.

WP3 looks at arenas where socio-technical combinations on RWM are formed through the co-production of knowledge between different actors. For this reason, networks or spaces are explored where people and organisations from various backgrounds interact with each other and create knowledge through a process of dialogue. A particular case study is the Implementing Geological Disposal Technology Platform (IGD-TP)[6].

WP4 links the research activity to the practice of RWM and GD by offering concluding reflections and recommendations.

[6] This technology platform was established in 2009 on the initiative of a number of European waste management agencies. European Technology Platforms (ETP) are a specific tool supported by the European Commission (EC) to bring together R&D-relevant stakeholders with various backgrounds, led by industry, to set a strategic research agenda and to develop a long-term R&D strategy and action plans in technological areas of interest to Europe (http://cordis.europa.eu/technology-platforms/home_en). Although most ETPs in one way or another seek connection to a broader range of stakeholders beyond the technical community in their particular field, there is no standardized approach to involve diverse stakeholder groups, nor are there specific instructions or expectations formulated by the EC in this regard (IDEA Consult, 2008). The IGD-TP has a dedicated Exchange Forum (EF) through which it wants to interact with stakeholders. Up until now this Exchange Forum has mainly been able to attract specialized stakeholders from the technical research community.

The InSOTEC Stakeholder Reflection Group is an advisory committee composed of nine individuals representing different groups interested in the subject (social scientists, implementers, local communities involved in RWM issues, national oversight bodies, the IGD-TP and the NEA). It is set up to ensure that different perspectives from potential end users are taken into account and that the results are useful to the 'practitioners' in the field.

InSOTEC AIMS

With this project, the InSOTEC partners hope to create greater awareness among the technical community of the social implications of their work, as well as of the underlying social assumptions that directly and indirectly colour the solutions they are developing. At the same time the partners hope the project will also provide other parties concerned (such as political decision makers or involved communities) with a better insight into the origins of certain technical concepts, which may help them to be better equipped when dealing with these issues in their own context.

Complementary to providing better theoretical insight in the complexities of RWM, and GD in particular, by describing them as socio-technical challenges, InSOTEC aims to provide concrete suggestions on how to address the actual socio-technical challenges identified within national and international contexts. We expect to offer insights (e.g. with regard to technology transfer and transfer of socio-technical innovations, the issue of reversibility, the inclusion of social aspects in the safety case model, …) to scientists and technical experts that could help them to communicate in a two way process about their work and to engage with stakeholders on technical and safety issues. With regard to the IGD-TP, InSOTEC will also investigate whether and how stakeholders representing different parts of concerned society with different backgrounds could be linked to the platform on a structured basis. In addition, advice will be provided on how to set priorities for a multidisciplinary research agenda which incorporates social sciences and which will address socio-technical challenges in a coherent and integrated way.

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Introduction

Both at the national and international level, the socio-political dimension of radioactive waste management (RWM) has mainly been treated in the context of preparing and legitimising decisions on siting, focussing on local communities and methods of engagement. Governance projects and initiatives on radioactive waste management both inside (e.g. COWAM, CIP, RISCOM, ARGONA) and outside the framework of the EC (e.g. CARL and the NEA's Forum on Stakeholder Confidence (FSC)) have had the merit of opening up the debate, bringing together relevant stakeholders on this subject, identifying good practices, strengths and weaknesses of emerging national initiatives and making concrete suggestions on the do's and don'ts of implementing participatory, deliberative decision making processes in RWM.

However, this does not mean that these projects and initiatives have not, in one way or other, considered the interplay between the 'social' and the 'techno-scientific' aspects of RWM, or geological disposal (GD) more in particular. This report therefore aims at reviewing the extent to which the reports related to these initiatives have described the socio-technical content of the processes analysed. This report thus provides a topical literature review of the main initiatives to address social aspects of RWM by international organisations (mainly the EU, the OECD's NEA, or the IAEA) over the last decade, focusing on the correlation of socio-political and techno-scientific challenges and whether or not they are acknowledged and dealt with as such. The initiatives reviewed differ in approach and background, but together provide a good overview of the key trends and topics in discussing the 'governance' of RWM in the last decade. We do not seek a completely comprehensive overview, but focus on most striking observations related to the extent to which socio-technical issues are addressed at the international level.

We reviewed the main findings from: previous EC-EURATOM funded 'governance' projects (FP5 to FP7)[7]; reports from the RISKBRIDGE and CARL project; reports from the OECD-NEA's Forum on Stakeholder Confidence (FSC) and Radioactive Waste Management Committee (RWMC); and one 'governance' oriented IAEA publication. For the EURATOM and CARL project, we reviewed the final reports, as they captured all themes covered in underlying documents. For RISKBRIDGE, we reviewed the "Riskfield Essay" on RWM. The dedicated summaries presented throughout this report are based on preparatory screenings from different contributors, using a matrix developed for this task (see Annex 1). The matrix was set up to capture the main research threads or argumentations of the various initiatives, but more importantly to identify whether they focused solely or mainly on socio-

[7] One will not find any reference to reports from the OBRA project (European Observatory for Long-term Governance on Radioactive waste management, 2006-2008). These were left out after a first screening, as the project was explicitly built around gathering knowledge about participatory methods. The OBRA report on conclusions from previous projects was thus mainly written from that perspective. Furthermore, all of these projects were in themselves included in our screening. The OBRA Thesis "Stakeholders' information needs on radioactive waste management" was not considered of further relevance, as it only dealt with Finland.

political issues, on socio-political issues as an 'add on' to the techno-scientific, or on the interrelation and mutual influence between the social and the technical, i.e. the socio-technical.

Previous EC Funded Governance Projects (EURATOM)

COWAM NETWORK (COWAM 1) - Final Report (2003)

The original Community Waste Management (COWAM) network (2000-2003) was set up to improve the decision making in RWM at the local and regional levels and to empower respective actors through a networking process at European level. It did not specifically address geological disposal, but considered all types of RWM related infrastructure from the perspective of the host-communities. The COWAM initiative was not a research project, it was about networking through seminars in local communities concerned with RWM and about identifying important questions for decision making to pave the way for wider reflections and actions in the future.

At the end of the project, recommendations were formulated regarding five specific challenges for RWM programmes and their relationship with concerned local communities. These recommendations were based on the discussion of a number of case studies presented by concerned parties during the network's seminars, and on further reflection in so called "mixed interest recommendation groups" (p.4 & 15) involving representatives from local municipalities, NGO's, national authorities, implementer organisations, research institutes and consulting organisations.

According to the general objectives of the COWAM 1 project, the character of the five recommendations can basically be defined as socio-political, as they aim at pointing out approaches that support the integration of stakeholders' views in RWM processes and in the respective decision making. The main focus lies on the procedural perspective of these approaches. Thus, a content related discussion on the socio-technical nature of RWM challenges does not take place. However, with respect to the three categories of interrelation of socio-political and techno-scientific defined for this review, some differences can be named regarding the context that the challenges deal with.

The challenge named "implementation of local democracy" (p.45 ff.) is socio-political in nature. The issues raised here were about the empowerment of local people and active participation of the wider population. It is based on an understanding that stakeholders on the one hand should achieve an improved understanding of RW issues while on the other hand national authorities' and implementer's awareness of local concerns should be raised.

Also the challenge "influence of local communities on the national RWM framework" (p.50 ff.) is treated mainly as a socio-political challenge, as it deals with sharing of responsibilities, cooperation of the different levels of governance, and a clear framework for decision making as necessary conditions to allow local communities to become involved, both at the local and the national level. In the context of the national framework also basic standards for health and safety and definitions of

waste types and volumes are mentioned as points of discussion. These issues have a clear socio-technical dimension but were not explicitly treated in the COWAM project from this perspective.

One challenge related to the socio-economic dimension of the siting of radioactive waste facilities, which up until that moment had been mainly perceived in terms of 'compensations'. The COWAM network considered that to be too narrow an approach, and recommended siting procedures to focus on the development of a facility at local level as a positive project linked in with the future and long term sustainable development of the region as a whole; and to do so with participation of local stakeholders. While with regard to this challenge, reference is made to long-term monitoring, continuous awareness of host communities and the availability of funding in case action (e.g. waste retrieval) would be needed in the future, this challenge is mainly portrayed as a social challenge following from (as an 'add on', so to say) the technical project.

The two remaining challenges, relating to "the access to expertise in the local decision making process" (p.48 ff.) and "the site selection process" (p.55 ff.) in general, are more explicitly framed as socio-technical challenges, even if the term as such is not used.

With regard to the site selection process, the challenges identified were the necessity to already include site related issues in the preparation of a national programme, to identify up-front key points in the decision making process, and to pay due attention to the integration in the decision making (e.g. regarding site selection criteria) of economic and political factors on the one hand, and technical and safety related factors on the other hand.

The, in our opinion, most explicitly formulated socio-technical challenge by the participants in the COWAM network, is that of providing local communities access to different types of expertise, to help them develop a "pluralistic perspective" (p.49), enable them to develop an opinion on the technical assessments, but also to assist them in making sure that their concerns and the "non-technical dimensions" (p.48) are properly taken into account in the decision making. In that respect, the need is stressed to develop expertise independent from the implementer, as knowledge is seen as "interest bound" (p.48) and therefore never objective.

COWAM 2 - Final synthesis report (2007)

The COWAM2 project (2004-2006) was set up from an action research perspective, aiming to develop an approach to allow for the co-building of knowledge with 'end-users', taking into account both their experience and their expectations.

The development of an ad-hoc methodology for cooperative research proved relatively successful, at least during the project's lifetime, and the project clearly helped actors already involved in actual decision making processes to reflect on their own situation and come to a better understanding. Whether this eventually resulted in a transfer of knowledge or experience to new actors or new processes and whether the more general and ambitious aim of implementing local democracy in a durable manner and supporting the influence of local actors on the national decision making process

was reached, is less clear and more difficult to judge. No concrete suggestions on how to achieve this were taken up in the projects final recommendations.

COWAM2 put a strong focus on socio-political challenges: notably promoting participatory democracy in the governance of nuclear activities. Social aspects were consequently treaded more as an 'add on' to the technical. Existing technical concepts for RWM are not put into question, and the inclusion of other dimensions is accepted only to the extent that they are seen as undermining the existing technical solutions.

In this project, the problem of RWM as concerns content was not studied or identified as a socio-technical challenge. Although not explicitly stated, one could read between the lines that COWAM2 presumes that technical performance in RWM has been reasonably demonstrated and does not need much further investigation. The problems of RWM are therefore mostly socio-political. Technical ambiguities are not dealt with. Contrary to some of the recommendations from the COWAM1 network, on the need to improve the understanding of RW issues by local governments, organisations and citizens, in COWAM2 a low understanding of technical problems by a lay public is considered a social problem which is not linked to the robustness of the technical solution itself.

While the aim of the project was formulated as developing approaches for the "co-building of knowledge" (p.45), the question of what outcome this could deliver in terms of new forms of knowledge was not as such addressed, and no analysis was made of socio-technical relations. No concrete considerations were pursuit on how to reframe the expert – 'lay' stakeholder relations in a way to improve governance performance.

CIP - Final report (2010)

CIP, or COWAM In Practice (2007-2009) was an action research programme to follow up on COWAM 1 and 2 and to establish (at least temporarily) informal local-national dialogue forums in five countries (France, Romania, Slovenia, Spain, and the UK).

In the final report of CIP, acknowledgement can be found of the fact that in order to eliminate the democratic deficit, technical expertise and societal aspirations need to be combined into a working management solution, and that one should prevent the use of technical aspects for defence of narrow political/economic interests in siting processes. It is also recognised that no player has all the resources, knowledge and/or authority necessary to tackle this question alone. The quality and safety of RWM are seen not to depend only on technical arrangements, but also on civil society vigilance and follow-up. The CIP report thus echoes criticism of systems where decisions are prepared exclusively by technical experts and public servants.

However, the project did not go beyond indicating the existence of such challenges and only mentioned a few general solutions. Although the project tried to implement an innovative action approach, the tools offered are rather humble in comparison to the complex socio-political grounds of the research problems. Methodological tools were offered to assess contexts for decision making

processes (e.g.: graphic representation, case studies, SWOT). While those are aimed primarily at clarifying stakeholders' views, they were also put forward as tools for empowerment. Overall, the project objectives were focused on democratisation of decision making process, not on the socio-technical content of the decision making process.

RISCOM II - Final report (2003)

The overall aim of the RISCOM II project, which ran from 2000 to 2003, was to support transparency of decision making processes in the radioactive waste programmes in the participating countries (Czech Republic, Finland, France, Sweden, UK), and of the European Union. The most important means to attain this aim is identified as a greater degree of public participation. The work is based on discussions, interviews, literature, document and process review, and focus groups. Depending on the specific activities within the various work packages it involved implementers, regulators, citizens in general and residents of candidate host municipalities, experts in various fields (e.g. performance and risk assessment), media and opinion leaders.

Throughout the project, the RISCOM model was developed, a tool to assess the policy making process. Therefore the focus lies on form, not so much on content. Although socio-technical issues are mentioned throughout the report as important parts within the evaluation of the policy making process, and a primary analysis of the challenges related to combining technical and social aspects is made, the traditional differentiation between (technical) facts and (social) values is not overcome, and sometimes even explicitly made.

'Transparency' is described as clearly entailing more than explaining technical solutions. Scientific facts do not lead to conclusions about what actions are right or wrong. This suggests a point of departure that recognises an inherent linkage between the social and the technical. However, within the model, the emphasis remains on the existence of an objective scientific 'truth', while involving citizens is linked mainly to the question of 'legitimacy' (see e.g. p.67). Even though it seems that the notion of 'authenticity' encourages the coupling of social and technical aspects, the focus is mainly on process, not on content: "It is not realistic to expect that stakeholders or citizens in more general terms can fully understand very technical issues, for example performance assessment in all its details. This is why there must be a process that allows them to evaluate the authenticity of the experts" (p.68). The main aim of the project thus seems to be exactly to differentiate between the social and the technical (by means of applying the right RWM process), rather than to study the complex interaction and mutual shaping of both throughout the content of RWM.

With regard to the RWM process, recommendations are given that can help create a situation where individuals can deliberate freely and on equal level, and suggests the concept of "stretching" (p.10) referring to the act of challenging the implementer of a proposed project with critical questions from different perspectives, and the appointment of a "guardian" (p.9) to ensure stretching can and does take place, and that decision-makers and the public can validate claims of respectively truth, legitimacy and authenticity.

In general the report focuses particularly on socio-political challenges related to the process of RWM, putting a larger emphasis on establishing "common grounds for developing procedures for effective communication", rather than developing "common views on the radioactive waste problem as such" (p.37).

The study of the role of post-closure Performance Assessment (PA) seems to be the RISCOM II research part that has the most explicit socio-technical components. A study was made of issues raised in PA of radioactive waste repositories to better understand how factual elements relate to value-laden issues. The RISCOM analysis found that "in many cases, it is difficult to see how to reconcile expert methods and public concerns. … Examples of challenges that may arise, are public concerns about

- worst case situations versus probabilistic approaches to modelling the future;
- individual doses versus collective averaging for critical groups (or potentially exposed groups);
- spectacular or tangible future events versus structured analysis of Features, Events and Processes (FEPs) to derive base and variant scenarios that subsume less likely FEPs " (p.49).

One related finding was that "From the specialist point of view, the core of PA lies in the arena of science whereas public values lie at the boundaries of PA. However, technical issues and values occasionally overlap in certain areas such as definition of acceptable risk, scenarios and handling of time frames. … These are aspects where facts and values can easily be found intermingled" (p.43).

However, to better understand this overlap and intermingling, a key element of the RISCOM II strategy for the PA studies "was to disaggregate the elements of PA and decision processes for a disposal facility into factual elements (experts' arena) and value judgements" (p.42). Concrete suggestions on how to reach a genuine integration after this analytical segregation remain relatively vague and some appear to be contradicting others (see p.48 – 53):

- On the one hand, it is argued that in order to integrate PA into a dialogue process, it is needed to reveal hidden values in expert investigations (in other words: by pointing out the social in the technical). Furthermore it is argued that new types of PA should be developed to incorporate stakeholders' issues and concerns (in other words: by adding the social to the technical, e.g. by working with a more cross-disciplinary PA group, making explicitly clear why PA is done, who it is for and how it fits into the wider process of decision making, …). With regard to the limits of PA, it is also pointed out that knowledge on the question of geological disposal will always remain incomplete and uncertain. Therefore it may not be possible to make an objective assessment of the true risk of final disposal, but stakeholders should be able to compare the consequences of alternative actions by using value-laden considerations and ethical principles.
- On the other hand, it is argued that it is essential that the PA can keep its identity as a scientific and engineering enterprise, and that engaging in public dialogue must not dilute the science and steer experts away (in focus or time-wise) too much from their core activity. This suggests an explicit viewpoint that facts and values are something different and that a

clear distinction between the social and the technical can and should be strived for. Along the same lines, it is suggested that the knowledge needed can only be generated by science and adherence to the scientific method (neither engineering nor lay knowledge are considered sufficient) (p.50).

Overall, RISCOM II seems to rather explicitly acknowledge RWM as a socio-technical challenge, by describing transparency in RWM processes as a triangle composed of truth, legitimacy and authenticity. Yet the recommendations following from this analysis seem to point in the direction of disintegrating the social (values) and the technical (facts). The socio-political aspects of the RWM process are emphasized throughout the project report, and it remains unclear how the social and the technical shall be integrated again in the concrete content of the RWM options to be adopted.

Towards implementation of transparency and participation in radioactive waste management programmes - Final report of the ARGONA project (2010)

The Arenas for Risk Governance (ARGONA) project ran from 2006 to 2010 and was set up as a research project, but also included practical implementation issues in a specific case. The main challenge targeted by the ARGONA consortium was how to organise arenas for increasing transparency and participation in RWM.

The research methodology used, was social science analysis of collected material from participatory activity in five countries (Belgium, Finland, Slovakia, Sweden and the UK), and analysis of an engagement activity set up within the context of the ARGONA project (Czech Republic).

The main question of organising transparency arenas was approached in the first place as a socio-political challenge, concluding that in Europe institutional settings for increasing transparency and participation exist. Even if they have their limits, the important thing is to focus on their opportunities. These are considered many and of much more use for the purpose of participation and transparency.

In addition, the central question was approached as an implementation problem. It was considered that enough knowledge had been gathered through research projects and actual steps taken in the field of RWM (approaches developed for participation and transparency), that the basic institutional framework was there, and that what still needed doing was to adopt these generic insights/approaches to best practices for the locality in which they will be implemented.

Throughout the project, specific attention was paid to creating a space for involving stakeholders that are critical to the existing process and therefore do not want to engage in them. Therefore transparency arenas are suggested to be set up alongside the formal decision making structures, to make regular intermediate 'check-ups' of the status of factual and value-laden issues as well as of the actors´ intentions and interests. Such "safe spaces" are described as settings "where different stakeholders could move forward together to increase their understanding of the issues and also of their respective views without being felt like hostages for a certain purpose" (p.148).

The main achievements of ARGONA appear to be:

- The setting up of a new engagement activity (the creation of the RISCOM reference group as a 'safe space' in the Czech Republic), based on the combined learning from stakeholder participation in 5 other countries; and
- The formulation of a set of guidelines for transparency and participation in RWM programmes: ranging from general principles to more specific and pragmatic examples (e.g. about 'best practices').

Some reflection was given to the need to consider how and in which context knowledge is being produced and how this may influence decision making. However, the focus of ARGONA remained on the organisational aspects of transparent participatory processes. When referring to the need to "build a knowledge base" in the concluding section of the final report, this meant "a knowledge base on processes for participation and transparency" and offering "a methodology for comparing approaches" (p.149). No particular attention was paid to the type of knowledge generated in the proposed 'safe spaces' or transparency arena's.

Local competence building and public information in European nuclear territories - Final report (2009)

This 2-year project (2007-2008) started from the assumption that the normative framework under the EURATOM Treaty on information about health protection of workers and the general public is insufficient, and that additional effort is needed to enhance transparency and participation at local level in municipalities hosting nuclear facilities.

It is argued that the 89/618/Euratom Directive on informing the general public about health protection measures to be applied and steps to be taken in the event of a radiological emergency, has been developed in different ways by each one of the EU Member States, leading to diverging procedures that are difficult to compare. In addition, there appears to be no legal basis to support activities at Community level to enhance transparency and public participation in the nuclear field. This is seen as a hindrance for the effective application of the principles embraced in the Aarhus convention in the nuclear sector.

A clear expectation is issued towards the European Community: calling for actions at the Community level to support transparency in the nuclear field and to harmonise practices of information and participation at European level. It is also suggested the EC could set up a label to acknowledge the quality of local information and participation practices for those municipalities fulfilling the requirements of 'good practices'.

The project furthermore aimed to support such EC initiatives, by providing a methodological framework to identify and benchmark good practices with regard to governance in nuclear issues at the local level. It collected information from: national workshops (Slovakia, Germany and Slovenia), national presentations from different parties, a targeted international workshop and survey, a survey

among local authorities' representatives, as well as two general seminars organised by the Group of European Municipalities with Nuclear Facilities (GMF).

Based on this analysis, five dimensions were listed of local governance on nuclear matters:

- Access to environmental information
- Participation
- Access to justice
- Local competence
- Local development

Also ten general recommendations for good governance in areas with nuclear facilities, with regard to processes of siting and constructing new facilities, operation and decommissioning, were put forward. Those remain quite general and are mainly of a socio-political nature (e.g. on the establishment of an effective legal framework for information provision and public participation, or on the creation of tools for public participation - local information committees, partnerships, etc. - around nuclear facilities, and guarantees for sufficient resources for local communities to undertake information and participation procedures). A few have to do with issues of local competence (e.g. on training programmes for competence building), access to information and know-how. A small opening towards a socio-technical perspective is offered here, through the recommendation that it needs to be ensured that the know-how of nuclear municipalities is effectively transferred and taken into account in the decision making process.

However, the overall emphasis in this project remained on governance methods and can be understood as looking at socio-political challenges as an 'add on' to the technical challenges.

Situation concerning public information about and involvement in the decision making processes in the nuclear sector - Final report of the IGNA project (2007)

The aim of the IGNA project (2005-2006) was to inform the DG TREN and interested parties of recent developments in the EC Member States in relation to public information and involvement processes in the nuclear sector, as well as on strategies to be followed by the EC and the Member States for improving the level of public information and involvement in nuclear decision making processes at the local level.

Two challenges were tackled:

- The access to qualitative and reliable expertise and technical training for local actors; and
- The need for justification of the industrial activities being promoted, which is considered an underexposed aspect of traditional governance (regarding nuclear issues).

Both challenges were addressed through an analysis of Eurobarometer results; a survey on applicable legislation at EU and national levels on public information and participation in decision making processes in the nuclear sector; ten case studies illustrating good practices of inclusive governance of nuclear activities; and a dedicated international workshop.

Recommendations remain very general, referring to:

- the fact that inclusive governance means involving various categories of experts and stakeholders with different backgrounds and values;
- local actors (and other stakeholders, for that matter) should be regarded as another type of knowledgeable persons, who can widen the scope for considerations;
- the need for training activity for both local actors (on the basic physical and technical processes at work, and on the difference between technical aspects and normative issues) and experts (on how to share their scientific knowledge and values with others who have their own values and expert capacity regarding their local situation);
- a need to "train" local actors on "the context of the expertise and the knowledge produced by experts and operators" (p.27).

Although hints are given about bringing the social and the technical at the same level, this seems more from a perspective of compatibility and 'adding on to', rather than looking at them as inseparable. The focus of the IGNA project furthermore remains on issues of process for inclusive governance at the local level, and the framing of such processes, i.e. regarding their justification through embeddedness in broader processes at the national (and international) level, as well as regarding their continuation over time (not just one-off events).

Other International Research Projects on Radwaste Governance

Risk Field Essay : Radioactive Waste - Radioactive waste related report of the RiskBridge project (2009)

The RiskBridge project (2006-2009) was a coordinated action funded by the European Commission under FP6 and its thematic priority 'Society'. It studied the interface between scientific knowledge and policy formulation processes within uncertain and ambiguous risk domains (Final Report: p.14), RWM being one of them. Its focus was on 'risk governance', understood as being constructed within one arena with researchers, policy makers and social actors, through a trial and error process with careful monitoring of results and analysis of possible problems (Final Report: p.16). The governance of radioactive waste was considered a "mature example" and it was assumed that lessons could be brought from the evolution and on-going innovation in that field (Final report: p.22).

The radioactive waste 'Field Essay' (the report we focus on for our analysis here) is based on a combination of desk research and interaction with a number of 'radioactive waste experts' over three consecutive workshops. It is not mentioned who were considered experts in this regard, nor is it clear from the separately published workshop proceedings who participated as an expert for which risk domain (as all three workshops covered different risk fields at the same time). This is a disadvantage since the report contains certain ambiguities (see infra) that may well be due to diverging backgrounds and opinions of the people that contributed to its content. A number of

topical cases from different countries (mainly the US, Canada and France, with some reference to the UK and Belgium) are used to highlight the arguments in the report.

Taking a 'risk governance' perspective, the report deals with both process (governance) and content (risk) of RWM. However, on both aspects rather diverging opinions can be traced throughout the report.

Focusing on policy and processes, on the one hand, RWM seems to be presented almost as an ideal case, where "the risk analytical circle (assessment-evaluation-management-communication) had been 'infiltrated' in every phase by stakeholders from the concerned public" (p.19) and it is claimed that the Riskbridge analysis confirms that "all these risk analytical phases today are profoundly informed by public perceptions, values, and demands, and significantly, a variety of stakeholders participate directly or indirectly in each phase (in most countries)" (p.20). It is thus stated that the new participatory policy trend in RWM "has profoundly altered both the process and substance of policy making" (p.7). On the other hand, it is pointed out that RWM inherently entails an unequal distribution of risks and benefits, and that "major issues remain as to the best means to ensure fairness in decision making and resource allocation for both present and unborn generations" (p.8).

A similar ambiguity can be found with regard to the content of RWM. On the one hand, a lot of attention is dedicated notably to the long term hazardous nature of high level waste and spent fuel and the connected uncertainties, both of a techno-scientific (mixing elements of variability, error and ignorance) and social (institutional, ethical, financial) nature. While the question thus is posed whether scientific knowledge about the safety of containment systems in the far future is sufficiently credible to enable commitment to deep disposal now (p.8), GD in itself is not questioned and it is stressed that "the field of radwaste is well established and the assumptions and bases of evidence are clearly set out. The field is privileged with enormous investment into scientific development of risk assessment and management. There is a pragmatic recognition that further evidence is unlikely to alter judgements" (p.12).

When these diverging opinions on process and content need to come together in dedicated risk governance, here too in our opinion some ambiguous findings are formulated. On the one hand, the centrality of *confidence* in light of inescapable problems of uncertainty, indeterminacy and contingency is pointed out, and a consequent need to include more qualitative assumptions, and principles of precaution, sustainable development and intergenerational equity (p.11). Yet on the other hand, it is stated that these insights do not offer "a straightforward means of making recommendations since they tend to rely on subjective assessments" and "For some, the level of knowledge will always be regarded as insufficient to justify policy" (p.12). From there, a turn is made to the classical response strategy of referring to the national regulator to make the judgement on acceptability from a safety and health perspective.

Elsewhere in the report, without elaborating on them much further, the following elements for implementation strategies are suggested:

- stepwise or phased procedures;
- a national review process involving stakeholders and the public through active forms of participation and engagement;
- technical and social facility siting criteria;
- partnerships with host communities;
- retrievability of wastes over a practicable period;
- monitoring arrangements;
- and ethical considerations (p.7).

The reason why these elements are suggested as potentially helpful, is because they were either suggested as such by the participants in the project workshops, or considered by the author as having had an impact on the advancement in at least one of the national cases referred to in the report. Reference is made to Canada as a good example (p.16), and to the UK and its Committee on Radioactive Waste Management (CoRWM 1) as an "outstanding example" (p.32). However, in the report, these examples are not analysed systematically according to the integrative model of risk governance which is presented as the basis for the RiskBridge research (Final report: p.9).

The report explicitly mentions the "close interweaving of technical and societal issues in RWM" (p.15) and the "intermingling of technical and societal dimensions of risk management" (p.16). The perspective of risk governance and stepwise decision making thus seems to outline RWM as a socio-technical challenge (mainly in light of the long term hazardous character of RW). However, statements that make a clear cut separation between techno-scientific and socio-political aspects can also be found, such as "We need scientific research to establish the fundamental physical processes and thereby lend confidence to our technical solutions. … The institutional arrangements have to foster confidence and credibility and the willingness to delegate to scientists, regulators" (p.33 – 34).

The siting of RWM facilities, finally, is seen as a major challenge which is more unambiguously depicted as socio-technical in nature: "The attempt to site RWM facilities is often the first encounter between publics and the technical project and its proponents. Scientific uncertainties are joined abruptly by other types of uncertainty which until then had been excluded from the paradigm (Mays & Poumadère, 1996). Siting attempts trigger or reveal controversy over the choices, implicit and explicit, that lie behind waste production and management." (p.18). To overcome this challenge, it is argued that a stepwise decision making process is needed, offering "flexibility and adaptability to changing technical, political, economic conditions", as well as "opportunities to engage stakeholders in considering and choosing options" (p.19). Furthermore a more open definition of "useful expertise" is called for, referring by means of example to "notably social science and ethics", which is considered to have become prominent in several countries (p.20).

Wanting the Unwanted: Effects of Public and Stakeholder Involvement in the Long-term Management of Radioactive Waste and the Siting of Repository Facilities - Final Report of the CARL project (2008)

The CARL project (Citizens, Agencies and Regulatory and Licensing authorities in RWM – 2004-2007) focused both on issues related to form and content, looking at six specific challenges for RWM: four of which could be described as mainly socio-political in nature, and two that were explicitly framed as socio-technical.

Socio-political challenges for RWM:

- the framing of RW risks
- the move from 'government' to 'governance'
- new emerging patterns of policy networks on RWM policy making and on the siting of RWM facilities
- potential limits to public and stakeholder involvement

Socio-technical challenges for RWM:

- understanding the entanglement between technical options and political choices in decision making on RWM
- remaining problems in the integration of social and technical aspects

The research was conducted through an analysis of collected material from stakeholder involvement processes in RWM in four countries (Belgium, Slovenia, Sweden and the UK), and the writing up of country reports to understand the influence of contextual factors on particular participatory initiatives and their outcomes.

Given that the project was mainly funded by RWM agencies in the participating countries, those were the main target group for the CARL conclusions. Some recommendations were nevertheless also aimed at a broader audience of citizens, researchers, licensing authorities, and other specific stakeholder groups.

Although most recommendations remain of a general kind, without addressing the 'How?' of handling RWM issues as socio-technical combinations, the CARL project opened up the discussion on the inseparability of the social and the technical in RWM by drawing the following conclusions:

- The technical-social divide is largely an artificial one.
- Participation and stakeholder involvement is about social and technical aspects. Technical aspects are, however, to a large extent "contained" in the techno-scientific community. It is therefore argued that taking a purely technical approach to the demonstration of safety and the building of safety cases is a missed opportunity for a more integrative approach towards the technical and the social (p.67).
- Social aspects are often reduced to socio-economic issues, but are much more than that. They are about "what constitutes legitimate knowledge", about "technical choices", about "how to bring together different knowledge systems and integrating their respective

cognitive perspectives into a sustainable solution", and they are about "finding creative solutions to a problem that is not only technically, but also socially, politically and economically complex" (p.67).

- The biggest challenge for the future is identified as working towards a closer integration of the technical and social aspects and in finding ways of meaningfully opening up the technical 'black box' to the mutual benefit of both experts and society. A general way forward would be to assist "the scientific and expert community in becoming more reflexive about the social assumptions implicit in the technical work", as well as continuing "the efforts to make the technical debate accessible to lay-arguments and more responsive to social needs" (p.68).

NEA – FSC Reports

The Forum on Stakeholder Confidence (FSC) was established in 2000 by the NEA's Radioactive Waste Management Committee (RWMC) to "foster learning about stakeholder dialogue and ways to develop shared confidence, consent and approval of management solutions"[8]. The FSC is mainly composed of representatives from implementers, some regulators, administrators and experts with experience and interest in the governance aspect of RWM. The forum organizes annual meetings, national workshops and community visits to investigate and discuss issues of confidence in relation to RWM. Its secretariat furthermore initiates desk research and organizes informative questionnaires among FSC members. This collaborative learning is subsequently published in workshop proceedings and topical reports. These publications are being reviewed in this section, starting with the milestone report on 'stepwise decision making'.

Stepwise Approach to Decision Making for Long-term Radioactive Waste Management - NEA-FSC report (2004)

At the time this report was written, stepwise decision making was already identified within the RWM community as indispensable for the development of any RWM programme, and most notably in view of defining and implementing disposal options. However, the concept of stepwise decision making had not reached full maturity yet. Therefore, this report wanted to contribute to identifying guiding principles and key issues by exploring in more detail the societal dimensions of this concept, and its roots in social sciences (p.15).

A key feature attributed to a stepwise decision making process in this report, is that it has a combined technical and social focus. This poses particular challenges, some of which are of an organisational nature (effectively involving stakeholders and adapting new forms of interaction), while others are related to the integration of societal dimensions in technical RWM concepts.

[8] FSC Flyer "About the Forum on Stakeholder Confidence" (www.oecd-nea.org/rwm/fsc/docs/FSC%20Identity-0907.pdf – consulted 11-04-2012).

Specific mention is made in this regard to the challenge of further developing the concepts of retrievability of waste, described as "a way to second the societal wish of being able to maintain control over the waste and how it is handled" (p.27), and of reversibility of decisions, described as assuring "that fall back positions are incorporated in the long-term waste management *policy*, as well as in the *actual technical programme*" (p.28).

Seven "specific action goals for radioactive waste management" were furthermore identified (p.42):

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

The first two could be considered general conditions that should be met or addressed as a first step in developing (or revising) a national RWM policy. They relate to the question of 'why' a RWM programme is needed. The third action goal refers to the 'what' of such a programme in general terms, and deals with questions such as: What types and volumes of waste are involved? Who are the actors involved? What management options are available? … Both social and technical aspects of this 'action goal' are referred to, but without making an explicit link. The main argument made, is that before moving to the step of proposing a specific management option, it should be made clear what problem (i.e. what waste) is targeted with this solution. Socio-technical challenges related to this action goal are, for example, reflected in debates about the types of wastes to be handled together within the framework of certain programmes. In some cases (e.g. Hungary and Germany) socio-political and technical issues at this point were strongly interrelated.

The last four 'action goals' we consider to be of a more explicit socio-technical nature. With regard to finding an appropriate method and site, the report recommends an approach in which the method is selected first, as this way "the developer can present to the safety authority and the public the physical characteristics of the facility before asking communities to host it" (p.47). It does however recognise the potential downside, namely that this allows for less room for the adaptation of the concept to its host environment and to the integration of local societal conditions. It is therefore recommended to leave the details of the waste management method, "including safety standards, monitoring and mitigation measures" to be finalised after deliberations with the host community (p.47). Finding that host community is seen in the report as the biggest challenge and most

controversial part of RWM programmes. A voluntary siting process, in which communities are allowed to withdraw at any time, is seen as the most recommendable. However, due attention needs also to be given to upfront dialogue on the general safety requirements and management method, as well as on procedures for identifying sites and for excluding sites that do not meet licensing criteria. No specific consideration is given about whether such criteria should encompass both technical and social aspects, but it is acknowledged that a broader debate on these criteria is desirable. It is furthermore recognised that potential host communities should not only be given the opportunity to negotiate "compensation or incentive packages", but also site characteristics, design features, community oversight schemes, etc. (p.49).

Finally, the report indicates that long-term solutions for managing radioactive waste will take decades to implement. It is therefore pointed out that RWM programmes should be able to respond flexibly to possible changes (e.g. in the techno-scientific background, or the environmental, socio-economic and political conditions) during this period of time. Reference is made to the potential of the concepts of retrievability and reversibility (see above), to enable to, at least partially, respond to this need for flexibility.

Learning and Adapting to Societal Requirements for Radioactive Waste Management - Key findings and experience of the FSC (2004)

The main focus of this report was to present a synthesis of the FSC key findings and collected experiences in the forum's first phase of work (2000-2004), and to point to some concrete governance challenges in RWM. Several concrete challenges could be distilled from this report, a number of which could be considered socio-technical challenges, although not all are framed in that way within the report.

The first big challenge is reconciling the competing requirements of goal-centeredness and adaptability. In other words, the question of flexibility or reversibility, albeit put in terms of RWM in general and not specifically for geological disposal. Taking a stepwise approach is considered an answer to this challenge, though it is pointed out that even then, not all steps or decisions can be fully reversible, given the limits of (technical) practicability.

The second 'socio-technical' challenge identified is the existence of multiple legitimate views and ethical principles, which may evolve over time, and sometimes clash, but between which no hierarchy or prioritisation can be made. Competing values do not necessarily have to be about social versus technical, but the report does take this as its primary example, referring to *"The tension that exists between competing values such as technical efficiency, community support and distributive equity …"* (p.29). No concrete suggestions are made to address this challenge, other than to strive for RWM strategies that can meet multiple ethical principles simultaneously and to trust in democracy to resolve the problem of clashing values.

A particular example of such competing values is to be found in another challenge listed in the report, namely balancing the competing requirements of passive safety and controllability. This

challenge is one that particularly affects geological disposal, but the report refers more generally to 'final disposal'. The inclusion of provisions for retrievability and monitoring during characterisation, operation and the post-operational phase are considered to be ways of accommodating this challenge. An interesting question is put forward on whether it would be acceptable to go for a socially optimal concept (that is, one in which residents have confidence), which is considered technically sub-optimal by the expert community. The example referred to is that of a low-level waste facility lacking full passive safety features) (p.34).

Another socio-technical challenge addressed, which is strongly related to the former one, is meeting at the same time the technical requirements for licensing and the political requirement of host community support. This challenge is most specifically related to the question of siting and site selection criteria. However, it is also suggested that RWM concepts (again the report does not make any difference between types of facilities here) should remain open for modifications after a site has been selected, to fit site specific characteristics and to accommodate host communities' preferences.

In order to address the former challenges, the report suggests that lessons from experience so far indicate the need for active involvement of stakeholders, and most particularly host communities, in RWM programmes and processes. Setting this up in a way that both technical content and quality of process are of comparable importance is indicated as yet another challenge.

Subsequently, it is considered a challenge to establish and maintain a long-term relationship between the local host communities and the waste management facility. A challenge that can, at least in part and to begin with, be facilitated by designing and implementing such facilities in ways that reflect the values and interests of local communities; which brings us back to the previous challenge and the competing values challenge.

Proceedings of the Topical Session of the 6th meeting of the FSC on the Link between RD&D and Stakeholder Confidence - NEA-FSC report (2005)

One of the rare FSC reports that focusses on issues relating specifically to geological disposal, this document reports of the discussions held during a topical session at an FSC regular meeting. It was attended by FSC members and guest presenters representing academia, consultancy organisations, implementers and local communities.

Two challenges of explicit socio-technical nature were discussed at this workshop, namely:

- GD faces both the complexity of geophysical systems and the complexity of the societal framework; and
- research and science are value driven and have to deal with uncertainties and ambiguities.

The focus of the discussion was on identifying methods to face these challenges. Therefore the formulated recommendations are mainly process oriented, and remain relatively general.

With regard to the combination of complexity in the geophysical system and in society, it is noted that RD&D has to fulfil a double role in the disposal process: meeting regulatory requirements and seeking broader social understanding and confidence in the decision taken. In order to fulfil the latter role, it is recognised that stakeholders' influence on the identification of research issues has to be foreseen. Furthermore, the workshop participants saw potential socio-economic problems that may have to be managed. Two general recommendations were made to tackle this complexity problem:

- approaching inter-disciplinary aspects of the project through 'bridging' and reciprocal learning; and
- providing special support to create openness among experts for dialogue.

With regard to the recognition that research and science are value driven and have to deal with uncertainties and ambiguities, it is noted that underlying values are often not made explicit and that therefore transparency about assumptions, uncertainties etc. is needed. It is suggested that this can be achieved by:

- setting up participatory processes, as they are assumed to contribute to achieving transparency on assumptions, (social) values and areas of remaining uncertainties as well as on interests of experts;
- giving social sciences a specific role in designing guiding processes and in furthering the understanding of social issues as essential components of integrated risk management.

It is furthermore argued that 'demonstration' plays an important role in the development of stakeholder confidence, which can be read as a preparedness to consider (at least some aspects of) GD as inherently socio-technical in nature. In line with this finding, the report attributes a role to social sciences beyond addressing process related issues (p.23).

Cultural and Structural Changes in Radioactive Waste Management Organisations - NEA-FSC report (2007)

This FSC report deals with the organisational and cultural challenges RWM organisations face when adopting a more participatory approach. The findings in this report are based on a survey conducted in 2005, directed at 17 RWM organisations in 11 OECD countries, and a subsequent topical session held by the FSC in 2006.

In the vast majority of the queried RWM organisations changes in mission and main goals, as well as in values and culture were observed over the past decade. Mission and objectives changed from purely technical to technical and societal ones. The issue of stakeholder confidence, and the values of openness and flexibility came to the fore.

What is clear from this report is that, at least in their discourse, most RWM organisations today indicate a greater awareness of social issues and the need to open up to different types of expertise, some explicitly incorporating that within their organisation. However, the findings of the report (based entirely on the input from the RWM organisations themselves) do not allow a further analysis

of the relation between discourse and practice, nor do they give an indication of whether the social and the technical are treated as separate aspects (covered for example by two different units within the organisation) or as intrinsically related (e.g. by setting up multi-disciplinary teams).

Fostering a Durable Relationship between a Waste Management Facility and its Host Community: Adding Value through Design and Process - NEA-FSC report (2007)

This report focuses on RWM facility siting in general, not specifically for geological disposal, and starts from the observation that RWM projects are likely to last for centuries. It is argued that the sustainability over the long term of an agreed solution is essential to success.

The notion of sustainability is here interpreted as "societal durability" and it is pointed out that this is not gained solely through financial compensation and development opportunities (p.9). The report takes the view that RWM projects also offer opportunities to improve well-being, consolidate knowledge, fulfil value ideals, elaborate community identity and image, and live out desired social relationships. Therefore planning for and implementing a facility should seize these opportunities.

While it goes without saying that an RWM facility must serve the primary purpose of assuring safe and secure long-term management of RW, it is argued that careful functional design can add value, by allowing parallel uses that are of direct interest to residents and visitors. The following design features are recommended for RWM sites: distinctiveness, aesthetic quality, understandability, memorialisation, integration, amenity, accessibility.

As a consequence the facility may become an icon, a positive part of local identity. People may draw pleasure from its presence rather than avoiding it. People can connect the RWM installation to various parts of their lives and their knowledge. The installation does not intrude on or disrupt people's living space. People get a feeling of security and familiarity rather than a sense of threat.

Furthermore it is argued that benefits may also be gained from the very process of planning and implementing RWM projects that target sustainability and quality of life. An RWM facility may provide jobs, services, stability, etc. to the local community. Communities may also draw cultural value from the very process of deliberating about hosting an RWM facility. Communities may create a positive community brand or profile with the RWM facility. Although it is also recognised that an RWM repository may not be compatible with a local (desired) image, the focus is on how to overcome such incompatibility.

Here we find a good number of elements that are also echoed in the report on the symbolic dimensions of RWM (see infra). Without entering into an in-depth analysis, this report touches on issues that hover on the boarder of the social and the technical: sometimes addressing the social aspects as 'add on' to the technical (e.g. by focussing on added value from functional design, the creation of jobs, etc.), and sometimes as intrinsically linked (e.g. by referring to design features in view of understandability, memorialisation and accessibility, as they implicitly assume a change of style to the classical technical approach to safety).

Stakeholder involvement in Decommissioning Nuclear Facilities: International Lessons Learnt - Proceedings of a Joint Topical Session of the RWMC-WPDD and the FSC (2007)

This report focuses on stakeholder involvement with regard to the decommissioning and dismantling (D&D) of nuclear facilities. The report brings together the results from a literature review and input from a joint topical session of the RWMC Working Party on Decommissioning and Dismantling (WPDD), and the Forum on Stakeholder Confidence (FSC).

Paying specific attention to the role of stakeholders involvement in D&D was felt necessary, as in general there are no legal requirements to involve stakeholders directly in decisions on the shutdown of nuclear facilities, while the consequential decision about the strategy for decommissioning usually does involve stakeholder consultation (if not involvement) through legal procedures such as EIA processes. It was thus considered a major challenge to establish guidance on stakeholder involvement in the whole process from the decision to shut down, to the actual decommissioning.

Recommendations are offered on:

- how to organise stakeholder involvement in the decision to shut down a facility;
- how to organise stakeholder involvement in the decommissioning and dismantling of a shutdown facility.

Recommendations of the first type are mainly of a socio-political nature, linking this question to debates on national energy policy and to national waste management plans. Recommendations on the second question follow general trends in FSC recommendations concerning involvement in siting processes for waste management facilities. Without going into specific detail, they cover issues such as: involvement of local actors in monitoring activities; ensuring that technical information is communicated in a meaningful way; setting up partnerships to allow for a structured relation between stakeholders and the project management, as well as for an integrated reflection on the end use of the site; flexibility in regulatory requirements to allow for the accommodation of local issues and preferences in decommissioning approaches, for tailor made plans for the future use of the site, …

Implicitly, this report touches on what could be considered socio-technical challenges, in recognising that the interplay between different actors is likely to influence the outcome of a D&D activity and by acknowledging different technical solutions could be envisaged, depending on social, economic, and other preferences.

Link between Research, Development and Demonstration (RD&D) and Stakeholder Confidence: Use of Analogues for Confidence Building - Proceedings of a Topical FSC Session (2008)

The aim of this report is to share experience on the use of analogues. With the notion of analogues, or 'natural analogues', one refers to materials or processes resembling those expected in a geological repository. Examples include different types of fossils or ores, preserved over several millennia in geological formations. The idea is that reference to analogues will help to create understanding and build confidence in RWM approaches and safety cases.

The report summarizes a number of case study results. The cases are drawn from national and international research projects and input from the NEA's Integration Group for the Safety Case (IGSC), which is linked to the Radioactive Waste Management Committee (RWMC).

It is argued that analogues can deliver qualitative and quantitative data to illustrate long-term behaviour or conditions and to validate assessment models, thus contributing to the scientific knowledge base. Meanwhile, analogues can contribute to the Safety Case, providing national waste management programmes with an additional line of evidence.

Two types of audiences are identified, with assumingly different expectations as regards the use of analogues and the way in which they can provide evidence and contribute to confidence-building.

A first type of audience is formed by the regulators. From the topical session it was concluded that regulators consider analogues a useful tool to confirm phenomenology and modelling. While "negative analogues" could become counter examples if left unaddressed, they were also seen as potentially providing useful information about situations that must be avoided in a repository (p.7). The use of analogues in arguing a Safety Case to a regulator was therefore considered a feasible challenge, as "common understanding of the use and limitations of analogues between implementer and evaluator is to be expected as the dialogue is a scientific technical one based on a comparable degree of specialisation" (p.7).

The general public is the second type of audience identified in this report. Based on experience from national projects the report points out that there are still a number of open questions regarding the use of analogues in stakeholder communication. This refers to the efficiency of arguments based on analogues in confidence building as well as on the way of communication and change of needs over the evolution of a repository project. While it is expected that analogues and anecdotes could help the public to grasp timescales and understand the basic rationale and principles of geological disposal, the participants in the topical session remained uncertain about the efficiency of analogues in supporting public confidence building. It was considered a particular challenge to adapt the demonstration of analogues to the audience and to make use of understandable language. The overall impression was that the use of analogues would be particularly useful in the early stages of a process, before a site is chosen, but less in more advanced stages and during active operation of a facility.

A final point of interest raised in these workshop proceedings, is the question of "socioeconomic analogues" (assumed to be contemporary analogues from projects which are similar in terms of investment, running costs, construction, operation life, footprint etc.): To what extent do they exist and in what way may they also contribute to (public) confidence building? (p.9).

The use of analogues as 'demonstrators' of safety could proof an interesting socio-technical challenge in the way that notion is understood in InSOTEC. However, from its proceedings, it would appear that in this Topical FSC session, the focus of the discussion was not on integrating the social and technical aspects. It rather looked at the technical / natural scientific capacities on the one hand, and the potential benefits in the context of stakeholder communication and drawing conveying messages from analogues on the other hand.

More than Just Concrete Realities: The Symbolic Dimension of Radioactive Waste Management - Proceedings of a topical FSC session (2010)

This report wanted to contribute to the understanding of the predominantly negative symbolism related to RWM and to consider facilitating a more positive dialogue (p.3).

It starts from the observation that key concepts in RWM (such as safety, risk, reversibility, retrievability) carry different meanings for the technical community and for non-technical stakeholders. Emphasis is put on the observed contrast between the technical community (assumed to hold an overall positive view with regard to RWM issues) and the non-technical stakeholders (generally understood to hold a far more negative view). The report touches upon the reasons and consequences of this observation, but focuses on how to overcome these differences, more particularly, on how to alter the negative symbolism around radioactive waste.

On the one hand, openness is created by the statement that "it is crucial to enhance the awareness of connotative meanings [i.e. the symbolic dimensions people attribute to words and objects]", as this "may help suggest ways to create constructive relationships amongst stakeholders or help resolve divergence and conflict" (p.11). On the other hand, it is argued that to overcome the negative symbolism that has risen around radioactive waste, one needs to highlight the positive symbolic meaning. Suggestions made in that regard are:

- to promote the use of terminology that reduces negative connotations (e.g. talk about "by-products" instead of "waste") (p.22-24);
- the possibility to look at RWM facilities as a form of art and to highlight their unique societal significance (p.16);
- to familiarize (local) stakeholders with RW and give them the opportunity to build a sustainable relationship with the RWM facility (p.16-17);
- to provide (local) stakeholders the possibility for personal control over the perceived risk ("safety by integration" as compared to "safety by exclusion") (p.19-20).

The report thus seems to display an acknowledgement of RWM as a socio-technical combination (e.g. through the importance of connotative meaning and the last two recommendations above), but by emphasizing the need to create positive symbolism, in our opinion the technical and the social are separated again, and the social interpreted as a 'mouldable add-on' to the 'neutral technical'.

Partnering for LT-management of Radioactive Waste: Evolution of Current Practice in Thirteen Countries - NEA-FSC report (2010)

The aim of this report is to share and reflect on national experiences with building closer ties between the RWM community and local communities in view of siting RWM facilities.

The report starts from the observation that providing information and consultation of the local public alone is a form of token involvement, which only rarely leads to long-term local support for RWM facilities. Also, attempts to site RWM facilities tend to be marred by conflicts, disagreements and delays.

The report notices that in response a shift has taken place from a more traditional "decide, announce and defend" model to one of "engage, interact and cooperate", which is understood as offering more potential for enduring local support (p.9).

As a practical recommendation, the report suggests to opt for a "partnership approach", which includes "voluntarism", and the "right of veto". In spite of the risk this entails of all potential host communities eventually withdrawing from the process, it has the advantage of empowering the local community and providing it better control over the situation (p.10-11).

The most outspoken and crucial feature of a partnership approach, according to his report, is that it should include cooperation between the implementer and the affected communities, dialogue between experts and citizens, mutual learning, and actual local influence on the RWM facility (that is on method and site selection, facility design, construction, operation, and closure, facility oversight and community benefits, etc.).

The later in particular demonstrates an implicit recognition of a strong interconnection between the technical and the social, although it is not clear to which degree they are considered to be two parts of the same coin, or are still seen as intrinsically different, while unavoidably bound together.

Overall, the report focuses strongly on issues of form, identifying as main challenges for applying a partnership approach: issues of representativeness as regards the local community; a preparedness to open up and improve communication activities from the side of the implementer; the significant investment needed of time and financial and human resources; and the methodological challenge of enabling effective expert-citizen interactions.

NEA – RWMC Reports with Potential Reference to Governance Issues

Moving Forward with Geological Disposal of Radioactive Waste - Collective Statement of the OECD/NEA RWMC (2008)

The NEA's Radioactive Waste Management Committee (RWMC) is "an international forum of senior representatives from operators and industry, safety authorities, policy makers and R&D institutions engaged in the management of radioactive materials and waste" (p.3). With this collective statement, the committee wanted to express its collective views on the status of geological disposal at the time, and why it is considered an appropriate waste management choice for high-activity, long lived radioactive waste. The statement furthermore considered challenges and opportunities for implementation, and listed the RWMC's expectations for further development.

Regarding the environmental and ethical basis and technical feasibility for geological disposal, the RWMC refers to previous statements and reports. However, RWMC members acknowledge that views have evolved regarding appropriate methodologies, policies and decision making processes. Therefore, the need was felt for a new collective statement.

In this statement, a 'socio-technical argument' is used to explain why geological disposal as the way forward is considered a given. Not only is it argued because of the scientific consensus regarding its technical feasibility, but also because many countries, after what is referred to as "significant public and stakeholder involvement", have adopted it as the reference long-term management solution for their high-activity, long-lived radioactive waste (p.8). The implementation of this solution nevertheless still faces significant challenges. This collective statement focuses on three key challenges.

The first challenge is that of site selection, which is framed as a political and social challenge. In order to face this challenge, national policy and legislative bodies are recommended to establish national RWM programmes that are open and transparent, allow for sufficient time, and assure meaningful involvement of all stakeholders, including "negotiation of a locally acceptable solutions with host communities and their leaders" (p.16). While the emphasis appears to be on participation and local development as means to establish a lasting relationship between the facility and its host community, reference is also made to "option identification" as part of negotiations (p.16). Regulators are furthermore advised to consider taking up the role of "the people's expert", as the RWMC members have seen expectations from society rise in this regard (p.16).

The second challenge is to define a broadly accepted national strategy for confidence building, as it is recognised that confidence by the technical community in the safety of geological disposal in itself is not enough to gain public confidence and acceptance. This challenge is more explicitly framed as socio-technical, as it is suggested that safety criteria should be based on "national and pan-national interests", and on "local and regional cultural views and societal values" (p.17). It is furthermore stressed that both decision-makers and the concerned public must be given the time and the means

to understand and evaluate proposed decisions. Adding reversibility and retrievability to the GD concept is considered to be helpful in some cases. However, the RWMC makes the point that there are time limits to their effectiveness, and that these need to be defined and explained. By no means should this jeopardise long-term safety.

The third and last challenge relates to the long time span needed for the technical development and implementation of disposal projects. Once a decision on implementation is taken, the challenge is to first and foremost maintain the support at local and national levels. Further out in time, it also becomes important to maintain the necessary infrastructure and the necessary human resources for knowledge preservation and transfer. However, for the RWMC, the long implementation times do not only present challenges, they also provide opportunities for programme adaptation and enhancement. For one, this allows for continued research and learning, and a continuation of international co-operation (sharing experiences and lessons learnt). But the RWMC members also see opportunities to build broad societal confidence in the concept and to develop constructive relationships with the most affected regions through phased decision making. How exactly this would be or should be established is not addressed in this statement.

Towards Transparent, Proportionate and Deliverable Regulation for Geologic Disposal - Workshop Proceedings - OECD/NEA RWMC Regulators' Forum (2010)

This report consists of the proceedings of a workshop of the RWMC Regulator's Forum (RF), held in Tokyo, 20-22 January 2009 and attended by app. 70 participants including regulators, implementers, policy makers, R&D specialists and academics. We analysed p. 1-51 of the proceedings, i.e. the summaries of papers, presentations and discussions, and the main findings. Input for the workshop included a series of RF activities, a survey of countries' regulatory positions that served to prepare the workshop, a review study on progress in regulation for GD since a previous workshop in Cordoba (1997), and a review study on guidance in the field of optimisation of geological repositories.

The aim of the workshop was "to deal with the questions of transparent, proportionate and deliverable regulation for LT safety in as broad a fashion as possible" (p.10) and to help assess progress and verify the current status and needs in regulation (p.3). The main themes of the conference in our opinion clearly show the relevance of the notion of 'socio-technical' for the field of regulation for GD: duties to future generations, timescales for regulation, stepwise decision making, roles of optimisation and BAT, multiple lines of reasoning, safety and performance indicators and limitations, recognition of uncertainties and the importance of stakeholder interactions (p.3). The notion of 'socio-technical' is however not referred to at any point, and it remains unclear to which extent a genuine willingness to treat regulation as a socio-technical challenge exists.

To fulfil its role of protecting man and the environment from hazards of ionizing radiation, regulators largely base their work on radiation protection, using quantitative dose limits as the main support for regulation development and dosimetric calculations as the main support for compliance assessment. Although throughout the proceedings it is acknowledged that numerical dose standards are

problematic on the long term (in light of uncertainty, because quantitative dose-detriment relations will likely change over time, …), they seem to remain to be accepted as the ultimate protection indicators by means of which regulators should do their job (e.g. p.19). Potentially complementary indicators mentioned also remain largely techno-scientific in nature (e.g. radionuclide concentrations, engineered containment capability, geological indicators, …) and qualitative criteria remain rather vague (e.g. simplicity, robustness and redundancy) (p.22).

On the other hand, it is acknowledged throughout the report that safety objectives in general are subject to multiple interpretation (what is safety? what is protection? what are undue burdens?) and multiple lines of reasoning and evidence are therefore recommended (p.47). The potential of the principle of **optimisation** (a concept from the field of radiation protection which lies at the basis of the As Low As Reasonably Achievable (ALARA) principle) is investigated in this regard. Optimisation refers to selecting "the best protection options under the prevailing circumstances based on scientific considerations, societal concerns and ethical aspects as well as considerations of transparency" (p.23). Answering the question "have I done all that I reasonably can to avoid or reduce doses" is acknowledged to be "a matter of judgement and necessitates co-operation between all parties" (p.23). Applied to GD, optimisation is seen compatible with a **stepwise approach** of repository development; a forward-looking, iterative and participatory process. With regard to such a process, the International Commission on Radiological Protection (ICRP) recommends that "quantitative methods may provide input to dialogue, but they should never be the sole input" and considers that "the parameters to take into account include also social considerations and values, environmental considerations, as well as technical and economic considerations" (p.23). Protection "is based on both science (quantification of the health risk) and value judgement (what is an acceptable risk?) and optimisation is the recommended process to integrate both aspects (p.24). The notion of optimisation can thus be interpreted as socio-technical.

Although some international guidance exists (e.g. from ICRP, IAEA), the report points out that many questions remain to be answered with regard to what optimisation in the context of GD would mean more concretely. The optimisation principle can for instance be interpreted in a contradictory manner: Should one aim for radiological optimisation (reaching dose standards at the least overall cost) or system optimisation (applying all reasonable means for optimal dealing with all hazards, including social and economic) (p.26)? A need for caution in applying optimisation in stepwise decision making was also identified: principles of optimisation (e.g. ALARA and Best Available Technology (BAT)) are situated in time; in light of speculative changes in future societies, economies and technologies, they can make the process endless and leave the implementer in uncertainty (p.24). Optimisation of future doses is thus considered problematic and introduces issues of intergenerational ethics (p.45). Moreover, it also was not clear from the discussions at the workshop which stakeholders should participate in which decisions.

Other questions mentioned throughout the proceedings with multiple dimensions beyond the technical alone, are for example: how can there be confidence in a situation of absence of controls and presence of uncertainty (p.17); what should be the duration of control and compliance

demonstration (p.21, p.49); should the same weight be given to potential exposures in the far future as to actual exposures in the present or near future (p.21), etc.

Although the report in our opinion implicitly reflects on (certain aspects of) regulation for GD as (a) socio-technical challenge(s), overall our impression is that the social (notably referred to as ethical issues, societal expectations, communication, credibility, risk perception and timescales (p.9, p.30)) is mainly treated as an 'add on' to the overall predominantly technically perceived content of regulation. Statements such as "dose remains the ultimate safety indicator" (p.19) and "accommodation of stakeholder concerns should not be allowed to jeopardise technical safety" (p.28) seem to confirm this impression. An important merit of the report lies in underlining the need to elaborate on the inclusion of qualitative factors, the concretisation of including 'multiple lines of reasoning,' and the involvement of a variety of stakeholders (p.35) in regulation for GD, but not many definitive conclusions or recommendations were formulated and it is difficult to assess to what extent regulators actually envisage the elaboration and concretisation of these issues.

Reversibility and Retrievability for the deep disposal of HLW and Spent Fuel - Final report of the NEA R&R Project - OECD/NEA RWMC (2011)

This report gives an overview of the 4-year international project on Reversibility and Retrievability (R&R) launched in 2007 by the OECD/NEA RWMC. Milestones in the project were the conduct of a bibliographic survey, a survey of NEA countries' positions, and discussions among interested parties[1] that culminated with an International Conference and Dialogue in Reims, France (December 2010). The report gives an (evolutionary) overview of ideas on R&R. It presents how R&R have been integrated (or not) in national programmes and how various stakeholders have incorporated it (or not) into their vision on RWM, and under which conditions (p.1). "The goal of the project studies and activities was to acknowledge the range of approaches to R&R, rather than to recommend a specific approach, and to provide a basis for reflection rather than to lead towards a particular conclusion" (p.2).

The point of departure of the report remains GD "without the need for active control or oversight" (p.2) and without the *intention* to retrieve (p.7). Although the main conclusion of the RWMC in 2008, that R&R "must not jeopardise long-term safety" (p.4) is maintained, one of the most important additional points of departure of this 2011 report is that, whether intended or not, retrievability will always be possible, exactly due to the strategy of confinement (non-dispersion) and containment characterising GD. Moreover it is pointed out that "Reversibility implies a willingness to question previous decisions and a culture that encourages such a questioning attitude" (p.4). The main reasons of programmes that include retrievability are summarized as "(a) having an attitude of

[1] The project was carried out by the working group on R&R, with participation from 15 countries, the IAEA, the EC, the NEA Forum on Stakeholder Confidence, the NEA Integration Group for the Safety Case and the NEA Regulators Forum. The project benefitted from inputs by and exchanges among representatives of waste management organisations, regulatory agencies, policy making bodies, and civil society at large, including social scientists and community leaders.

humility or open-mindedness towards the future; (b) providing additional assurance of safety; and (c) heeding the desires of the public not to be locked into an 'irreversible" situation'" (p.5). Although this seems to indicate R&R as socio-technical issues, the ultimate goal of final closure and passive safety through the technology of GD is not questioned, and R&R are still mainly indicated as originating in "social pressures" (p.7). The focus of the report is therefore on the pre-closure phase (although mechanism for post-closure oversight (e.g. monitoring and memory keeping) are also mentioned) and R&R are described as attributes of the design *process* towards GD but not of the (intentional) design *content* of GD itself (p.8).

So although in general a differentiation is made between social policy issues and technical and safety issues, there nevertheless is attention for their interaction, illustrated by sentences such as: "Because they touch on freedom of choice and its relationship to safety, the concepts of R&R link societal and technical considerations" (p.20). The report also reflects that the relationship between the social and the technical throughout R&R is not stabilized yet and remains open for interpretation. E.g.:

- "Some interpret reversibility as a means for facilitating the correction of potential mistakes in the future, which would imply that it primarily addresses uncertainty regarding the long-term safety of waste management facilities. Others, however, argue that reversibility draws on the positive connotation of flexibility and freedom of choice provided for future generations. According to this interpretation, reversibility represents a commitment to the values of intergenerational equity and democracy" (p.23)
- "It is desirable that research should always support safety, and not be done purely in order to improve stakeholder acceptance. On the other hand, research and development that are triggered by stakeholder requests should be integrated into the developer's overall programme and not seen and undertaken as simply an add-on" (p.48)
- "A recent Swedish study observes for instance that retrievability is an issue that was thought closed about a decade ago, but it may now need to be re-opened based on interest expressed by a number of stakeholders" (p.20)

The report found two important questions in relation to the motivation of 'preserving options': (1) how should options be preserved? and (2) for how long a time is it considered reasonable or desirable to preserve these options? It is clearly stated that "The answers to these questions depend upon technical, political and social factors, and are therefore variable from country to country" (p.20). Technological variables mentioned include the nature of the waste (spent fuel containing known energy resources vs. high level waste), the geological surroundings (which affect both the likelihood and consequences of radioactive materials reaching the environment as well as the ease of retrieval) and repository construction techniques (affecting, for example, the ability to keep galleries open for extended periods after emplacement). Societal variables may include attitudes towards freedom of choice vs. assurance of safety, the degree of optimism with respect to future technological developments, and legal requirements (p.7, 8, 20).

With regard to the recommendations formulated throughout the report, it is not always clear whether they are based on a socio-technical vision of R&R or on vision in which social aspects are an

'add-on' to the technical. Apart from more general suggestions such as involvement of social sciences, public consultation and regulatory involvement, the following examples can be found:

- "[…] the decision of whether to proceed to the next step, or to modify the design or the process, is made in light of technical as well as social and political factors and in light of the terms of the licence. The stepwise approach provides opportunities for technical, societal and political reviews and, in principle, allows for the building of shared confidence in the feasibility and safety of the facility, as information and experience are acquired and decisions are democratically made. The stepwise approach also allows the process and its decisions to be progressively informed by data obtained through monitoring" (p.30).
- "The creation of a geological disposal facility for nuclear waste in a specific territory should be considered as a public issue, and therefore the robustness of such a project will be measured both in technical and in social terms. Along with safety analysis and performance assessment, matters of concern could include such items as local land-use planning, environmental preservation, techno-economic optimisation, integration of scientific and technical progress, social acceptability" (p. 45).
- "Granting future generations the possibility of intervention for a certain period, and thus making choices in intermediary operational stages, calls for much more than technical expertise alone. The capacity of maintaining multiple perspectives, technical as well as social and political, and maintaining a continuous dialogue with all the interested parties must therefore be included in the project design. Research and development activities relating scientific and technical development to decision-making processes and social sciences research may be very useful in order to deal with this complexity" (p.45).
- "[…] the possible distinction between physical closure (sealing of the last access shaft) and regulatory closure, which may be some time later in order to accommodate a post-closure surveillance period during which the operator may continue to be responsible. If the time period foreseen for such a surveillance period is very long, it may be necessary to have some method to transfer responsibility" (p.34).

The report also points out some remaining issues, in which we may recognize socio-technical challenges, such as the long term preservation of records, knowledge and memory (p.33), the relationship between R&R and safeguards (complementary requirements but somehow contradicting goals (p.49), prolonged monitoring (p.53), and the need for continuing R&D for the credibility of R&R (p.45).

Although the report reveals some socio-technical understandings, a distinction between reversibility and retrievability is made in which we may discern a tendency to once again split the social and the technical. It is clarified that reversibility is about the ability to reverse or reconsider decisions, and retrievability is about the ability to recover the waste (p.4). Following these definitions, it is stated that "reversibility is primarily a management or decision-making concept, rather than a technical one" and "As compared with retrievability, for which many of the issues are technical in nature and are often discussed by experts in the physical sciences and engineering disciplines, discussions of reversibility may benefit from participation of experts in the various social sciences" (p.26).

Introducing such a differentiation between reversibility (as the more social component) and retrievability (as the more technical component), could be understood as a way of regaining control over the situation by delineating a 'manageable playing field' for the physical sciences and engineers in which 'technical safety constraints' are felt to remain dominant. Although this may be perceived as contradicting a socio-technical understanding, the report is about reversibility **and** retrievability, and does seem to treat both notions as two sides of the same coin ("If reversibility is decided upon as a feature of a repository programme, then it would also be necessary to foresee retrievability strategies in the planning, design and implementation of the disposal facility." p.30).

Summarized, this report can be described as a testimony of a technical community looking for means of addressing a perceived societal demand for more flexibility and controllability, by tracing the multiple origins of the notions of R&R and by trying to make them more tangible and integrate them in their 'technical' concept of GD. What is ultimately clear from the report, is that the last word on R&R has not been said, but that attempts are made to deal with uncertainty and to find a workable relationship between 'the social' and 'the technical'.

IAEA Report on Governance Issues

Factors affecting public and political acceptance for the implementation of geological disposal - IAEA-TECDOC-1566 (2007)

This TECDOC can be considered a one of its kind, explicitly addressing societal aspects[9]. It reviews factors that the contributors consider to have an impact on the societal support for programmes to develop and implement geological disposal strategies.

The report was built on contributions gathered from invited participants from implementers, public administrations, (nuclear) research institutes and consulting companies (18 in total) to 4 meetings between December 2004 and December 2006, and a brief review of insights from recent international projects and activities. A number of cases were considered, based on experiences in most of the countries represented in the meetings (Canada, China, Germany, Japan, Sweden, UK, USA), and in a range of countries with small nuclear programmes (Argentina, Bulgaria, Hungary, Lithuania, Romania, Slovenia).

The report's aims was to illustrate the added value of broadening the technical dimension with social dialogue and insight in value judgements; and this to help decision makers, politicians and institutions proceed with geological disposal programmes. Therefore, the identified factors influencing acceptance are mainly listed in view of their controllability by those responsible for

[9] The IAEA Technical Documents (IAEA-TECDOC) series reports on various aspects of the Agency's work, but are in general – as their title suggest – dedicated to more technical questions.

developing national waste programmes. The concept of geological disposal in itself is not questioned in this report, but accepted as the final stage in RWM in most IAEA Member States, based on the existence of a "strong scientific and technical consensus" (p.1).

The process of developing and implementing a programme is considered to be broadly containing the following 6 stages (p.1):

(1) Development of a waste management policy;
(2) Establishment of legal and institutional frameworks;
(3) Identification and elaboration through research of a generic technical concept for geological disposal;
(4) Initiation of surface and underground investigations to characterize host rocks, and development of research programmes to assess waste management system interactions;
(5) Determination of the suitability of a site for development as a deep underground repository;
(6) Design, licensing, construction, operation, and closure of a deep underground repository.

When further describing these stages in more detail with reference to the experience in different Member States, public involvement is mentioned explicitly only in relation to stage 5 (determination of site suitability) and then only in view of "the process of regional development and planning" (p.9). Although public concerns are mentioned as an issue in the development of a waste management policy (stage 1), no hint is given as to a possible need for public participation at this stage. Stages 2 (development of a legal and institutional framework) and 3 (elaboration of a generic concept for GD) are described as inherently 'technical' in nature and thus expert driven. Even though public and political acceptance is mentioned in stage 4 as a pre-condition for (site) investigations to characterize host rocks, again that is not explicitly linked to issues of participation. Neither is this made explicit with regard to the last stage, which covers the whole range from design, over licensing, construction, and operation to closure of the repository (stage 6). This is particularly striking as this stage alone seems to contain more issues than all other stages put together, and is certainly the one that will take the longest to get through.

Three main challenges can be derived from this report. The first is the more general challenge of gaining sufficient support from relevant actors to take action at a given step in the repository development process. Even if referring to a "need to open up a domain traditionally exclusive of technical expertise" (p.3), that need is considered to stem from developments in society and new policy discourses, but not following from any shortcomings on the technical side to deal with the issue, as the first sentence in the following quote seems to indicate:

"Progress on the scientific and technical aspects of geological disposal made over recent decades have created the basis for the demonstration and confirmation of the soundness of the geological disposal concept. However, ***continuing societal concerns limit the application*** *of deep geological disposal in many countries* ***regardless its consideration of a technically feasible and a demonstrably safe option****." (p.3 – emphasis added)*

Therefore this challenge seems mainly framed as a socio-political challenge. It is indeed stated that stakeholder concerns should be addressed alongside with technical issues during the geological repository development process. However, in the final recommendations of the report, this is only considered of major importance with regard to the site-specific stages (stages 4 to 6). In the detailed description of the six stages in implementing GD, it is furthermore only explicitly mentioned in reference to stage 5 (determination of site suitability).

The second challenge of building confidence in a technology without definitive demonstration is framed more explicitly as socio-technical:

"This report has shown that a feasible solution has its technical dimension, but that 'an acceptable solution' always will have a combined technical and social dimension." The social dimension *"cannot be considered separately from technical criteria" (p.39).*

A third and last big challenge addressed in this report is that of siting. Again this framed as a socio-technical challenge, through acknowledging that it will simply not be possible to ever identify "the best" site. The reason for this: there are important practical limitations to finding the best site. Even in a large country, it is not deemed realistic to investigate in detail more than a few sites. Therefore the report concludes that "identifying a 'best' approach or site is never possible", and that on must look "for an 'acceptable' approach and site", which seems to require a social process (p.39).

Factors influencing both the siting and confidence question are subsequently identified and categorised as either "technical", "structural", "behavioural", or related to "process" (p.10). Among the technical factors, reference is made to e.g. the integration of social robustness into the demonstration of the robustness of technical options; and – more concretely – including requirements such as retrievability, monitoring and flexibility into the concept (p.12). Among the structural factors, the existence of mechanisms for societal control, such as oversight groups for audit and control, are listed (p.14).

Conclusion

Throughout this report we reviewed the main past initiatives to address social aspects of RWM by international organisations, focussing on the extent to which they are linked to technical issues. Overall, this review can be said to confirm our initial idea that social science research on RWM has so far mainly focussed on participatory processes, and that less effort has been dedicated to describing and analysing the socio-technical content of such processes.

Almost all projects have identified RWM and/or GD as entailing tensions between the social and the technical, but often this is done in a manner that highlights the separation between the two. Some reports fully reflect this separation, describing remaining issues in terms of socio-political challenges and accepting the proposed waste management technologies as a given. These reports focus on democratic processes to involve a broader range of stakeholders, most notably local communities, and suggest tools and conditions for doing so. The gain of participatory processes is mainly located in the favourable characteristics of decision making it enables (inclusiveness, fairness, robustness, …), focussing on the "governance virtue" of participation (cf. Pellizoni, 2001): participation as a strategic means to attain social acceptance and legitimacy. Less attention is paid to the "cognitive virtue" (ibidem) or "substantive" function (cf. Stirling, 2008) of creating new knowledge and new solutions as a result of bringing in alternative perspectives, and how this could contribute to technical choices. Trust is put in democracy to resolve the problem of clashing values, which does not need to have a substantial effect on the technology that causes clashing values to surface.

When participation is elaborated to also include the phase of knowledge building, more socio-technical aspects come to the foreground in some reports. This notably happens in the context of addressing the interest- and value-laden nature of knowledge and research, in particular with regard to dealing with uncertainties (notably related to the long-term). The inclusion of multiple perspectives by various actors and disciplines is often recommended, but again most reports focus on process-related qualities (openness, transparency, …) more than on the content-related outcome of incorporating pluralistic values and opinions in the concrete development of disposal technology.

Some reports give an explicit acknowledgement of the mutual shaping of technology and society (e.g. CARL, RISCOM II, the FSC report on "Partnering for LT-management"). However, a thorough analysis of the specificities of the socio-technical nature of RWM and GD and, moreover, of the means to achieve real socio-technical combinations, so far does not seem to have been made. Most reports furthermore focus on siting, implicitly suggesting that once beyond that hurdle, (technical) 'business as usual" can be resumed. Given that in a number of cases, that hurdle has fairly recently been taken (e.g. for GD in Sweden and Finland, for other types of waste in Belgium and Slovenia), it may merit further exploration how this evolves in practice.

Throughout the FSC reports, some more concrete ideas of the potential social shaping of technology (also beyond siting) are mentioned, e.g. design features in view of understandability, memorialisation and accessibility. But with regard to how these ideas can be concretely realized and what the consequences will be, the reports remain rather vague. Moreover, the main emphasize is not on the

influence of the social in shaping the technical, but on the influence of the technical in shaping the social in a certain direction, e.g. towards creating positive symbolism around GD. In line with this finding, a reoccurring idea in many reports is that social aspects are important, but technical safety prevails. The reasons why socio-political aspects need to be taken into account are hardly ever directly related to safety, which often remains defined as a techno-scientific quality. This tallies with a vision of social aspects as an 'add on' to technical aspects, the former, 'subjective opinions' needing to be reconciled with the latter, 'objective facts'.

Some perspectives seem to offer potential for a more equal and integrative treatment of the social and the technical, such as the frameworks of 'risk governance' (as the notion inherently couples content (risk) and form (governance) (e.g. RISCOM II, ARGONA, RiskBridge) and 'stepwise decision making' (e.g. FSC, RWMC). With regard to the latter, an important challenge is identified as needing to reconcile the competing requirements of goal-centeredness (final, passive disposal) and adaptability (flexibility, reversibility). Taking a stepwise approach is presented as a means to deal with this tension, but only partially and temporarily. This deserves further attention throughout the InSOTEC project. Reports that discuss more integrative perspectives often also refer to topics that the InSOTEC partners have also identified as crucial, such as retrievability, siting, and defining safety and performance assessment criteria.

In general, many reports reflect the finding that in RWM today a greater awareness can be noticed of social issues and the need to open up to different types of expertise than in the early days. It remains, however, hard to judge to what degree this finding goes beyond discourse and will actually influence the technologies that eventually will be implemented. Still, a significant number of the reports reviewed (even if the majority focusses on RWM in general, and not on the specific technology of GD), do touch (some occasionally, and some consistently) on the fact that 'social' (whether political preferences, public concerns, social values, national traditions, assumptions about future generations, financial aspects, decision making processes, …) and 'techno-scientific' aspects (e.g. the kind of waste stored, the geological characteristics of the disposal site, the physical properties of containers for storage, (tools for) measurements, …) of GD are not easily separable (cf. Sundqvist, 2008). Echoes of socio-technical challenges (e.g. siting or monitoring) and socio-technical combinations (e.g. reversibility and retrievability) could be found in most reports, even if often implicitly and sometimes even in juxtaposition to the main line of argument. It would thus seem that the time has indeed come to explore this entanglement further and make it more explicit.

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Annex 1: Screening Matrix for the Reviewed Reports

Basic information to situate the report	
Title of report	Year of publication
Project or initiative it relates to	Period
Author organisation(s)	Type of organisation [1]
Other organisations involved	Type of organisation [1]
Aim(s) of the report / project [2]	

Main social challenges covered		
CHALLENGE 1 … *[fill out the sections below for each identified challenge]*[3]		
General description / Problem analysis [4]		
Type of challenge		
	Mainly socio-political in nature [5]	
	Social challenges as an "add on" to the technical [6]	
	Socio-technical challenges [7]	
Relating to …[8]		
	Geological disposal	
	RWM in general	
Approach and method for analysis		
Type of sources used as basis for analysis [9]		
Actors and arena's identified around this issue		
Suggested solution(s), outcomes & recommendations, … [10]		
Regarding the (scientific) knowledge base:	Claimed benefits / added value [11]:	
	Potential risks / challenges of implementing that solution [11]:	
Regarding national RWM programmes:	Claimed benefits / added value:	
	Potential risks / challenges of implementing that solution:	

Regarding specific stakeholder groups:	Claimed benefits / added value:
	Potential risks / challenges of implementing that solution:
Identified open points, need for research and/or action [12]	

Elements for further analysis
Please provide here any comments, reflections, … that could be used in Part 2

[1] E.g. NGO, implementer, research institute (technical, social, mix), …

[2] In as much as this is explicitly stated; to shed light on the context of the approach taken and how challenges are addressed.

[3] Not all sections need to be filled out in exactly this form and order. Just as long as the required information is, in one way or other, provided for.

[4] Give in a few general terms the way the challenge is addressed in the report, with attention to the context and objective under which the issue is treated. Indicate how the issue/problem is analysed.

[5] Under this category we think of classical governance issues: on procedure, increasing legitimacy, political issues not directly related to the content of the technical.

[6] Here we see a closer relation between the social and the technical, and some contemplation about the content of the technical programme. Still the social is mainly framed as something to be added on to the technical: additional values to be considered, different priorities, …

[7] This category we reserve for the more fully integrated issues; where the focus is on the social in the technical (opening up the black box etc.), on the interdependency between the two, ...

[8] Indicate here if the challenges apply specifically to GD and/or to RWM in general (according to the report).

[9] E.g. case studies, national experience, workshops, …

[10] If any solutions are suggested, indicate, to the extent possible, if these are aimed at the (scientific) knowledge base, national RWM programmes, specific stakeholder groups.

[11] Also indicate if particular benefits or added value are claimed, and/or if potential risks and challenges are mentioned related to implementing a specific solution.

[12] Offered by the author(s) of the report and in as much as not already covered in the section above.

Annex 2: Specifications of the Reviewed Reports

PREVIOUS EC FUNDED GOVERNANCE PROJECTS (EURATOM)

COWAM Network: Nuclear waste management from a local perspective – Reflections for a Better Governance – Final Report	
Year of publication	Period covered
2003	2000-2003
Project or initiative it relates to	
EC FP 5 Concerted Action	
Author organisation(s)	Type of organisation
Mutadis	consulting organisation
Screened by:	Beate Kallenbach-Herbert - ÖKO

COWAM 2 Final Synthesis Report	
Year of publication	Period covered
2007	2004-2006
Project or initiative it relates to	
EC 6th framework programme	
Author organisation(s)	Type of organisation
Mutadis, Symlog, Syncho Ltd ETH, CEPN	consulting organisations research institutes
Screened by:	Drago Kos - UL

COWAM in Practice (CIP): European-level Guidelines for the Inclusive Governance of Radioactive Waste Management	
Year of publication	Period covered
2010	2007-2009
Project or initiative it relates to	
EC 6th framework programme	
Author organisation(s)	Type of organisation
Mutadis, Symlog, Galson Sciences Ltd, Westlakes Scientific Consulting Ltd IRSN	consulting organisations research institute
Screened by:	Drago Kos - UL

RISCOM II final report	
Year of publication	Period covered
2003	2000-2003
Project or initiative it relates to	
EC 5th framework programme	
Author organisation(s)	Type of organisation
Karita Konsult, Syncho Ltd, Galson Sciences Ltd, Diskurssi Ltd, Wenergy Nirex, SKB, Posiva SKI, SSI, UK - Environment Agency EDF IRSN, NRI Lancaster University	consulting organisations implementers regulators industry research institutes university
Screened by:	Jantine Schröder - UA

Towards implementation of transparency and participation in radioactive waste management programmes	
Year of publication	Period covered
2010	2003-2010
Project or initiative it relates to	
ARGONA (EC 6th framework programme)	
Author organisation(s)	Type of organisation
Swedish Radiation Protection Authority Karita Research AB, Sweden	Regulator Consulting organisation
Screened by:	Göran Sundqvist - UiO

Local competence building and public information in European nuclear territories	
Year of publication	Period covered
2009	2007-2008
Project or initiative it relates to	
Local competence building and public information in European nuclear territories	
Author organisation(s)	Type of organisation
GMF Amphos21	Association Consulting organisation
Screened by:	Meritxell Martell - MERIENCE

Situation concerning public information about and involvement in the decision making processes in the nuclear sector	
Year of publication	Period covered
2007	2005-2006
Project or initiative it relates to	
Inclusive Governance of Nuclear Activities (IGNA project)	
Author organisation(s)	Type of organisation
Mutadis CEPN, CIEMAT University of Aberdeen	Consulting organisation Research institutes University
Screened by:	Meritxell Martell - MERIENCE

OTHER INTERNATIONAL RESEARCH PROJECTS ON RADWASTE GOVERNANCE

RISK FIELD ESSAY – Radioactive Waste	
Year of publication	Period covered
2009	1/7/2006-30/6/2009
Project or initiative it relates to	
RISK BRIDGE (Coordinated Action on Building Robust, Integrative inter-Disciplinary Governance models for Emerging and Existing risks)	
Author organisation(s)	Type of organisation
SYMLOG	Consulting organisation
Screened by:	Anne Bergmans - UA

Wanting the Unwanted: Effects of Public and Stakeholder Involvement in the Long-term Management of Radioactive Waste and the Siting of Repository Facilities. Final Report of the CARL project	
Year of publication	Period covered
2008	2004-2007
Project or initiative it relates to	
CARL project	
Author organisation(s)	Type of organisation
Univ. of Antwerp, Univ. of East Anglia, Univ. of Gothenburg, Univ. of Ljubljana	Universities
Screened by:	Göran Sundqvist - UiO

NEA – FSC REPORTS

Stepwise Approach to Decision Making for Long-term RWM. Experience, Issues and Guiding Principles	
Year of publication	Period covered
2004	2000-2003
Project or initiative it relates to	
Forum on Stakeholder Confidence	
Author organisation(s)	Type of organisation
OECD - NEA	Intergovernmental
Screened by:	Anna Vari - MTATK

Learning and Adapting to Societal Requirements for Radioactive Waste Management	
Year of publication	Period covered
2004	2000-2003
Project or initiative it relates to	
Forum on Stakeholder Confidence	
Author organisation(s)	Type of organisation
OECD - NEA	Intergovernmental
Screened by:	Anna Vari - MTATK

Proceedings of the topical session of the 6th meeting of the FSC on "The link between RD&D and stakeholder confidence"	
Year of publication	Period covered
2006	6th meeting 2005
Project or initiative it relates to	
FSC 6th meeting	
Author organisation(s)	Type of organisation
OECD - NEA	Intergovernmental
Screened by:	Beate Kallenbach-Herbert - ÖKO

Cultural and Structural Changes in Radioactive Waste Management Organisations	
Year of publication	Period covered
2007	2000-2006
Project or initiative it relates to	
Forum on Stakeholder Confidence	
Author organisation(s)	Type of organisation
OECD - NEA	Intergovernmental
Screened by:	Anna Vari - MTATK

Fostering a Durable Relationship Between a Waste Management Facility and its Host Community	
Year of publication	Period covered
2007	2000-2006
Project or initiative it relates to	
Forum on Stakeholder Confidence	
Author organisation(s)	Type of organisation
OECD - NEA	Intergovernmental
Screened by:	Anna Vari - MTATK

Stakeholder Involvement in Decommissioning Nuclear Facilities. International lessons Learnt	
Year of publication	Period covered
2007	14-16/11/2005
Project or initiative it relates to	
Results from a joined topical session of the RWMC Working Party on Decommissioning and Dismantling (WPDD), and the Forum on Stakeholder Confidence (FSC)	
Author organisation(s)	Type of organisation
OECD - NEA (WPDD & FSC)	Intergovernmental
Screened by:	Anne Bergmans - UA

Link Between Research, Development and Demonstration (RD&D) and Stakeholder Confidence: Use of Analogues for Confidence Building	
Year of publication	Period covered
2008	9th meeting, 2008
Project or initiative it relates to	
Forum on Stakeholder Confidence	
Author organisation(s)	Type of organisation
OECD - NEA	Intergovernmental
Screened by:	Beate Kallenbach-Herbert - ÖKO

More than just concrete realities: the symbolic dimension of RWM	
Year of publication	Period covered
2010	5/06/2008
Project or initiative it relates to	
FSC: symbolic dimension as a transversal theme to its programme of work. Topical session at 9th regular session	
Author organisation(s)	Type of organisation
OECD - NEA	Intergovernmental
Screened by:	Jantine Schröder - UA

Partnering for Long-term Management of Radioactive Waste	
Year of publication	Period covered
2010	2000-2009
Project or initiative it relates to	
Forum on Stakeholder Confidence	
Author organisation(s)	Type of organisation
OECD - NEA	Intergovernmental
Screened by:	Anna Vari - MTATK

NEA – RWMC REPORTS WITH POTENTIAL REFERENCE TO GOVERNANCE ISSUES

Moving Forward with Geological Disposal of Radioactive Waste	
Year of publication	Period covered
2008	unspecified
Project or initiative it relates to	
Collective Statement of the NEA Radioactive Waste Management Committee	
Author organisation(s)	Type of organisation
OECD – NEA (RWMC)	Intergovernmental
Screened by:	Anne Bergmans - UA

Towards Transparent, Proportionate and Deliverable Regulation for Geological Disposal	
Year of publication	Period covered
2010	Workshop 20-22/01/2009
Project or initiative it relates to	
Regulator's Forum (RF) of the NEA RWMC – Workshop Proceedings	
Author organisation(s)	Type of organisation
OECD – NEA (RWMC - RF)	Intergovernmental
Screened by:	Jantine Schröder - UA

Reversibility and Retrievability (R&R) for the Deep Disposal of High-Level Waste and Spent Fuel: Final Report	
Year of publication	Period covered
2011	2007-2011
Project or initiative it relates to	
NEA R&R Project	
Author organisation(s)	Type of organisation
OECD – NEA (RWMC)	Intergovernmental
Screened by:	Jantine Schröder - UA

IAEA REPORT ON GOVERNANCE ISSUES

Factors Affecting Public and Political Acceptance for the Implementation of Geological Disposal	
Year of publication	Period covered
2007	12/2004-12/2006
Project or initiative it relates to	
IAEA-TECDOC-1566	
Author organisation(s)	Type of organisation
IAEA	International
Screened by:	Anne Bergmans - UA