Radioactive Waste Management
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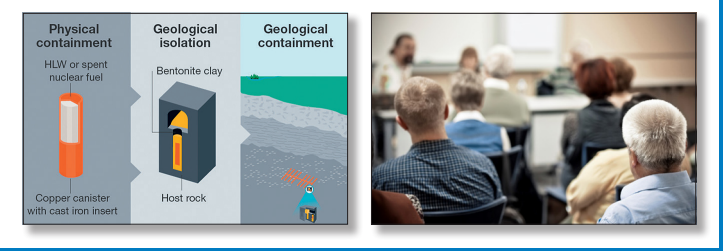
Communication on the Safety Case for a Deep Geological Repository



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Radioactive Waste Management

Communication on the Safety Case for a Deep Geological Repository

NEA No. 7336

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The mission of the NEA is:

- to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes;
- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include the safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information. The NEA Data Bank provides nuclear data and computer program services for participating countries.

Cover photos: Conceptual figure of a deep geological repository (RWM, UK); Communication group (© iStockphoto.com/vm).

Foreword

The mission of the Integration Group for the Safety Case (IGSC) of the NEA Radioactive Waste Management Committee (RWMC) is to assist member countries in developing effective safety cases supported by a robust scientific technical basis. In addition to addressing technical aspects, the IGSC also works to address the strategic and policy aspects of repository development. In 2014, a subgroup of the IGSC was formed – the Safety Case Communication Group – to address the challenge of communicating highly technical information to less technical stakeholder audiences. This report contains the results of the first phase of this group's work, dealing with the questions: i) what is the experience base concerning the effectiveness or non-effectiveness of different tools for communicating safety case results or certain aspects of it to an interested non-technical audience, and ii) how can communication based on this experience be improved and included into a safety case development effort from the beginning?

This report benefitted from a number of sources cited in the text and listed in the appendices. The IGSC also co-ordinates with the NEA Forum on Stakeholder Confidence (FSC), another technical working group under the RWMC umbrella. The report complements the FSC report on *Partnering for Long-term Management of Radioactive Waste: Evolution and Current Practice in Thirteen Countries* (NEA, 2010), which outlines the importance of establishing true partnerships and communicating technical information interactively with a non-technical audience so as to ensure that understanding is achieved and learning is mutual. The present report examines how this goal may be reached through discussion of the practicalities involved in effectively and fairly communicating technical information to a non-technical audience. Members of the IGSC Safety Case Communication Group who prepared this report include Lucy Bailey (Radioactive Waste Management, United Kingdom), Frederik Bernier (Federal Agency for Nuclear Control [FANC], Belgium), Wilhelm Bollingerfehr (DBE Technology GmbH, Germany), Miguel Cunado (Enresa, Spain), Doug Ilett (Environment Agency, United Kingdom), Gloria Kwong (NEA), Ulrich Noseck (GRS, Germany), Klaus Röhlig (TU Clausthal, Germany), Abe van Luik (Department of Energy, United States), Jan Weber (Federal Institute for Geosciences and Natural Resources, Germany) and Eef Weetjens (SCK•CEN, Belgium). The IGSC would like to acknowledge the helpful contribution of the FSC in reviewing the report.

This report is dedicated to Dr Abraham Van Luik for his kindness and devotion, and for his tremendous support to the IGSC.

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List of abbreviations and acronyms

ABWR	Advanced boiling water reactor
BfS	Bundesamt für Strahlenschutz (German Federal Office for Radiation Protection)
Enresa	Empresa Nacional de Residuos Radiactivos, S.A. (Spanish National Radioactive Waste Management Agency)
FSC	Forum on Stakeholder Confidence (NEA)
GDA	Generic design assessment
GRS	Gesellschaft für Anlagen- und Reaktorsicherheit (Germany)
ICRP	International Commission on Radiological Protection
IGSC	Integrated Group for the Safety Case (NEA)
IPA	Integrated performance assessment
IPAG	Integrated Performance Assessment Group
JNC	Japan Nuclear Cycle Development Institute
MONA	Mols Overleg Nucleair Afval (Belgium)
NEA	Nuclear Energy Agency
OECD	Organisation for Economic Co-operation and Development
ONDRAF/NIRAS	Belgian Agency for Radioactive Waste and Enriched Fissile Materials
OPG	Ontario Power Generation
R&R	Reversibility and retrievability
RD&D	Research, development and demonstration
RWMC	Radioactive Waste Management Committee (NEA)
SITEX	Stainable Network for Independent Technical Expertise
SKB	Swedish Nuclear Fuel and Waste Management Company
SKI	Swedish Nuclear Power Inspectorate
SSI	Swedish Radiation Protection Authority
STORA	Studie en Overleg Radioactief Afval (Belgium)
URL	Underground research laboratory
US DOE	United States Department of Energy
US NRC	United States Nuclear Regulatory Commission

Chapter 1. Introduction

Evidence, analyses and arguments that a deep geological repository will be safe have to be provided within a safety case. Compiling the safety case for a deep geological repository is a highly technical undertaking involving a number of scientific disciplines, as well as the principles and mathematics of engineering and design. The selection of materials and approaches used in designing a geological disposal facility involves availability, constructability and scientific considerations. The safety case also substantiates the myriad decisions that go into the design of a safe operating system, and ensures that its long-term performance meets safety criteria and satisfies regulatory requirements. Compiling a safety case thus generates an extensive set of voluminous documents with technical and scientific content.

The documentation, observations and field and laboratory studies that support a repository safety case, as well as the analyses themselves, are likely to be both massive and unintelligible to a typical "stakeholder", and more so to the average member of the public. Yet it is the stakeholders and the public that will be asked to accept that a proposed repository will be safe during its lifetime and long afterwards. The challenge is to communicate the case for safety in plain language – which accurately reflects the outcome of the many technical studies, analyses and calculations.

Members of the Nuclear Energy Agency Integration Group for the Safety Case (IGSC) represent implementers, regulators, organisations supporting both, and research organisations from a number of countries with radioactive waste disposal programmes. Collectively, they have much stakeholder communication experience, both in terms of successes and failures. The purpose of this report is to collate the lessons learnt and insights from that collective experience in order to guide ongoing stakeholder communication efforts by implementers and regulators. A number of documents were reviewed by IGSC members in support of this report, and these reviews are shown in Appendix A (NEA technical documents) and Appendix B (European Commission studies/technical documents). In addition, several IGSC member organisations were each asked to share their lessons learnt from a recent major national communication activity, as shown in Appendix C. For all these reviews, a default table with 12 questions was developed and completed by each reviewer.

Chapter 2. Stakeholder communication objectives and major messages

All communication is a two-way process and therefore good stakeholder communication requires the involvement of the stakeholders[1] from the outset. The communication mindset should be that of communicating "with" rather than "to" stakeholders. This means entering a dialogue and engaging with stakeholders from the beginning of the process. Such an approach enables understanding of the issues from the stakeholder perspective and therefore helps to facilitate a successful communication outcome.

Telling a compelling story: The essence of successful communication

"Planning Theory" is a professional journal that publishes research on the planning process which, as indicated by van Hulst (2012), describes the communications process, as well as the planning process itself, as "storytelling". The gist of this approach is that when telling a story, one gives a background to set the stage, identifying the problem and the history around any previous attempts to solve that problem, and then makes a strong case for why this attempt at a solution is likely to succeed where others may have failed.

In terms of a proposed radioactive waste repository, this would translate into a description of the problem which can be further examined and addressed in a safety case. Safety cases provide a basis for discussion between stakeholders by allowing critical review of the presented evidence as to why a repository is acceptably safe. The benefits provided by creating these wastes (nuclear power, medicine, naval vessel power, or whatever is nationally or locally relevant) can be addressed as part of this back-story of why the waste exists. However, the point can be that whatever one may think of the uses made of this material, the waste now exists. It exists on the surface, where it needs guards, gates and physical inspection and maintenance.

The story can then take a national turn or international turn describing deep geological disposal as the preferred option for the majority of nations with a nuclear power programme. It is considered the safest, most practical, efficient and ethical way of disposing of high-level waste by moving the source of hazard from the surface to deep underground, to take advantage of geological stability over much longer timescales than it is possible to provide at the surface. Honing in on the national scene can then include, if appropriate, previous repository siting efforts and why this one is likely to succeed (more favourable geological setting, more local support, more mature design, etc.).

Then finally it is time to unveil the case for safety: the story of why it is expected to be safe operationally as well as in the very long term. The safety case helps the decision making related to siting, designing and operation of the radioactive waste repository. It is also expected to play the role of a common basis for communications about scientific/technical topics between experts and non-technical audiences. That is where this document begins: how to communicate the technical case for system safety to audiences that span the scientific/technical knowledge scale from expert to high school student.

1. For a definition of stakeholders, see Chapter 3.

General principles and objectives

The following is based on observations from document reviews as well as on experiences and views of the authors of this report. It provides a basis for further discussion from the Integration Group for the Safety Case (IGSC) member organisations' perspectives.

Communication planning is necessary, so that a communication strategy should be developed. A communication strategy defines the objectives and goals to conduct communication with stakeholders.

A communication plan is a tool to implement the communication strategy for a particular project/event and initiative. It can be regarded as a map to reach the goal. To create a communication plan, the following elements should be addressed:

- define the scope and objectives for any given communication effort;
- derive the central messages to be communicated;
- identify target groups and tailor the messages for understanding technical subjects;
- select communication channels and tools to deliver the information and key messages in an effective manner;
- develop communication means to enhance effectiveness and, if possible, enhance understanding;
- design instruments and practices, including shared platforms, that allow communications effectiveness to be achieved and measured, with the specific purpose of fostering confidence and information exchange among stakeholders.

The ***scope*** for this report is the communication of safety cases (i.e. their role, content and results) with stakeholder non-technical audiences.

The ***objectives*** of such communication depend on the role of the respective actor. The IGSC is composed of representatives from implementers, regulators, organisations supporting both and research organisations. Naturally, this variety of roles results in a potential range of objectives. Nevertheless, objectives can be identified which are common for all these actors because they are part of a governance process aiming at a feasible and safe disposal solution for radioactive waste. In order to shape such a governance process according to modern rules and increase its chances for success, it is necessary:

- to promote openness/transparency throughout the process;
- to increase trust in the process as a whole (even if there might be less trust in specific actors);
- to ensure/keep accessibility to the information related to decisions of the site selection and the safety/security frameworks of the repository, for future generations;
- to increase capacity for technical understanding in the suite of different audiences that make up a facility's "stakeholders".

Irrespective of their specific role in the process, all the participating actors need to demonstrate their real dedication to safety as well as their competence. This means the actors can then convey their key ***messages*** in an effective way.

Key factors to pay attention to are as follows:

- the role of participants, in order to manage and to respond to stakeholders' expectations;

- uncertain information;
- individual differences about risk perception;
- existence of emotion.

Effectiveness can be measured in a variety of ways, including quite simply by asking if the audience had its questions answered satisfactorily. Because some members of any public gathering may be reticent to raise their hands and speak, comments could also be provided by asking people to fill out a form that is made readily available to the audience. Use of web (blogs, fora of discussion) can increase ways of receiving feedback and hence measuring a communication's effectiveness.

Building technical understanding and capacity among stakeholders

On behalf of the European Commission, Ferraro and Martell published an online "lessons learnt" document reflecting the Euratom Programme's experience. In observations on communications of technical information, they underscored the above comment that capacity building is a necessary objective of technical communications. They also cautioned against the idea that unilateral, protracted information campaigns can be sufficient:

- Capacity building is key for local communities and non-governmental organisations if they are expected to take part in participatory processes. Unlike non-governmental organisations, local involvement may be limited by the lack of competences of specific groups and individuals which can be of many kinds (technical knowledge, organisation capabilities, communication skills, etc.).
- Material resources are particularly important for local competence building. For instance, training should be provided to local communities to allow them to understand the complexity of radioactive waste management.
- Through linkages and exchanges among local communities across countries, municipal actors could learn from one another's experience. A stronger link among European local communities emerged as a strong need.
- Networking of local communities of the same country is also often missing; platforms should be put in place to help intra-state connections among local communities which may share similar problems and similar possible solutions. Intra-state linkages among communities may also help to achieve a sufficient critical mass to influence national decision making.
- Time is needed for stakeholders to grasp the issues at stake.
- Enough time should be allowed so that local players are able to develop dialogue and build their input. However, extending the process too much may induce "stakeholder fatigue" and the withdrawal of individuals with other responsibilities.

The primary reason to emphasise capacity building, especially in local and regional communities, is to create a self-sustaining, self-spreading awareness and, if warranted, acceptance. Since repository facilities are by definition multi-generational enterprises, it is important that knowledge of what is being done is transmitted across both space and time. After initial, rather intense engagements with the communities to build their understanding and capacity to understand and evaluate technical information, less frequent public meetings will maintain the community capacity that was built up at the beginning. However, neglecting the local communities during the long period of operations will cause a loss of technical capacity and require a much greater communications effort to maintain acceptance, especially in case of a mishap. There needs to be an effort to maintain technical capacity to assure awareness, mutual

understanding and acceptance in case of a need to propose and examine changes such those that optimise system performance and that enhance disposal system capacity, or come at the start of closure operations.

The awareness challenge and the avoidance of "surprises"

A major challenge in the process is that awareness among what is called "the general public" is mostly rather low. This, however, can rapidly change when parts of the "general public" (e.g. a region or a municipality) become affected and thus concerned, e.g. by a siting consideration or decision. Experience, also from fields other than radioactive waste management, shows that such a consideration or decision might be perceived as a "negative surprise" even if actors might argue that the preceding process was completely legal, according to the rules and transparent.

Additional "surprises" after siting might concern the amount of waste to be managed or certain planning details about transportation, the size and function of surface facilities, etc. The effect of such surprises might become amplified by the actions of mass media for which news value is often a more important consideration than getting the details and implications correct. It is therefore an important objective to avoid such "surprises" by communicating all salient aspects of the proposed project fully and widely. An early involvement of journalists and bloggers, through seminars and focus groups, can be very helpful in providing the means to keep the balance between news values and correctness.

It is important to tell a story that covers the stages that have gone before and the timing of what is being proposed. Building understanding requires such supporting information. Supporting information could also include what options have been considered before recommending the current course of proposed action.

Dealing with divergent views among stakeholders, and with expert dissent

During the communications process, divergent views among stakeholders – even about fundamental issues such as the hazard potential of the waste and the disposal facility, the concepts of passive safety, oversight, or retrievability, the necessity of and potential for monitoring, or in general, the construction of a safe repository – are unavoidable. Expert dissent might be communicated to, and contribute to, the divergence of views among non-expert stakeholders.

Downplaying such divergence and claiming that the experts now addressing the stakeholder audience are the only ones who are able competently to address the issues at stake is neither honest nor promising. Rather, an objective ought to be to address divergent views through two-way dialogue acknowledging, as appropriate, the validity of the divergent view and at the same time placing it into the context of what is being proposed, and showing, as appropriate, how the issue worrying the expert is known, anticipated, and being dealt with through design or additional scientific evaluation work. If that work has already been done its outcome, perhaps showing it is not a safety-relevant concern given the repository site properties and design, can be communicated in a non-adversarial manner.

It is important to keep in mind that a successful communications effort is a team effort. Technical experts as well as leadership ought to be part of such a communications effort so that the audience members realise they are speaking with, or at least in the presence of, the scientists, engineers and managers that do the work being described. This is an important public-confidence enhancing approach.

Dealing with general misgivings concerning the long-term safety of the proposed repository

Although the public may generally be more interested in the near-term safety of their environment, interested members of the public have also expressed fundamental doubts about deep geologic disposal being the most appropriate management endpoint for (especially long-lived) radioactive waste. These doubts are associated with the perception that the concept of passive (inherent) safety implies abandoning the waste. The questioner does not have confidence in the performance of systems designed to be passively safe in the very long term, typically citing examples of things that went wrong in spite of promises that they would not. This is an example of analogue reasoning. The very long timescales of post-closure concern play an important role in this type of discussion. It is therefore crucial to communicate:

- that we cannot rely on society to "guard" the waste in the very long term for a variety of reasons and therefore another solution is needed;
- that geology offers the potential to establish such a solution, "deep rock is more stable than society";
- that it is planned to carry out oversight for as long as achievable – even if one does not rely on this oversight for safety;
- that there is no intention to "abandon" the disposal facility, rather every effort will be made to ensure that its location remains known to future societies. The intention is that it should not be a burden on those future societies, i.e. no maintenance of the facility is required;
- that over such long timescales, uncertainties are inevitable. We need to be honest about the uncertainties and explain how they are addressed in the safety case, explaining that they are/will be subject to regulatory scrutiny and that no facility would be licensed where the uncertainties are unacceptable;
- that the world consensus is that there is a basis for confidence in deep geological disposal as a safe solution based on extensive research and development, and there is a sound technical basis for the worldwide consensus that geological disposal is the most practical, practicable, and ethically acceptable way to remove risk from the "biosphere," the surface of the Earth where people live (NEA, 1995; IAEA, 2003; EC, 2011).

These general messages need to be underpinned by more detailed ones about how the system should perform (safety concept) and how we assure that it is going to function this way (safety assessment/safety case). Depending on the stage of the project and the discussion with stakeholders it may be good to forestall questions about why geological disposal with statements about what has been considered by the world's nuclear communities before honing in on geological disposal as the preferred solution.

Tailoring the message to the expected/intended audience

The safety concept, safety assessment, and safety case need to be communicated with a degree of detail depending on the audience and the aim of the communication event, therefore a "translation" of the safety concept, repository concept and associated safety functions needs to be made into non-technical language. Furthermore, one needs to communicate why the applicant or regulator believes this concept to be appropriate and safe, i.e. the multiple lines of evidence that suggest that the system will function as intended are to be "translated" and presented. In particular, in response to the very likely question "what will happen if …" it is important that "things have been thought about",

i.e. it is to be clarified that the safety case comprises both the expected or normal evolution scenario, as well as less likely but credible alternative scenarios.

It is worth stressing that different points of view about what has to be considered in a safety case may contribute to improving the content of the documents, and to guaranteeing an active role for main stakeholders, especially when they come from non-technical fields.

Analyses and impact assessment outcomes can be discussed without diving into technical detail or jargon, although it is important to communicate that less likely scenarios of the repository's future have been taken into account.

If a stakeholder asks about a scenario not considered in either the normal evolution or alternative scenarios, and if that scenario has been recognised, considered and screened out, the reasoning behind the screening decision can be given. If, however, the scenario seems credible but has not been previously considered, an action should be taken to consider it and report back.

The message should not be that all issues are already clear and resolved. Communication needs to openly and honestly address recognised open issues and assessments of their relevance to safety, as well as ways and plans to tackle them. This part of the message should be presented alongside the staged process of repository development with its decision points, together with the distribution of roles and responsibilities among actors (of which the actors are aware and respectful), and the capability of identifying uncertainties, open issues and any expert dissent via a systematic approach. It needs to explain how these issues are addressed in terms of their importance to safety and resolved as the process of establishing a repository continues. Assurance should be given that waste will only be placed in a repository if facilities and radioactive waste management at the repository satisfy the regulatory requirements that have set the tolerance limits on risk. In human endeavours, there is no such thing as an absolute zero risk.

Chapter 3. General safety case communication aspects

General communication issues and the safety case definition of "stakeholders" and the "public"

Stakeholders are "interested and affected parties (state, local, tribal officials, non-governmental organisations, industry and labour representatives and interested members of the public) impacted by a government programme and who have something aside from a financial stake in public policy outcomes" (Holm, 2011). The public or parts thereof, therefore, is a stakeholder among other stakeholders. Stakeholders may have a wide range of technical insights and capabilities.

The public stakeholder is likely to be non-technical in terms of understanding repository science and engineering. However, it is possible that some public stakeholders may hire expertise to aid their judgements concerning a government or industry nuclear facility or activity proposals or regulatory decisions regarding the likely safety of such a facility.

The public is not a homogenous group. The information needs of the public located relatively near a proposed or working repository will be dependent on national and local context and culture, and will also change over time.

Simply recognising the diversity in the stakeholder cohort is not sufficient, however. It may be helpful to create a checklist to assure that a given communications effort is designed to meet the needs of the particular audience expected to be present. This checklist could look like the one presented in Table 3.1, with the descriptions of the likely composition of the audience on the left and a description of likely topics and tools above, allowing boxes to be checked as planning for a particular event proceeds. For all audiences seeking feedback after the event, providing a questionnaire or comment form and an e-mail address for further comments or suggestions will be valuable. Feedback should be positioned in terms of what additional information the stakeholder would have liked to have received, rather than how the communication could be improved, i.e. it should be sought from the perspective of the needs of the stakeholder, rather than the communication team. This helps the stakeholder to feel that their understanding is important, rather than that they are being used as "guinea pigs" in a trial.

After the event or the public meeting, "media monitoring" might be helpful to receive feedback and to identify further information needs of stakeholders. Media monitoring is the activity of monitoring the news reports in newspaper, TV, online media, etc. It is usually conducted by an in-house sector or a private company (a media monitoring service).

Table 3.1. Safety case communication event planning guide/checklist

Audience characteristics	Safety case communication team considerations	Materials to be used and/or made available beforehand
Technical levels	Identify range of likely technical competence levels in targeted audience.	Define technical competence level of target group(s) within audience and tailor presentations to those levels.
Demographics: 1. Age 2. Gender/health 3. Distance from facility 4. Type of business/farm	Related to but not same as technical competence level, assure guardians/ parents not surprised by what their children come home from school with. Typically the female portion of the population is more interested in health risks.	Address obvious questions such as worries over babies and children, farm products, or property or business resale values.
Positional: 1. Government 2. Regulators 3. Community groups 4. Community technical advisors 5. Non-governmental organisations	Address very specific issues and sub-issues as needed for (1) and (2) – overviews such as the history of the decision process not needed for these groups. Address specific concerns raised by (3) and (4).	Presentations may be technically beyond non-technical persons in audience. Provide background materials for them.
Workers	Workers are stakeholders too and communication of the overall enterprise they are part of and its importance is an important part of maintaining a strong safety culture. They could be looking at you as a potential employer.	Workers live in nearby communities, hence providing them with information brochures will result in their wider yet local distribution*. Workers will be interested in employment prospects, safety issues.

* A great good will be achieved by workers, who are respected and trusted members of their local communities talking to their neighbours and explaining their confidence in safety in their own words rather than just handing out corporate literature, i.e. if they are speaking first as a community member and not as a radioactive waste employee.

Stakeholder/public communication

Establishing an active periodic public interface is key to maintaining effective communications as times change. As the political landscape changes, so does the make-up and agenda of this communications task. Active engagement and having a substantial number of the staff of the project become part of the local public are central to maintaining a smooth working interface. Regular briefings and dialogues with local, regional, state and national-level elected officials are also part of a well-managed public interface.

The successful communication to a non-technical audience requires the use of plain language. Plain language ought not to be seen as a "dumbing down" of the message, rather it ought to be understood as a way to build technical capacity in the audience. Technical capacity has a way of spreading, people like to share new things they have learnt or insights they have gained.

The basis for the safety cases for both operational and long-term safety of a proposed or a working repository needs to use illustrations of principles and processes based on analogous situations or processes that are likely to be familiar to the public. This analogue approach would involve both human and natural analogues. Learning and insight are developed when analogies are used to promote questioning on the part of the public stakeholder. For a fuller discussion of the potential value of analogues in communications, see Chapter 4.

Implementers and regulators are to be accurate information providers, not zealous missionaries out to convince or convert. This point underscores the importance of the credibility of the information providers. They are the enabling factor in the communication process. Arrogance, impatience, and a tendency to try and prove being smarter than the questioner is not going to bode well for creating understanding. Important as the information-provider dialogue may be, true two-way communication also requires the presence of someone who is specifically assigned and identified to take comments and suggestions seriously and who can run them through a fair process of consideration by the implementer or the regulatory organisation and provide feedback. Mutual respect and understanding are the outcomes of good public dialogue.

Before conducting the safety case communication, it is crucial to recognise the difference between "ordinary risk communication" and "safety case communication". Radioactive waste management is a very long-term issue, because of long-lived radionuclides in the waste. Therefore, the timescale (time axis) of safety case communication is much longer than that of ordinary risk communication related e.g. to the radiation health effects by operation of a nuclear power plant. However, it is worth explaining that the nature of radioactive waste is such that the hazard it presents does decay considerably over time. This is a particularly helpful point to make in the context of discussing uncertainties over long timescales, i.e. as the uncertainties increase, the hazard decreases.

Generational challenges and informational/educational communications

The public consists of several generations. Bypassing the older generations and aiming communications at younger people, because they are the future decision makers and managers of radioactive wastes, is not wise. The parent/grandparent generation needs to be convinced that their offspring are being given factual information, especially in schools if there is a curriculum developed to explain the science and engineering aspects of radioactive waste management systems. Table 3.1 included demographic detail which can include age-dependent/school-level information for a target audience.

A non-site-specific, curriculum-addendum to include nuclear science and relevant repository-related sciences, prepared with the help of an accepted neutral but recognised expert educational institution, or multiple institutions such as state or national universities or academies of sciences, would be of great value. Explaining the basis of such a curriculum to parents would also increase its impact and may be necessary in some countries in order to allow children to be part of classes that address such a curriculum.

Opposition challenges

The phenomenon of organised citizens' or non-governmental organisation initiatives against proposed or even operating nuclear facilities is a worldwide reality. To assure that the implementer's voice, and the regulator's voice, will be recognised and can be heard by the public, it is necessary to create and sustain a meaningful public, as well as elected officials, dialogue from the moment there is a project proposed for a given area. Working with elected officials allows public consultation and information meetings to be planned jointly with them, enhancing local credibility.

Care must be taken to take expressions of fear of all things radioactive seriously and respond adequately in a non-dismissive manner using carefully thought out answers that make reference to the natural world with which people have experience. Neutral but effective meeting moderation may be the key to ensuring that all viewpoints, including those of implementers and regulators, are heard.

General safety case aspects

Tailoring technical messages to the less technical stakeholder (including public) audience

Dependent on audience, multiple levels of documentation might be required, but there is a need to assure consistency, transparency, traceability and openness. Emphasis can change with audience, but the key messages need to be consistent with the overall safety case (NEA, 2013).

Especially when communicating with a less technical audience there is a negative impact of too much information in very large documents. This can, to the recipient, seem like an attempt to overwhelm. The very large documents provide traceability to technical audiences, and they need to exist, but they may appear impenetrable and non-transparent to a less technical audience. Therefore, there is a need to create fairly short and readable documents that summarise the safety case; this may require dividing the documentation into two parts, one pulling together all safety arguments as transparently as possible, and another one providing a traceable route to details (which in any case is needed for technical purposes of safety case production and review).

The traceable route to details ought to lead to a publicly accessible repository of technical reports and perhaps even data in some understandable form. This way a member of a stakeholder group will not feel stymied in their searches or feel that information is being deliberately withheld.

Providing local stakeholders expertise

There may be a need to provide public representative organisations with the means to hire experts to interpret aspects of the safety case for them, independent of the implementer creating more readable explanation documents. This should be regarded as part of an open and transparent process in which the safety case is open to challenge and independent peer review and should be embraced by the implementer.

Depending on the level of support, it can also bring the local municipality into the development of information that can be incorporated into the performance assessment, the safety case or the regulatory review. An active role for the municipality in contributing to the development of the safety case can serve to build confidence, and effectively increase the "stake" that the stakeholder feels in the project. For example, funding provided by the United States Department of Energy (US DOE) to the host county of the proposed Yucca Mountain repository was used by the county for a series of exploratory wells that helped in characterising the aquifer in the far-field flow path from the repository. The drilling programme, which took place over several years, was conducted under a quality assurance programme reviewed by all parties and the data and samples were made available to the implementer, regulator and other stakeholders. Although not inexpensive, this programme helped build confidence and trust with the host county. The drilling programme was planned to transition from a characterisation activity to a monitoring activity as the project progressed.

Public representatives

It may be wise to develop specific tools and methodologies for engaging the "concerned" public in discussing aspects of the safety case and the development and regulatory decisions that are related to those aspects. It may be wise to work with elected officials in establishing a platform for dialogue, and let them manage the citizenry that participates. The implementing organisation should not be the selector of citizen group participants.

For an implementer to try and hand pick representative concerned citizens is a recipe for failure. A study of the successes and failures stemming from the use of citizen site-specific advisory boards (SSABs) in the United States may be useful in considering whether or not, or how, to set up such a board to represent the public to an implementer

organisation. The root cause of problems with SSABs was either perceived or actual withholding of information by the US Department of Energy. The Department of Energy said there was no withholding of information, but that was considered to not be true by some participants (see Bradbury et al., 2003). This example underpins why it is so important to build trust that the implementer is making all safety-relevant information openly available.

Stakeholder empowerment

Civil society's stakeholders have an expectation of taking part in the decision-making process as the repository project progresses. This would encompass the earliest stage at which the need for a siting decision becomes apparent, the later stages where the safety case is developed and evolved through site characterisation, design development and construction, and the still later stage where the system is operational but decisions are being considered in terms of optimisation and, later, closure.

The implementer and the regulatory organisation should recognise and understand their expectations. Expectations from the public might change over time as the process progresses. The implementers and the regulatory organisation should adapt to these changes.

There has to be a real commitment on the part of the implementer or regulatory organisation to taking in the suggestions of the public and considering them carefully. This is essential for developing a co-operative relationship with stakeholders. In order to address their expectations, the implementer and the regulatory organisation can establish a framework or develop an approach to attain effective interactions with stakeholders. A written consultation and co-operation agreement that binds both parties and is signed off at a high level on both sides can help assure that the next election does not undo all the understanding and co-operation that was built up under a previous administration at the local or wider (provincial or state) levels.

Dealing with critical observations

Critical public comments will need to be considered and addressed appropriately, even if the implementer or regulator being addressed believes that the underlying issues raised are not important to either operational or long-term safety. If comments are received that are not accepted, the implementer must respond to the issue, explaining the reason why the comments cannot be accepted.

Careful and thoughtful evidence must be given regarding the rejection of any comments due to the lack of importance to safety. Regulators, when asked by members of the public to pursue certain technical questions, may feel it to be up to the implementer organisation to provide credible and convincing evidence of the issue's non-importance to safety and request that organisation to address the comment. Nevertheless, regulators are required to recognise their own roles and accountability. The regulators should address the issue at stake and express their views in a timely and appropriate manner.

The role of peer review

Support of the independent scientific community is needed. The scientific community audience provides an important peer review function through the refereeing of publications submitted for publishing in scientific and engineering journals, and to a lesser extent through commenting on and questioning presentations at professional society and scientific meetings. It is a good thing if technical staff are represented in professional/academic societies as members.

Any novel claims of a scientific or technical nature ought to be given credibility through an independent expert peer review process, either as part of publishing such a development in knowledge or as a hired peer review for a specific model or process. The overall flow of information should be included in a peer review in order to assure the general public of the fairness of the consultation process.

The NEA provides peer reviews of major programmatic milestone documents on request and developed a guiding document for conducting such reviews (NEA, 2005). An NEA review can complement a regulatory review and aid in the building of public confidence.

Specific safety case presentation aspects

The specifics of the safety case presentation are secondary to first establishing a working relationship with some degree of real empowerment of the local and regional (and maybe wider) recognised bodies formally or informally representing the citizenry. Without trust through empowerment there is no appetite on the part of the public to listen to discussions of the finer technical aspects of the bases for the claim to safety.

Once such a relationship exists, the presentation of a case for operational or long-term safety ought to include the following points, several of which are addressed in NEA, 2013:

- The purpose and context of the safety case.
- Where this safety case sits in the programme context and decision-making plan and schedule.
- What lessons were learnt from previous iterations of the safety case and its underlying safety assessments, and how those lessons learnt led to either a need or an opportunity to make a change in the proposed, or functioning, repository.
- What lessons have been learnt by studying other, but relatable, safety cases (abroad), consultations with other repository programmes, and peer reviews.
- The safety requirements in the regulations being addressed, and the regulator's role as an independent technical arbiter, need to be explained in the documentation, as well as in presentations.
- A broad description of the facility's safety functions digestible to the target audience, together with arguments about why the repository is likely to function as intended.
- Explicit statement of what is known and what is unknown on a scientific basis, quantifying risks and describing uncertainties in the context of overall safety, never without that context.

Comparisons of radiological impacts with other hazards and risks (e.g. air pollution, passive smoking, road traffic deaths and lightning) may also be included, but there is a danger that they may be interpreted as not being relevant, e.g. comparing voluntary or "natural" risks with risks "imposed" by the nuclear industry. The correct balance of providing information without appearing to justify the impacts of waste disposal by comparisons with other impacts is a challenge. It is also sensible to avoid illustrating safety using overly conservative hypothetical values as they may be misunderstood as a worst, but still possible, case, thus giving a false impression of limited system safety performance or overwhelming uncertainties. Overall there is a need to act and communicate in such a manner that promotes, and does not detract from, the safety case being a trustworthy assessment that is part of a fair and well-defined societal decision-making process.

Regulatory aspects

In the context of a safety case, the mission of the regulatory body involves several types of activities such as the establishment of regulatory requirements as well as of procedures and conditions for meeting these requirements for the various stages of the licensing process. The roles of the regulatory body include the review of the safety case and its updates throughout the whole process of developing and implementing the geological disposal programme.

One of the tasks of the regulatory body is to improve the quality of the interactions between experts and stakeholders including non-governmental organisations, elected officials, other recognised community leaders and the public at large in the regulatory decision-making process (Mutadis et al., 2014). Stakeholder empowerment, in this decision-making process context, needs to be defined and explained. Regulatory decisions may be different in scope and content and constraints than expected by the stakeholders. For example, a decision to allow waste to be disposed in a repository is not the time to undertake a complete review of the siting decision, which was a different decision made by the regulator as part of the licensing action that allowed facility construction.

The regulatory body has a key role to play in the development of appropriate governance patterns to conduct these interactions that should constitute an opportunity for stakeholder feedback and two-way communication. To be successful, the regulator needs:

- to have access to different sources of expertise in order to enhance its technical knowledge and capacities;
- to raise its capacity and knowledge in order to engage in a meaningful way along the radioactive waste management decision-making process at local, national or international levels.

Key conditions for the regulatory body to gain the trust of civil society are: transparency, competence, openness, listening and responding to public inquiries. The regulator needs to explain to the public (Mrskova et al., 2014):

- the principle of independency of the expertise function within the regulatory body;
- the regulation, norms and standards determining certain decisions and governing waste management facility operations;
- the safety principles and requirements;
- the position of the regulatory body's experts in the context of the safety case review.

Transparency requires creating conditions that give effective access to relevant and reliable information as well as to independent advice on that information. Representatives of civil society commonly do not have sufficient knowledge and resources to enter discussions on an equal footing with the implementers of the projects (Mrskova et al., 2014). The availability of independent regulatory reviews, and access to independent experts, can provide civil society with assurances that cannot be provided by the implementer or regulatory organisation alone.

A key role is played by the timing of implementer-regulator technical interactions and making them publicly accessible. This involves reliably scheduling the timeline of each interaction between implementers and regulatory bodies, in a stepwise approach, to assure stakeholder confidence in the regulatory decision-making process.

In cases where the implementer and regulator are different agencies of the national government, public perception of the different roles may be very blurred, with both seen as just different aspects of the same government that has the goal of siting and operating a facility. The regulator can convey its independence by conducting separate outreach activities to discuss the safety case, stressing its role as a reviewer and decider (or at least "recommender") and not appearing to advocate for the implementer's case. In a similar manner, regulator behaviour during implementer-hosted public meetings can also serve to display both regulatory independence, as well as technical competence, which can build public confidence in the regulator and hence in the overall review and decision-making process.

In the larger picture, the regulator will provide its high-level opinion of the safety case during review of application (usually for construction). There is potentially value for building earlier into the process a means for the regulator to comment or ask questions on the safety case as it is being developed. Doing this in a public manner can help inform stakeholders of the issues being discussed and develop understanding of how specific conclusions are reached. For example, in the United States, the development of the formal site recommendation and licence application for the repository at Yucca Mountain took several decades of extensive site characterisation work by the US DOE. The role of the United States Nuclear Regulatory Commission (US NRC) staff during this period evolved over time, to encompass the formal definition of "key technical issues" agreed to by both the US NRC and US DOE, with extensive public (and some non-public) technical meetings aimed at reaching resolution (although the resolution was non-binding in the sense that all issues were open to further review by the US NRC in the licence application). These interactions engaged those stakeholders with technical support (the state and host county, who had funding for their own experts) and also generated significant documentary material. In addition, the long pre-licensing process led the US NRC to establish a local office of on-site representatives (not at the site but at the US DOE offices in Las Vegas). The principal purpose of the on-site representatives was to monitor US DOE activities, but it also provided local contacts for the public and a means for routine outreach to stakeholders on the regulator's role.

Materials and methods, tailored to purpose

The communication approach needs to be modern and forward-looking, using the latest technology to hold audience attention. (The days of respectful silence while talking-heads drone on are over.) At the same time, the impression of providing a too smooth, slick and glossy-looking performance is to be avoided – the communication should mirror the real situation: People professionally addressing the problem and openly accounting for doubts and uncertainties. Communications need to engage the audience member on several levels and not either bore them or talk down to them. Appropriate illustrations and animations are potentially effective tools for illustrating complex operational or long-term natural processes.

The communications approach is different for the purpose of gaining public acceptance and trust for a proposed or potential repository than it is for general education purposes. The former, through information sharing, consultation and collaboration, focuses on engaging the public in open, honest communications which ultimately aims at developing trust and strong stakeholder relationships. The latter, general education, typically addresses the characteristics of radiation and its effects on humans, the nature of the nuclear enterprise in a given nation, the nature of the waste produced, and the consensus view on the best approach to dealing with that waste in terms of reprocessing for reuse or processing for final geological disposal given the internal dynamics of the specific national approach and situation. There is no single "optimal" approach for stakeholder communication. Each situation requires thorough

planning specifically tailored to suit the purposes. In designing a stakeholder communication process, the following principles may be considered:

- presenting safety data in a meaningful format and language that is readily understandable and tailored to the needs of the target stakeholder group(s);
- maintaining an open dialogue that allows all participants to exchange views and to have their issues identified and addressed;
- respecting local traditions and views of minority, vulnerable groups;
- disseminating information in ways that allow ease of access by stakeholders and providing information in advance of consultation activities and decision making;
- providing clear mechanisms for responding to the identified concerns, for incorporating feedback into the repository project, and for reporting back to stakeholders.

Many waste management programmes have noted the importance of understanding stakeholder issues and meeting their expectations. An open collaborative process that involves all stakeholders offers an efficient environment to enable stakeholders to collectively identify the issues that need attention, precise information can be provided and mutually beneficial solutions can be developed. Working collaboratively with all stakeholders essentially enhances the ability to leverage collective knowledge and creates synergy among all stakeholders as they work towards a common goal.

Effective communication requires that the public be informed and knowledgeable about the issue of concern. To assist the public in understanding the issues, the feasible alternatives or solutions, general education plays a crucial role in acceptance of a geological repository development programme.

General education for the part of the nation's demographic being asked to accept a disposal facility can be more site-specific of course, and may involve:

- Setting up a **visitors' centre** with informative interactive displays and advertising its use for school tours etc.
- (As soon as a recognised facility exists), **public tours** to allow the public to have contact with project scientists and engineers and their work. Site visits can be complemented by "virtual site trips" offered online.
- A **curriculum** for younger persons to introduce them to general science and engineering concepts related to repository functioning. This may employ interactive computer applications to allow the interested person to run limited simulations of processes or events; for the younger set these can be made into computer games.
- **Online resources** – as the public always represents several levels of technical savvy, online resources and presentation ought to provide links to additional materials that deal with the same topics at a more advanced level.

In terms of an approach to providing a more general educational experience for the public, existing one-way communication examples based on museums, modern libraries and successful public information centres dealing with highly technical and even controversial issues ought to be consulted. Communication materials ought to be made as accessible as possible, including the use of braille for text boxes, and provision of community language translations. Documents at all levels of technical detail ought to be publicly available, except if classified for nuclear safeguards and security reasons.

In terms of promoting a general awareness of things nuclear in the wider national or regional society:

- A "nuclear industry month" campaign could be run, during which people would visit nuclear sites, see interactive displays, talk to staff and discuss issues. This could include displays in museums, libraries and schools.
- Displays on such an occasion would relate radioactive waste to familiar things in our lives, such as the use of X-rays, nuclear medicine and the generation of electricity, in order to show that radioactive waste is a by-product of processes beneficial to society.

Presentation/dialogue and behaviour

The presenter/discussant needs to be technically competent, meaning he or she understands the subject under discussion thoroughly. At the same time, this person must be able to explain technical ideas in plain language. It is a benefit if it appears to the audience that the presenter is enjoying the discussion and is ready to accept new ideas and points of view, being themselves enriched by the exchange.

Either the presenter or an identified person from the same organisation needs to be empowered to accept and respond appropriately to audience suggestions or questions not dealt with in the course of the dialogue. The stakeholder concerns expressed, regardless of the source, must be treated seriously, respectfully and calmly. A feedback mechanism must be established describing actions taken in response to suggestions, even if only the evaluation process is described in cases where no action was taken.

Impatience or exasperation from the presenter will reflect poorly on the presenter, regardless of the tactics used by intervenors in an audience. Nothing turns the public off more than a rude presenter, even if the rudeness is directed at a rude intervenor. To control the event, it is a good idea to have a neutral meeting moderator to keep order in an even-handed way to assure that all viewpoints, including those of the presenters, are clearly heard.

Materials and their distribution

It is a good idea to make materials available to public officials for use in discussing the proposed system and its degree of safety or risk with their constituents, and in preparation for any public or other stakeholder meetings.

Materials ought to have only one main message – operational or long-term system safety and its basis – clearly presented in the introductory material and supported by the technical material that leads to the conclusions. The idea is to avoid conflicting or non-supportive sub-messages except as part of a discussion of alternative models that can be based on the known data and what is being done to evaluate them.

If the poster format is used, each poster should treat one key issue at a time and be accompanied by a presenter who can credibly answer questions at an appropriate level of detail.

Materials ought not be too glossy, but professional design is an important element. It has to be an appealing presentation for discussion with a member of the public, but it should not look like a slick advertisement: the goal is to share information with a public sceptic, not to convert him or her to our point of view via a clever slogan.

Chapter 4. Selected safety case topics with high relevance for communication

Fundamental issues of a safety case

It is an internationally agreed concept to dispose of high-level radioactive waste in deep geological repositories (NEA, 1995; IAEA, 2003; EC, 2011). The primary purpose of the repository is to isolate the waste from the biosphere and to provide long-term safety of human and non-human biota (e.g. NEA, 2013). In order to demonstrate that this purpose will be fulfilled, a safety case has to be developed, which is a formal compilation of evidence, analyses and arguments that quantify and substantiate a claim that the repository will be safe. Therein, both operational safety and post-closure safety have to be considered. Some important aspects of a safety case, particularly regarding communication with the public, are briefly discussed in the following sub-sections.

The strategy for implementation of a repository should provide sufficient flexibility in a stepwise process to cope with unexpected site features or changes in technical or political boundary conditions, as well as to take advantage of advances in scientific understanding and engineering techniques (NEA, 2013). Such a strategy might include the option for reversibility and/or retrievability of the waste, as it is, for example, foreseen in the regulatory requirements of France and Germany (JORF, 2016; BMU, 2010), or not, as in Finland (STUK, 2015). In the course of repository construction, monitoring systems will be installed to verify for example the predicted geomechanical behaviour of the host rock during the repository operational phase. There is an ongoing debate regarding how long and to what extent monitoring systems should provide data after repository closure. The current experience in NEA member countries show that both retrievability and monitoring are subject to controversial discussions between the stakeholders in the repository implementation process.

A central element of the safety case for the post-closure phase is the long-term safety assessment, i.e. a systematic analysis of the hazards associated with a geological disposal facility and the ability of the site and designs to provide the safety functions and meet technical requirements (NEA, 2012). However, there is international consensus that the robustness of the safety case and the resulting confidence in the repository concept is strengthened by the use of additional lines of evidence, which includes complementary safety arguments that can compensate for shortcomings in any single argument (NEA, 2004; NEA, 2012). Typical types of such complementary safety arguments can be derived from the application of different kind of indicators or from natural analogues (see Chapter 4). Both types of arguments are thought to be useful for communication of technical safety case aspects and may help to overcome problems occurring during discussion of abstract graphs and numbers derived from numerical simulations with complex coupled models with non-technical audiences.

Monitoring

Monitoring, principally, is a collection of technical data to verify the performance of a disposal system and to assist in making decisions. The NEA Forum on Stakeholder Confidence (FSC) conducted a survey in 2012 to evaluate local communities' expectations

and demands on monitoring. The survey showed that while most public stakeholders consider monitoring may contribute to building confidence in developing geological repositories, their expectations and the roles of local communities in monitoring varied among the responding countries (e.g. French citizens prefer to be actively involved in monitoring, while others are more interested in only the monitoring results). The same study also noted most local stakeholders considered the involvement of independent bodies in performing monitoring an important factor in achieving public confidence (as in the case of the Waste Isolation Pilot Plant and the role played by the independent Carlsbad Environmental Monitoring and Research Center). Another study carried out within the MoDeRn project (Bergmans et al., 2012) observed that the meaning of monitoring and how monitoring contributes to long-term safety differ from repository experts to public stakeholders. To the experts, monitoring is about collecting evidence to confirm the behaviours and/or impacts of the disposal system on the environment whereas to the public, monitoring has a much wider scope relating the repository to both the natural and social environment. The study stated that citizens seem to be less concerned about what is monitored and where it is being monitored, but are more interested in the comprehensiveness of the monitoring programme as well as if a response plan exists in case an unexpected event occurs or a monitoring result is outside the bounds of what is expected. The MoDeRn project thus suggests that monitoring should be recognised as a "sociotechnical activity" that involves the "pursuit of social and institutional innovations as much as technical and industrial innovation".

Comparably, the NEA Preservation of Records, Knowledge and Memory Across Generations (RK&M) Initiative noted that public stakeholders who are interested in repository monitoring seldom have the capacity to form an objective evaluation of a repository monitoring programme. They tend to rely on the competency of the regulatory authorities (NEA, 2014). Thus clear guidelines and rules governing the planning and performance of monitoring as well as the sharing of results with the public will overcome potential distrust, in addition to solely stating the compliance status of a facility. It is possible that public stakeholders may raise monitoring requests that have no obvious technical justifications (e.g. demanding monitoring to continue after repository closure and sealing or until beyond the planned institutional control period), it is recommended that a pragmatic compromise be sought not only to avoid damaging disputes but also to build social acceptance and trust. The RK&M Initiative analogously noted that the selection of parameters for monitoring may well be driven by socio-political considerations rather than technical reasons. In this sense, it would be useful to state that monitoring should be performed for the time required to demonstrate the expected safe behaviour of the repository (institutional control period up to closure) and that, if monitoring evidences an unexpected outcome or event, appropriate measures can be taken after a safety re-evaluation.

Stakeholders may be concerned that after the institutional control period the waste is "abandoned". It should be explained that it is planned to carry out oversight for as long as achievable and it is not intended to "abandon" the disposal facility, rather every effort will be made to ensure that its location remains known to future societies (see Chapter 2). What can tie a discussion of this point to the safety case is to show that in the sensitivity studies performed as part of the safety assessment, the most likely indicators of repository function, or malfunction, have been identified and to an appropriate extent are being monitored now, will be monitored throughout the life of the facility, and will continue to be monitored at some frequency. This is a constructive response to the recurring issue of diverging opinions between experts and the non-technical stakeholders on the need and feasibility of post-closure monitoring.

In the United States, with the Department of Energy (US DOE) in charge of geological disposal facilities, the implementing office within the department passes off its monitoring duties after final closure to another office within the department, currently known as the Office of Legacy Management, which monitors formerly used US DOE sites

throughout the nation, usually in a co-operative way with state and local jurisdictions to assure that local awareness and interest is maintained. Land use control, and making land available for recreational or other appropriate purposes, is an important aspect of their co-operative control programme. Monitoring is done at some sites as appropriate, and even remediation if required. The Office of Legacy Management is to provide long-term monitoring and management with no cut-off date, hence the very existence and functioning of this office is evidence that there is no plan on the part of the US government to ever abandon a radioactive waste geological repository.

This is a near-term concern, perhaps an intermediate term concern (a century or so), but the emphasis in addressing this concern ought not to miss the opportunity to reiterate the concept of passive safety, and that monitoring to a certain point in time gives continually more assurance of continuing system safety beyond the last occurrence of planned environmental sampling. At the same time, thresholds have been pre-set to indicate that action needs to be taken when measurements suggest a system failure, or sub-system failure, in which case there may need to be corrective action taken.

A discussion of the monitoring topic ought to involve the regulator's point of view when appropriate and possible. Regulatory requirements for the long term ought to be explained, conveying why these requirements make the regulator more confident about system safety for the long term.

Retrievability

An oft-expressed concern is the irreversibility of the decision processes concerning a repository either in the phase of site selection, design, construction, etc. There is a concern that once any waste goes underground it cannot be retrieved. Nowadays, these concerns are addressed in many national regulations by requiring that the waste or waste packages must remain partially or wholly retrievable until the repository is finally sealed (closed). In some nations the retrieval option is required not to be precluded by design at even later stages. In that case, for instance some decades after repository closure, the retrieval action of waste packages can be considered as an intervention measure. The NEA Reversibility and Retrievability (R&R) Project (NEA, 2011) observed that national programmes which planned for retrievability were driven by three main reasons: i) an attitude of humility or being open-minded towards the future; ii) demonstration of additional assurance of safety; and iii) to heed the desires of the public and political leaders to avoid being "locked in an irreversible decision".

There are few studies available describing the technical and safety implications of a retrievability requirement on the repository design, construction and operation. Exercises demonstrating the retrieval of waste packages are also absent. However, first results showed that retrieval of waste packages would not be either easy or cheap; and with regard to operational safety a substantial worker risk has to be taken into account during the retrieval process. As well as other works with radiation exposure, justification and optimisation are needed in order to conduct the retrieval work. In a case where waste container integrity has been compromised over time this would lead to greater technical efforts and greater risk to handling, lifting and transportation operations. In any case technical provisions in the repository might have to be implemented to enable or to facilitate the retrieval action e.g. a durable steel liner in boreholes. A fair debate with non-technical people should include a clear explanation of the state of art of this technique and the advantages and disadvantages of implementing retrievability. In addition with regard to future necessary activities an outlook should be given regarding how the retrieved waste packages could be stored and the plan for the final disposal at any other site or with other means. The retrieval, handling and transportation of waste packages become new subjects to regulation. Appropriate information disclosure and sufficient explanation are essential in decision making regarding activities related to the

retrieval. In other words, when discussing retrievability there is a need to consider the full context.

On the other hand, retrievability measures might cause conflicts concerning confining the waste in a most robust way. Undoubtedly, there is a delicate balance between safety, practicality and cost.

It is clear that the R&R project links societal and technical considerations. The social pressures for reversibility and retrievability may be more to avoid irreversible steps and of keeping active a continuing participatory decision-making process, rather than of specifically requiring ease of retrieval. Such pressures could also be motivated by various drivers ranging from being unfamiliar with the disposal technology, discomfort with the concept of purely passive safety without relying on any means of oversight, or simply reluctance to make decisions today.

In considering a policy on reversibility and retrievability, in addition to following the principle of preserving options for future generations, one must understand that any decision to retrieve wastes after even partial closure would imply a major undertaking technically and fiscally. From the very beginning of communicating retrievability with stakeholders/non-technical people it should be stated that any retrievability provisions must not impair long-term safety of the repository. Furthermore communications must clearly indicate that the retrieval period and process may last as long (if all waste packages are concerned) as the operational phase. In any case, waste retrieval is a regulated activity and should require the same level of technical, societal and legal scrutiny as was the case of waste emplacement. Legal and regulatory requirements to maintain the option to retrieve ought to be part of the dialogue.

Indicators

The typical endpoint of a long-term safety assessment is the calculation of a dose or risk, which can be compared to a legally or regulatory defined radiological constraint. This indicator can be denoted as a primary indicator. A recent review on the use of indicators in safety cases (NEA, 2012b) showed that besides dose and risk a variety of other indicators is currently widely used by implementers and regulators. These indicators in addition to dose and risk are called complementary indicators and might be categorised in the following three groups (NEA, 2012b):

- concentration and content-related indicators, that provide information on the radionuclide inventory and its distribution within compartments of the repository and the environment (e.g. total radioactivity content of the waste form or radiotoxicity concentration in groundwater);
- flux-related indicators, that provide information on the transport of radionuclides between compartments of the repository and their release to the accessible environment (e.g. radioactivity flux from the engineered barriers to the geosphere or total integrated radiotoxicity flux from the geosphere to the biosphere over time);
- status of barrier-related indicators, that provide information on the functioning and containment capability of the barriers in the repository system (e.g. container lifetime or buffer swelling pressure).

The NEA (2012b) survey also showed that implementers (waste management organisations) usually have a clear view and strategy about how to use complementary indicators in their internal work and reports. Several examples for quantitative and qualitative use of indicators are given in NEA (2012b). It is stated that there is very limited experience internationally of using complementary indicators to help make safety cases more accessible and understandable for non-technical audiences. It was noted that

several programmes have yet to test the use of complementary indicators with the public, and there is some concern that they could cause confusion if not appropriately presented and explained.

Nevertheless, ideas for the use of indicators in a dialogue with non-technical audiences are formulated. For example, complementary indicators can be used to explain potential impacts of a repository using language and concepts that are understandable to a wide range of audiences (fluxes can be explained in terms of everyday units of mass or volume, e.g. kilograms and litres) which are broadly understood by most people. This is not the case with units and language of radiological protection, e.g. units such as Becquerels and Sieverts are not part of people's normal experience (NEA, 2012b). Most people do know what a kilogram is and so could make a judgement about the ability of the repository to contain the waste if they are told that the amount of material that might return to the surface is only, for example, 0.00001 kg/a. This value can be compared with the information that repositories are needed to contain many thousands of tonnes of waste. But, such a low released amount might still be very toxic, i.e. the use of such indicators needs to be carefully and transparently prepared. The information may also need to be embedded in a broader context.

It is proposed that indicators could also be of value for two-way engagement, i.e. that public and stakeholders are asked what complementary indicators they would like to see in a safety case. This could lead to a set of indicators that is significantly different to those currently applied in safety cases. In order to reach this agreement, a sound, well prepared dialogue is certainly needed, since indicators are abstract ideas that firstly need to be explained to non-technical audiences. However, concerning the timescales considered, there seems to be a discrepancy between the presentation of typical post-closure safety case results (timescales vary but can include 1 million years) and the timescales most people of the public are concerned with, which rarely extends beyond the lifetime of the next few generations (their children and grandchildren). This can be important because with deep repository designs it is extremely unlikely that any releases to the surface will occur within the lifetime of many generations of local residents. Safety assessments therefore generally focus on the far future and address, as well as the normal evolution, assessments of less likely or even unlikely (conservative) failure scenarios. This approach, while technically valid, can give a false and pessimistic sense of the expected impacts which can be misleading to non-technical audiences.

Complementary indicators can often readily be expressed in relation to the local environment around a site (e.g. radionuclide concentrations in a river). Once a potential site for a repository has been identified, it is possible to develop indicators with local significance. So, although the safety assessment may focus on, for example, dose to a hypothetical future exposed population engaged in subsistence farming, complementary indicators could present these impacts in terms of the present day environment and community. This will enable people to appreciate what the consequences of the repository may be for them and their children, and the things they value. It should be possible, for example, to develop a set of indicators that match and answer the questions that most concern local residents, as for example shown in Table 4.1 (NEA, 2012b).

Another frequently formulated aspect is that indicators can help to explain and illustrate how the various components of the repository system contribute to the containment and isolation of radionuclides. Many indicators used in safety assessments provide a measure of the behaviour of an individual repository component or sub-system and thus are useful in explaining the nature of the multiple barriers and their functions in determining system performance.

As stated before, there is now a wide use of indicators in safety assessments of organisations from different countries but so far there is little experience on the use of indicators for communication with non-technical audiences.

Table 4.1. Examples of questions of concern for local residents, and suitable indicators to help answer them

Question of concern	Matching indicator
Will the local river be polluted?	Maximum concentration of waste derived radionuclides in local river water and the time at which it occurs, compared to present day tap water quality.
Can I continue to grow fruit and vegetables in my garden?	Maximum concentration of waste derived radionuclides in local soils over next 100 years, compared to present day soil quality.
Will my great grandchildren be able to swim at the nearby beach in summer?	Amount of waste derived contamination that will accumulate on the foreshore over the next hundred years.
Will the air next to the repository be polluted?	Confinement of inventory (quality of waste packages, transportation systems, etc.), on-site monitoring and maximum allowed releases from the repository.

Natural analogues

To the implementer, the regulator, and members of the various stakeholder constituencies, analogue reasoning comes naturally. It is about using the familiar to gain understanding of the unfamiliar. However, analogue thinking is often practised and expressed by members of the public or other stakeholder groups when they reach for an example of an engineering failure; for example, to contest a statement of reliability of an engineered feature made in a presentation. Similarly the occurrence of two local 100-year floods in two weeks may allow them to argue that the frequency table shown for a scenario initiating-event is totally unreliable. The challenge in safety case communication is to present analogue studies as positive examples of the potential longevity of engineered barriers and, perhaps most importantly, to build familiarity with and understanding of the processes and materials important to the safety case.

Analogue studies may be defined as investigations of natural, anthropogenic, archaeological or industrial systems which have some definable similarity with one or more components of a radioactive waste repository and its surrounding environment (Miller et al., 2006). In the international discussion the term “natural analogue” usually comprises both, natural and man-made systems, which can be observed in the environment. In the same way the term is used in this report. The main value of natural analogues is that they provide information on the complexity of a natural system and on the characteristics of processes which are expected to occur in repository systems in the future, over long time scales. Several analogues operate on temporal and spatial scales which are similar to those considered in long-term safety assessment, and which cannot be covered by laboratory and field experiments. Further they represent concrete examples of important functions such as long-term confinement properties to illustrate potential repository situations which might otherwise be seen as “pure theory”.

Since a crucial aspect for deciding about how an analogue might be applied is its degree of similarity with the system, it might also be helpful to classify analogues, as proposed by the FSC (NEA, 2008). When a fairly direct similarity to repository situations exists, the case may be used as an argument to support a phenomenological theory and its modelling, and is then denoted as an analogue. As the degree of similarity decreases (e.g. if relevant chemical or physical conditions do not coincide with those of the repository and the consequences of deviations cannot be quantified or if system boundaries cannot be defined), the case applies more narrowly to the generic feasibility of medium- to long-term safety of geological disposal. When the degree of similarity is quite low, the case may provide a “common sense” rationale supporting the concept of geological disposal as an option and be used as one part of a compilation of evidence, arguments and analyses. In the latter cases, the situation is considered an analogy, or even only an anecdote.

There are a number of characteristics of natural analogues that should make them valuable for communication purposes (Miller et al., 2006):

- Natural analogues are directly observable in the environment. They are part of mankind's environment and history and there is also an inherent attractiveness of nature to most individuals, i.e. most people have some interest in the natural environment. Therefore, nature is an effective vehicle for dialogue (as it is for example frequently used in commercial advertisements).
- Natural analogues can help make the timescales of interest to radioactive waste management meaningful. The notion that we are concerned about times far in excess of that for which the sphinx has been in existence has more meaning than a four, six or eight digit number.
- Natural analogues are inherently qualitative. This has often been seen as a weakness since it can make them difficult to use for modelling and quantitative prediction. However, for communication purposes it can be a strength since for most people, life is qualitative and intuitive.
- The fact that natural analogues are the result of a range of environmental processes, operating together on some artefact or material is a direct reflection of "what will happen" and provides a means of observing the integrated consequences.

However, a general impression from the past use of natural analogues in public communication is the lack of impact that they have had (Miller et al., 2006). This may be due to the emphasis on the use of written media, namely too static, one-way forms of communication with the objective to convince. The typical mode of presentation of analogues in communication materials has been in the form of brochures and leaflets. Audiences are very sensitive to underlying motivations. Any suggestion of propaganda can undermine the value of the information transfer. Further, too much simplification of an analogue in order to make it easy to grasp by a layman may end up with overstating its significance. Therefore it is important to mention the conditions and limitations of an analogue.

Important limitations of natural analogues include, however, that the initial and evolution conditions cannot be always well known and that the materials used may be different from the ones to be considered in a repository (see above). Also, analogues will never reproduce exactly the possible repository situations including the coupling of thermal, hydraulic, mechanical and chemical (THMC) conditions. Therefore, analogues cannot be used as a sole and unique demonstration, but need to stand as one of multiple lines of evidence. This is also true for communication with non-technical audiences. The arguments will be strengthened, when natural analogue information is embedded in information from other sources supporting the same statement or aspect of disposal. As the degree of similarity with possible repository situations diminishes, examples become analogies or anecdotes and their arguments are more useful in terms of supporting generic and conceptual feasibility of geological disposal (NEA, 2008).

With respect to communication with non-technical audiences, the use of analogues to provide information relevant to questions regarding long-term radioactive waste management is proposed. With this information the audience can make their own judgements. This would be a dynamic use of analogues in communication. There is now quite a lot of experience concerning the sorts of questions people will ask in the context of radioactive waste management. Based on this and that natural analogues will provide information about the behaviour of natural systems, the questions likely to be raised can be classified into four key themes, which is explained in more detail in (Miller et al., 2006):

- Time: How can one be sure that the repository will work over the timescales involved?

- Depth: How does one know that something so deep underground can be built?
- Process: How does one know what processes will operate in the repository?
- Precedence: Has this ever been done before and how successful has it been?

This broad classification can potentially be used to index past analogue studies and the information they have provided, so that relevant examples can be readily identified to help address the questions that stakeholders may ask in an open dialogue. The precedence aspect indicates that communication will probably become easier once there are more repositories in operation.

Given that analogues are concrete representations of possible repository situations, it seems plausible that the public may be more likely to find a *national* analogue persuasive and comprehensible, since it is geographically and culturally closer to their own experience and likely to be very concrete, especially in the case of anthropogenic analogues. However, stakeholders in some contexts may display more confidence in findings and illustrations presented by international parties who are assumed to be more neutral. These are complementary positions, and if possible national, as well as international analogues ought to be pursued (NEA, 2008).

It is to be expected that much of the acceptance of analogue arguments will depend on the degree of trust established between the implementers and regulators and the public. Experiences from Carlsbad (New Mexico) show that even after a radiation release mishap local public support (and even state level support from the current administration) remained strong based on the level of trust established over the years, aided by an independent monitoring organisation that is run through a local branch of a state university which declared there was no cause for public safety concerns. It might also be expected that the role of analogues is dependent on the stage of the repository programme. As the programme focusses on specific sites and concepts, closer relationship with repository situations (geology, materials, etc.) is possible. Later, when the project is accepted in principle by local public stakeholders, the need for analogues, analogies and anecdotes decreases. Again, the latter statement remains to be proven valid.

In general, analogues seem to have a great potential for dialogue with non-technical audiences. However, like the technical discussion of the safety case, this can be more successful once a constructive dialogue platform has been established with representative organisations speaking for and in view of the public, thus establishing a real two-way dialogue.

Chapter 5. Summary and conclusions

This document has compiled salient lessons learnt from both failures and successes in communicating technical information to audiences representing non-technical stakeholders. The source documents for these lessons are experiences documented by the NEA Integrated Group for the Safety Case (IGSC) member organisations (see Appendix C), from other NEA efforts (see Appendix A), and from EC studies (see Appendix B).

Implementers and regulators should both be involved in stakeholder outreach and dialogue. Basic rules of civil dialogue and pointers for effective two-way communication are described in Chapters 2 and 3. As shown through past failures and successes, communication is an interactive process and can be a complex and challenging task. When conveying complicated or technical information to the public in plain language, clear, accurate and accessible information that does not minimise or exaggerate issues has been found to be necessary and practical.

When discussing technical issues with public stakeholders, an explanation of the national regulatory framework for ensuring safety should first be provided, giving an overview of defence-in-depth and emergency preparedness, in particular, to demonstrate the completeness of the regulatory process and build public confidence in the regulator's competency. Generally, it is recommended to start the presentation by explaining how the facility has been designed to be safe, rather than presenting calculations of the risks from failed waste containers. In presenting technical issues to the public, materials presented should be tailored to engage the audience and should take into account their education levels, interests, risk perceptions and preferred methods of reviewing information. Tools such as photos, diagrams, animations are effective in illustrating the complex, long-term process of repository evolution. In dealing with critical observations, it is important to understand the emotion behind the issue and recognise that stakeholders may have a different concept or definition of risk than technical experts or regulators. When communicating about risk, being honest about the inherent uncertainties and presenting information in an uncomplicated and open manner can help build the public's trust, as well as increase receptivity to understanding and discussing issues constructively.

To illustrate how to communicate measures used to support repository safety in a safety case, Chapter 4 provides a more detailed and in-depth discussion of the major points to be discussed in order to convey a safety case, and in that context discusses the use of indicators as well as the regulations and plans for retrievability and monitoring in communicating a safety case. Monitoring may consist of qualitative and quantitative parameters and can be an effective means to address public concerns if set up appropriately. Clear rules governing the planning and performance of monitoring as well as the sharing of the results will avoid a potential distrust in the information.

The use of indicators is one possible line of reasoning to provide additional assurance of repository performance. Engaging the public in developing the use of indicators and/or assisting non-technical audiences to understand the applications/interpretations of different indicators and monitoring of results could enable local communities to better appreciate the functions of the engineered barriers and the repository system.

The involvement of independent (neutral) technical and non-technical bodies in designing monitoring activities and indicators will also enhance public confidence. Monitoring a facility is essential to enable the reversibility decisions, if this becomes necessary, as it provides information on the facility and its performance.

As observed in many national programmes, considering the reversibility (of decisions) and the retrievability (of the emplaced waste) to add flexibility to the implementation process and robustness to the disposal system involves balancing safety, practicality and cost.

A supplementary discussion of the potential uses of natural analogues is provided in Chapter 4. There has long been a debate regarding the potential value of using analogues for public communication and confidence building. The visual appeal of some analogues (e.g. the longevity of Roman establishments) has led some countries to bring analogue information into their engagement with non-technical audiences (e.g. Spain, Sweden and the United Kingdom). Despite this, it is still not proven that analogues are effective in explaining disposal concepts and long-term safety. One potential problem of using analogues in public communication, as in the case of indicators, is the concern of "over interpretation". Therefore, it is important to mention the conditions and limitations of an analogue. Provided that analogues are used appropriately, qualitative analogues can be used for general confidence building in parallel with using quantitative analogues as technical inputs in safety assessments (see NEA/RWM(2013)10). To improve effective communication with non-technical stakeholders, the use of analogues in a real two-way dialogue is recommended.

Communication clearly has a specific role in repository development. Through effective communication among stakeholders, technical experts are able to hone their communication skills and communication experts are effectively integrated into the development process. An essential starting point for all such communication is trust in the communicator. Therefore, building trust with stakeholders, especially the local community, is the key requisite for effective communication with the public.

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Appendix A. Review of NEA projects/studies/documents

Table A.1. NEA status report: Indicators in the safety case (reviewer: GRS)

Reference

NEA (2012), "Indicators in the Safety Case. A report of the Integrated Group on the Safety Case (IGSC)", NEA/RWM/R(2012)7, www.oecd-nea.org/rwm/docs/2012/rwm-r2012-7.pdf.

Context (siting, research, licence application)

IGSC (NEA) exercise to evaluate the state of the art for the use of indicators in safety cases.

Role of the author(s)

One consultant, four authors from waste management and research organisations.

The information in the report is based on a literature survey, where 16 organisations (waste management, regulators and research organisations) from NEA member countries participated.

Which messages the authors wanted to convey?

The authors want to show the potential of indicators for various uses in a safety case.

With respect to communication with non-technical audiences indicators are stated to be useful for explaining the potential impact of a repository putting it in relation to the local environment (e.g. around a site) comprehensible timescales (assessment timescales that most people are concerned with).

Which were the audience(s)?

The report discusses the use of indicators for communication with different stakeholders, namely regulators, technical experts and non-technical audiences (public, local communities).

Media (live discussions, report, flyer, video, web) used for communication

The report does not address this issue.

Direct/indirect communication (one way/two way, static/dynamic)

The report proposes the following ideas:

- It is proposed that indicators are of value for two-way engagement, i.e. that public and stakeholders are asked what complementary indicators they would like to see in a safety case. This could lead to a set of indicators that is significantly different to those that suggested and currently applied in safety cases. The important point is not that the indicators asked for by the public should replace the more technically focused ones, but that they should all be presented collectively, and in a complementary manner.
- Another issue is that repository safety and performance needs to be presented using a wide range of measures and units, so that readers can choose for themselves which is most meaningful (to them) and enables them to understand the likely significance of the repository impacts. It should be recognised that safety means different things to different people, and that the measures of radiological safety are, by themselves, unlikely to engender a sense of "feeling safe" with the majority of people.

Type of information provided (graphs, explaining text, numbers, indicators, videos)

For presentation of indicators, up to now often graphs are used together with explaining text. Numbers are referred to when comparison with reference values are made.

Expectations of the audience

Not applicable.

Experience – lessons learnt

There is broad agreement that complementary indicators are potentially useful in communication with non-technical audiences. For example, for ÚJV řež, a. s. (Czech Republic), the main objective of using complementary indicators is now seen primarily in communication with public as an illustration of the results of a safety case.

There is some uncertainty:

- which indicators may be best used;
- how they should be presented.

In particular, using indicators may provide four very important benefits:

- impact significance;
- local context;
- comprehensible timescales;
- two-way engagement.

Complementary indicators can be used to explain potential impacts of a repository using language and concepts that are understandable to a wide range of audiences (fluxes can be explained in terms of everyday units of mass or volume, e.g. kilograms and litres) which are broadly understood by most people. This is not the case with units and language of radiological protection.

Complementary indicators can readily be expressed in relation to the local environment around a site (e.g. radionuclide concentrations in a river). Some organisations proposed to compare them with more than one reference value or ranges that illustrate the intrinsic variability of natural systems and claimed this help in communication.

Performance indicators can help to explain and illustrate how the various components of the repository system contribute to the containment and isolation of radionuclides.

The survey showed that there is very limited experience internationally of using complementary indicators to help make safety cases more accessible and understandable for non-technical audiences. It was noted that several programmes have yet to test the use of complementary indicators with the public, and there is some concern that they could cause confusion if not appropriately presented and explained.

Did the audience find the information relevant for the message?

Not applicable.

Did the audience understand the message of the author?

Not applicable.

Table A.2. FSC topical session on natural analogue communication (reviewer: GRS)

Reference

NEA (2008), "Link Between Research, Development and Demonstration (RD&D) and Stakeholder Confidence: Use of Analogues for Confidence Building – Proceedings of a Topical Session held during the NEA Forum on Stakeholder Confidence", NEA/RWM/FSC(2008)3, www.oecd-nea.org/rwm/NEA_RWM_FSC_2008_3_ANALOGUES_OLIS.pdf.

Context (siting, research, licence application)

The NEA FSC investigates the link between RD&D and stakeholder confidence. Within this context the FSC hold a topical session on the use of analogues to help understand and to build confidence in radioactive waste management and safety cases.

Role of the author(s)

The topical session was organised and performed by the FSC. Information about the use of analogues in the safety case was requested by a questionnaire sent to the IGSC members of each country. In addition input from the EC projects Performance Assessment Methodologies in Application to Guide the Development of the Safety Case (PAMINA) and NAnet was given.

Which messages the authors wanted to convey?

How can analogues be used to increase stakeholder confidence in repository programmes and safety cases.

Current experience and ideas for the future.

Which were the audience(s)?

Safety assessors and regulators, who comprise a scientific and technical community.

Political decision makers.

The public at large (main audience).

Media (live discussions, report, flyer, video, web) used for communication

Not addressed.

Direct/indirect communication (one way/two way, static/dynamic)

Not addressed.

Type of information provided (graphs, explaining text, numbers, indicators, videos)

PowerPoint presentations with graphs and explaining text.

Expectations of the audience

Not applicable.

Experience – lessons learnt

Distinction between analogue, analogy and anecdote with respect to the degree of similarity.

For safety assessors and regulators analogues are a useful tool, one of multiple lines of evidence used in the safety case to confirm phenomenology and modelling. (analogies, anecdotes less important).

For the public analogies and anecdotes could help to grasp time scale and understand basic rationale principles of geological disposal. However, there is a lack of demonstrated evidence.

The presentation of analogues and analogies must be adapted to the audience, using understandable language and their limitations should be clearly stated. Nagra stated there is a need for "translation". Pictures, symbols analogues must be adapted to the specific society.

Analogues represent concrete examples of important functions such as long-term confinement properties to illustrate potential repository situations which might otherwise be seen as "pure theory".

Given that analogues are concrete representations of possible repository situations, it seems plausible that the public may be more likely to find a national analogue persuasive and comprehensible, since it is geographically and culturally closer to their own experience and likely to be very concrete, especially in the case of anthropogenic analogues. However, other FSC members suggest that stakeholders in some contexts display more confidence in findings and illustrations presented by international parties who are assumed to be more neutral. Neither position has been systematically demonstrated through societal surveys and each must be considered as hypothetical for the moment.

Role is dependent on the stage of the repository programme: As the programme focusses on specific sites and concepts closer relationship with repository situations (geology, materials) is possible. Later, when project is accepted in principle by local public stakeholders, the need for analogues, analogies, anecdotes decreases. The latter statement remains to be proven valid.

Did the audience find the information relevant for the message?

Not applicable.

Did the audience understand the message of the author?

Not applicable.

Table A.3. International Experiences in Safety Cases for Geological Repositories (INTESC) (reviewer: TU Clausthal)

Reference

NEA (2009), *International Experiences in Safety Cases for Geological Repositories (INTESC)*, OECD, Paris, www.oecd-nea.org/rwm/reports/2009/nea6251-INTESC-eng.pdf.

Context (siting, research, licence application)

International survey and workshop (2007) in order to analyse existing cases and document progress. The survey covered the issue "presentation of the safety case", which is applicable to the project addressed here. Context widely varying, dependent on context of the respective national programme at that time.

Role of the author(s)

Replies by ten implementing organisations or consortia (The Nuclear Waste Management Organization of Japan (NUMO) and Japan Atomic Energy Agency (JAEA) counting as one; BfS/GRS BS/Colenco counting as one), three authorities (Swedish Nuclear Power Inspectorate [SKI] and the Swedish Radiation Protection Authority [SSI] counting as one) and one technical support organisation.

Which messages the authors wanted to convey?

Wide variety, dependent on context of the respective national programme at that time.

Which were the audience(s)?

In the survey, just three questions about presentation were asked: About levels of documentation/argumentation in the safety case, about media other than printed ones, and about documenting the regulatory review process. More in-depth discussion can be found on process questions related to stakeholder trust and confidence, but I considered this as beyond scope.

INTESC synthesis:

- safety case documentation in majority of replies to questionnaire aimed at technical audience and often for review by regulator;
- summary presented at environmental impact assessments;
- shorter summaries and brochures for wider audiences;
- regulators prepared, or planned to prepare, documents about how they will review. Audience for these not mentioned.

Media (live discussions, report, flyer, video, web) used for communication

See above. Only some respondents gave an important role to media other than print products (computer graphics, videos) NUMO/JAEA and Ontario Power Generation (OPG) referred to 3D virtual realities, virtual repositories; OPG to exhibits, Nagra to public meetings. OPG (and others): Brochures.

Direct/indirect communication (one way/two way, static/dynamic)

Not applicable.

Type of information provided (graphs, explaining text, numbers, indicators, videos)

Reviewer's observation: Although the document discussed indicators, it does not address their role concerning communication.

Expectations of the audience

Wide variety (see above).

Experience – lessons learnt

Dependent on audience, multiple levels of documentation might be required, but need for consistency! Need for transparency, traceability, openness.

There might be a conflict between transparency and traceability, but this was not addressed by most respondents. Posiva mentioned keeping the main documents fairly short and readable, Nagra suggested dividing the documentation into two parts: one pulling together all arguments as transparent as possible, another one providing a traceable route to details.

NUMO/JAEA: Main safety report, supported by several main references and a number of lower-level reports. Andra: Four levels. Others argue in a similar way.

Necessity:

- to communicate purpose and context of safety case upfront;
- to refer to lessons learnt from previous assessments;
- to other safety cases (abroad) and peer reviews.

Did the audience find the information relevant for the message?

Not reported.

Did the audience understand the message of the author?

Not reported.

Table A.4. IPAG-3[1] (reviewer: TU Clausthal)

Reference

NEA (2002), *Establishing and Communicating Confidence in the Safety of Deep Geologic Disposal: Approaches and Arguments*, OECD, Paris.

Note that the title IPAG (Integrated Performance Assessment Group) refers to something that we would nowadays call "safety case".

Observation of the reviewer: The French version carries the title: "Établir et faire partager la confiance dans la sûreté des dépôts en grande profondeur". In my opinion, "to communicate" and "faire partager" are quite different from each other. That much about communication!

More importantly: The reviewer remembers that safety case communication (or "communication of integrated performance assessments", as it was called at that time) was quite an issue at the IPAG-3 workshop in 2000. Nevertheless, little can be found on that in the IPAG-3 report. The most explicit reference is made in "Appendix B. Making oral presentations about the safety case": "The IPAG-3 Questionnaire responses contained many references to experience with presentations of integrated performance assessments (IPAs). Some indicated that they believed there had been effective communication with the intended audience, and others indicated that effectiveness was questionable, and at best not quantifiable…"

The information the reviewer found to relevant for our topic (at least to some extent) is pasted below but it remains quite general. Although the word "communication" is frequently used, it mostly refers to the use of arguments and evidence in a safety case rather than to their communication.

The reviewer, however, believes it worthwhile to separately treat "Appendix B. Making oral presentations about the safety case" – see next table.

Context (siting, research, licence application)

NEA exercise to evaluate the state of the art for obtaining, presenting and demonstrating confidence in long-term safety, and make recommendations on future directions and initiatives for improving confidence.

Role of the author(s)

Questionnaire replied to by 20 organisations from 12 countries, representing both implementing organisations and regulatory bodies.

Which messages the authors wanted to convey?

Confidence in long-term safety.

Which were the audience(s)?

Varying dependent on specific national case, but mostly authorities.

Media (live discussions, report, flyer, video, web) used for communication

This is copied and pasted (with the summary left out, since the organisation-specific information is still rather general):

Other presentational media

Quite a few IPAs are presented, or will be presented, in brochures and newsletters intended for the general public (ONDRAF/NIRAS, Posiva, BfS, GRS-B, in the Atomic Energy Canada Limited's (AECL) answer, OPG, the Swedish Nuclear Fuel and Waste Management Company (SKB), noted by SKI, US DOE). Many organisations have also prepared various presentations of materials including slides, videos and a video-wall (Enresa) to be used in oral presentations to the public. However, OPG notes that the AECL media for the most part took a much wider view than just the "performance assessment story" because the final results of integrated assessments did not become available until quite late in the research programme. SKI notes that the SKB brochures mostly were intended to explain how the repository was constructed, how it works during the operation and the type of waste that is placed there. Only small parts were devoted to aspects of long-term safety that mainly discussed decay of nuclides.

GRS-K notes that in the framework of the licensing procedure the Plan KONRAD was displayed publicly in 1991 and a public hearing with duration of 75 days took place in 1992/1993.

Some organisations have developed more computer oriented information systems. Some information in TILA-99 can be found on the Posiva website. The Japan Nuclear Cycle Development Institute (JNC) has developed a publicly available database system specific to the IPA and information relevant to the individual arguments can be accessed through the web. In addition, a "virtual repository system" was developed. This system, called GEOFUTURE 21, is a tactile "ride-like" display that is part of the public outreach activities at JNC's community museum in Tokai-mura, Japan. The information can also be accessed on a CD-ROM. The US DOE distributed to the entire Total System Performance Assessment-Viability Assessment (TSPA-VA) on a CD-ROM and it is also accessible from the Web. In addition, a Simplified Total System Performance Assessment Model (based on the VA model), which will be a fully functional model that graphically depicts how all of the components fit together, is being created.

1. Incorrectly referred to as "IPAG-2" during the kick-off meeting.

Some organisations have not yet published much other presentational material to support the IPA (French National Radioactive Waste Management Agency [ANDRA], the Radioactive Waste Repository Authority (RAWRA), the British Nuclear Fuels Limited, UK Nirex Ltd, Nagra and US NRC). However, UK Nirex Ltd notes that much effort was focused on making the report visually pleasing and using illustrations at every opportunity to assist in communication. The British Nuclear Fuels Limited notes that there is a need for other means of communication with the public, but the forward strategy to communicate its main findings to a wider audience is still being developed. The Swiss Federal Nuclear Safety Inspectorate (HSK) notes that the repository concept and the associated safety concept have been explained in publications intended for a general readership and Nagra notes that an edition of the "Nagra Bulletin" was issued on the disposal programme for high-level waste.

Direct/indirect communication (one way/two way, static/dynamic)

Not really referred to (except remarks pasted above).

Type of information provided (graphs, explaining text, numbers, indicators, videos)

Not really addressed.

Expectations of the audience

Not applicable.

Experience – lessons learnt

It is important for the safety case to communicate, for each development stage, the basis for the current level of confidence in the decision to move forward, and clearly indicate the strategy for resolving the outstanding issues.

IPAG-3 participants suggest the following four issues to be explicitly addressed in a safety case:

- The inherent limitations in modelling the future evolution of the repository: why is it still reasonable to move forward?
- The level of integration: is all collected information properly used and does it lead to a consistent picture of the system? Alternatively, what are the potential impacts of the unresolved inconsistencies on safety?
- The completeness and quality of the various types of information and data that are available for making the safety case: what are the uncertainties and their potential impacts on safety?
- Any disagreements among technical experts: how were these disagreements taken into account in the analyses?

Key confidence arguments

Category	Arguments
Confidence in the proposed disposal system	• Intrinsic robustness of the multi-barrier system • "What if?" scenarios and calculations • Comparisons with familiar examples and natural analogues
Confidence in the data and knowledge of the disposal System	• Quality of the research programme and site investigations • Quality assurance procedures • Data from a variety of sources and methods of acquisition • Use of formal data tracking techniques
Confidence in the assessment approach	• Logical, clear, systematic assessment approach • Assessment conducted within an auditable framework • Building understanding through an iterative approach • Independent peer review
Confidence in the IPA models	• Explaining why results are intuitive • Consideration of alternative conceptual models and modelling approaches – simple and complex • Testing of models against experiments and observations of nature • Model comparison exercises • Comparisons with natural analogues • Independent evidence such as paleohydrogeological information
Confidence in the safety case and the IPA analyses	• Clear statements and justifications of assumptions • Demonstrate that assumptions are representative or conservative • Sensitivity studies • Clear strategy for managing and handling uncertainty • Multiple safety indicators • Multiple lines of reasoning
Confidence via feedback to design and site characterisation	• Support for any disposal concept design changes • Overall quality and safety of the disposal system

This is copied and pasted (with the summary left out, since the organisation-specific information is still rather general):

Are all confidence statements published?

Most respondents suggest that all confidence arguments are published or will be included in the IPA report when it is published (ANDRA, JNC, ONDRAF/NIRAS, Posiva, RAWRA, UK Nirex Ltd, Nagra, US DOE, US NRC). However, in some instances (BfS and GRS-B) the IPA reports are not publicly available. There, only parts of the arguments are available for the public. GRS-K notes that the arguments are part of the documentation prepared for licensing authority. They were also widely discussed during the public hearing.

In contrast, OPG notes that the IPA safety assessments and model reports generally include only the confidence arguments that directly bear on specific issues deemed to be most relevant at the time the reports were being written. Other arguments are cited in the text, but it is clear that a larger number of confidence statements were omitted from the IPAs. Also during the review, non-discussed aspects relevant to confidence building were noted. Also the Swiss Federal Nuclear Safety Inspectorate assumes that the confidence building internal to the organisation further rests on a multitude of minor facts that add up to a consistent picture. SKB notes that information on natural analogues gathered over the years was not utilised to the extent possible in the IPA report. The British Nuclear Fuels Limited notes that key messages that build confidence in safety are published. Some arguments have been tested internally, for example, comparisons of radiological impacts with other hazards and risks (e.g. air pollution, passive smoking, road traffic deaths and lightning). These arguments may not be directly used in the safety case as they may be interpreted as not being relevant, e.g. comparing voluntary or "natural" risks with risks "imposed" by industry. The correct balance of providing information without appearing to justify the impacts of waste disposal by comparisons with other impacts is still being developed.

Evidently some analyses are not published. Enresa notes that some mathematical model verification exercises were not published. Some scoping calculations made by AECL were never published. However, these scoping calculations prompted questions to the AECL to perform additional and now published calculations. Internally at SKI there was some concern about the relatively high sensitivity of calculated dose rates to some of the parameters and models used.

Arguments of potentially questionable value:

- JNC notes that parts of both the natural analogue and the multiple safety indicator assessments were less valuable in making the original IPA presentation. However, their long-term value in terms of public acceptance was difficult to quantify.
- The British Nuclear Fuels Limited notes that formal feedback on the status report has not yet been received. This may reveal that some lines of reasoning are not contributing to the overall safety case and we must listen carefully to our stakeholders to ensure a well-focused post-closure safety case is produced for September 2002.
- OPG notes that the complex quantitative analyses and accompanying arguments had a detrimental impact on many reviewers of the environmental impact statement and safety cases. In particular, the complexity and lack of transparency of the probabilistic safety assessment methodology using Systems Variability Analysis Code (SYVAC) may have been viewed as detrimental to the safety case.
- Nagra notes a potential problem in using overly conservative hypothetical values, in that they may be misunderstood as a worst but still possible case, thus giving a false impression of limited system performance or existing uncertainties.
- US DOE notes that all arguments were useful. However, specialists on external oversight and peer review panels felt that there were many unanswered questions. They asked pointed questions about sensitivities, which showed that they believed that only a few of the data sets were meaningful and important, and others were not important within the ranges of the data obtained. This was not to discourage the approach, however, but to suggest more of it should be done to really test the model and understand its limitations.

Most respondents did not identify any less useful arguments.

Did the audience find the information relevant for the message?

Not applicable.

Did the audience understand the message of the author?

Not applicable.

Table A.5. IPAG-3, "Appendix B. Making oral presentations about the safety case" (reviewer: TU Clausthal)

Reference

NEA (2002), "Appendix B. Making oral presentations about the safety case", *Establishing and Communicating Confidence in the Safety of Deep Geologic Disposal: Approaches and Arguments*, OECD, Paris.

Context (siting, research, licence application)

Part of IPAG-3 exercise, see table above.

Role of the author(s)

IPAG-3 subgroup.

Which messages the authors wanted to convey?

We are at the "meta-level" here: The authors wanted to convey messages about how messages about confidence in long-term safety can be conveyed.

Which were the audience(s)?

At the "meta-level" mentioned above: Authors of safety cases.

At the secondary level (as mentioned in the document):

- the public;
- public officials;
- internal audiences;
- other "customers";
- regulatory authorities;
- governmental or other oversight/peer review groups;
- scientific community.

Most meetings will have a mixed audience; important to identify "primary audience".

"Characterising the primary audience involves ascertaining their expectations, their technical information needs, interests and sophistication. Experiences with the audience, and directly discussing or planning the meeting with representatives from that audience, serve to make presentations and exchanges more productive.

In dealing with a public information meeting or other public exchange, it is important not to underestimate the audience's technical sophistication. To talk down to an audience, or even to be perceived as talking down, hinders communication and polarises the audience and presenter. Further, it is important to try to understand the audience's issues and perspectives regarding the disposal facility.

In addition to technical content, the potential primary audience needs to be consulted regarding the format and style of the meeting. There is a big difference between a series of presentations followed by questions, and a round-table format with short opening statements and presentations, and the bulk of the time dedicated to questions and answers or other formats for open exchanges and discussions.

The time that is to be available for a presentation or exchange is an extremely important part of planning for a presentation to any audience. All audiences, no matter how technical or interested, are human beings with limits on how much material they can assimilate and how long their attention span is optimal. On the other hand, a short time period for a presentation is an opportunity to stay focused on the primary message.

Finally, it is important to maintain flexibility, to be able to listen to the audience and to change the emphasis of the presentation to suit the expressed needs of the audience if it is different from that originally assumed. Interacting with representatives of the primary audience as part of the planning for the presentation is a good way to prevent this from occurring, but circumstances and events can also change the needs of that audience."

Experience – lessons learnt

Rather recommendations:

"The safety case should be well argued and supported, should state its purpose, and should place itself into a programme context: identifying where it sits in the decision-making plan, and showing where it is on the decision-making schedule.

There are … reasons for suggesting this should be done in the safety case documentation itself, although it can certainly also be shown in brochures or meeting handouts or announcements." "regulations and the regulator's role need to be explained in the documentation, as well as in presentations … also important because it documents the implementer's interpretation of the regulations"

Need to communicate "…the idea of the safety case being a trustworthy assessment that is part of a fair and well-defined societal decision-making process" "the presenter needs to be technically competent:

- Audience "The public": "… concerns, regardless of the source, must be treated seriously, respectfully and calmly. Impatience or exasperation from the presenter will reflect poorly on the presenter, regardless of the motives or tactics used by intervenors. There will likely be observers in the audience who do not agree with the viewpoints of the intervenor, but will, as human beings, be very interested in how the intervenor is perceived and treated. It is a good idea to have a neutral meeting moderator to keep order in an even-handed way." "… may have differing concerns and viewpoints. The important point is to recognise that a presentation of safety case material may need to appeal to all these viewpoints …"Audience "Public officials": again "wide spectrum of viewpoints". "make materials available to public officials for use in discussing the proposed system and its degree of safety or risk with their constituents".
- Internal audiences: Report just states the obvious.
- Audience "utilities and other 'customers'": "It is important that waste generators allow the safety-assessment-related work to be done honestly and openly."
- Audience "regulatory authorities": "Typically, some of the interactions between implementers and regulators will occur in public fora, and as with all interactions, it is important that discussions be both frank and respectful. The implementer needs a strong and independent regulator for the public to have faith in the societal decision-making process. Further, the societal process will be called into question if either side acts in a way that may be perceived as unfair towards the other. Professional decorum and correct social behaviour are required on both sides."
- Audience "governmental or other oversight/peer review groups": "important to be able to impart a justified sense of scientific and engineering competence, and of dedication to doing the right work for the right reasons."
- Audience "scientific community": "… necessary to engage the scientific community, so that the scientific community can be a participant in the societal decision-making process. Without the support of the scientific community, obtaining public acceptance will be difficult if not impossible. However, scientific community support alone will not guarantee public acceptance. The scientific community audience may best be reached through publishing in scientific and engineering journals, and through presentations at professional society meetings. Having recognised experts from the scientific community review work or give advice, as mentioned above, is another way of engaging the scientific or engineering communities. However, in engaging a competent scientist or engineer to give advice, it must be recognised that critical comments will be provided. The comments will need to be considered and addressed appropriately, even if the implementer believes that the underlying issues raised are not important to long-term safety."

"only one "main message"" "clearly presented in the introductory material or introduction. … should be supported by the conclusions"

"no conflicting or non-supportive sub-messages"

"Messages can differ greatly in terms of technical detail, however efforts are required to avoid the appearance of using the safety case to give different messages to different audiences."

Preparation:

"Tailor presentation to primary audience in terms of length, emphasis, detail and packaging.

- Show what is to be explained (system features description).
- Show how the system works (system process and events description, starting with the expected evolution of the system).
- Explain modelling process (integration of FEPs/abstraction of complex calculations).
- Explain basis for modelling (site investigation, design, materials testing and emphasise commitment to continual improvement).
- Show the expected safety and its uncertainty (system safety indicators; show expected, undisturbed performance first, show potential results of low probability events separately).
- Balance the uncertainties associated with long time frames, large spatial domains and complexity of the disposal system with confidence that the system will be safe for the hazardous lifetime of the wastes.
- Demonstrate the complementary roles of the engineered and natural barriers and the robustness of the disposal system.
- Maintain consistency between the safety case and supporting documentation.
- Use specialised terms and acronyms judiciously.
- Provide evidence that the safety case methods, tools and procedures are correct, well accepted and appropriate for their intended use.
- Place the regulatory criteria, design basis, site features and assessment results into context and perspective with those of other national programmes.
- Identify and address reviewer/regulator/public issues and concerns in a direct and open manner.
- Explain what is needed to be more sure, and show there is ongoing work and plans for future work to obtain that information.

- State whether or not there is sufficient certainty to meet the goals of the safety case in terms of the decisions that need to be made (a "statement of confidence" in a specific context, saying that because of these results and what is known, we are ready to move to the next step).
- Experiment with alternative ways of presenting information: different audiences must receive the same message, based soundly on the safety case, but tailored to their ability and needs. The use of focus groups with randomly sampled members of the public may be helpful in terms of learning to more effectively communicate with the public.
- Be prepared, especially in a public meeting, if it appears to be the will of the audience, to forego addressing long-term safety and instead discuss more near-term risks, such as those from construction, operation, or transportation (perhaps have another presentation, or even another presenter, at hand).

Attempt to understand audience expectations.

Practice, if possible, before a live, critical audience.

Use figures, graphics and illustrations of principles and suitable natural and anthropogenic analogues with simple self-contained messages."

"The balance between objectivity and advocacy can be achieved by freely disclosing uncertainties, the information needs implied by those uncertainties, and indicating that work is planned or in progress to obtain the information."

"…both technical staff and communications specialists are required at public meetings, because they have complementary skills … need training …"

"… avoid speculating in cases where the answer to the question is not known. … avoid discussing preliminary safety case/IPA findings that are not yet understood or have not yet been internally reviewed. Presenting complex results without fully understanding the reasons for the shapes of curves, for example, could lead to embarrassment if the audience asks pointed questions. Changing or contradicting an answer that was given at a previous meeting can be perceived as deceptive. On the other hand, saying that the answer is not yet known, but that evaluations and sensitivity studies are in process to determine the answer, is both honest and credible if true. This type of answer needs to be followed up with a commitment to provide an answer at a later date, and an arrangement to do so must be made."

"…express confidence, if one has confidence, as a personal conviction based on several lines of evidence …"

"…necessary to have a formal way of openly and honestly dealing with contrary technical opinions …"

"The presentation of a safety case is not an attempt to create converts or believers. It is an attempt to communicate the safety case and its basis. Communication is successful if a stakeholder, whether for or against a repository, comes away with a clearer understanding of the course of action recommended in the safety case and its basis. This basis includes the technical issues and risks involved, and also the processes for further developing the repository and its safety case, for stakeholder involvement and for decision making."

Did the audience find the information relevant for the message?

Not applicable.

Did the audience understand the message of the author?

Not applicable.

Table A.6. NEA monitoring documents (reviewer: TU Clausthal)

References

NEA (2013), "Monitoring of Geological Disposal Facilities IGSC", working document (provisional version), NEA/RWM/IGSC(2013)5/PROV.

NEA (2013), "Local communities' expectations and demands on monitoring and the preservation of records, knowledge and memory of a deep geological repository", NEA/RWM/R(2013)4.

NEA (2014), "Preservation of Records, Knowledge and Memory across Generations (RK&M) – Monitoring of Geological Disposal Facilities: Technical and Societal Aspects", NEA/RWM/R(2014)2.

H.Gharbieh: „Gegenüberstellung der technischen und gesellschaftlichen Sichtweise hinsichtlich des Monitorings von Endlagern in tiefen geologischen Formationen" ("Juxtaposition of technical and societal views regarding the monitoring of final repositories in deep geological formations", seminar paper, in German, 2014).

Context (siting, research, licence application)

Paper 1 addresses technical issues (based on literature), paper 2 societal issues related to monitoring (based on a survey). EC project MoDeRn accounted for. Papers 3 and 4 attempt to synthesise the two aspects.

Role of the author(s)

1-3: International body, 4: student.

Which messages the authors wanted to convey?

Differences in the views of technicians and non-technical stakeholders concerning monitoring. In the opinion of the reviewer, these differences might (in part) be caused by inefficient communication about the possibilities, limitations, and usefulness (or otherwise) of monitoring.

Which were the audience(s)?

Technicians, scientists.

Media (live discussions, report, flyer, video, web) used for communication

Not applicable.

Direct/indirect communication (one way/two way, static/dynamic)

Not applicable.

Type of information provided (graphs, explaining text, numbers, indicators, videos)

Not applicable.

Expectations of the audience

Not applicable.

Experience – lessons learnt

In the view of technicians, there seems to be a general tendency of non-technicians to overestimate potential and usefulness of monitoring. Nevertheless, there seems to be agreement that safety must not rely on monitoring, rather it is considered a means of increasing confidence. Different views about how effective such a means could be. Potential for development on the technical side is identified in the reports.

Interest of non-technicians focused on environmental issues (even epidemiological data) and societal issues (including the long term), while technicians tend to focus on performance issues (mainly during operation). (Interestingly, there is a tendency to enlarge the scope of the term "monitoring" towards social and economic issues, which, in the view of the reviewer, bears the danger of further blurring terminology and, consequently, communication.)

There is only little direct reference to communication issues in the documents. Exception: "Local stakeholders demand simple proof that the closed disposal facility has attained passive safety status which is difficult to provide in general: the evidence is based on a complex and extremely long-term monitoring programme and its scientific evaluation and interpretation. Reaching consensus on how to address this problem is vital in attaining full stakeholder confidence." (Document no.3).

However, the reviewer believes that the set of documents evidences a significant communication problem not only concerning the role of monitoring but, in a broader context, **indicates a problem concerning communicating the concept of passive safety as such**. Our project should keep that in mind when addressing the nitty-gritty of indicators, curves, 3D virtual repositories and the like.

Did the audience find the information relevant for the message?

Not applicable.

Did the audience understand the message of the author?

Not applicable.

Table A.7. The Reversibility and Retrievability (R&R) Project: The International Conference and Dialogue on Reversibility and Retrievability – Reims, France, December 2010 (reviewer: Enresa)

Reference

NEA (2012), *Reversibility and Retrievability in Planning for Geological Disposal of Radioactive Waste: Proceedings of the "R&R" International Conference and Dialogue, 14-17 December 2010, Reims, France*, OECD, Paris.

NEA (2011), "Reversibility and Retrievability (R&R) for the Deep Disposal of High-Level Radioactive Waste and Spent Fuel: Final Report of the NEA R&R Project (2007-2011)", NEA/RWM/R(2011)4.

International Retrievability Scale (final 4-page leaflet for stakeholder communication).

www.oecd-nea.fr/rwm/rr.

Context (siting, research, licence application)

Research project on the feasibility of implementation of reversibility and retrievability (R&R) in geological repository programmes. The goal of the project studies and activities was to acknowledge the range of approaches to R&R and to provide a basis for reflection.

"The objectives of the conference included allowing and recording as many points of view as possible, discussing and better understanding commonalities and differences, testing and refining the findings of the draft NEA R&R project report, and refining the international R-Scale, a tool for dialogue that has been developed within the framework of the NEA R&R project."

Role of the author(s)

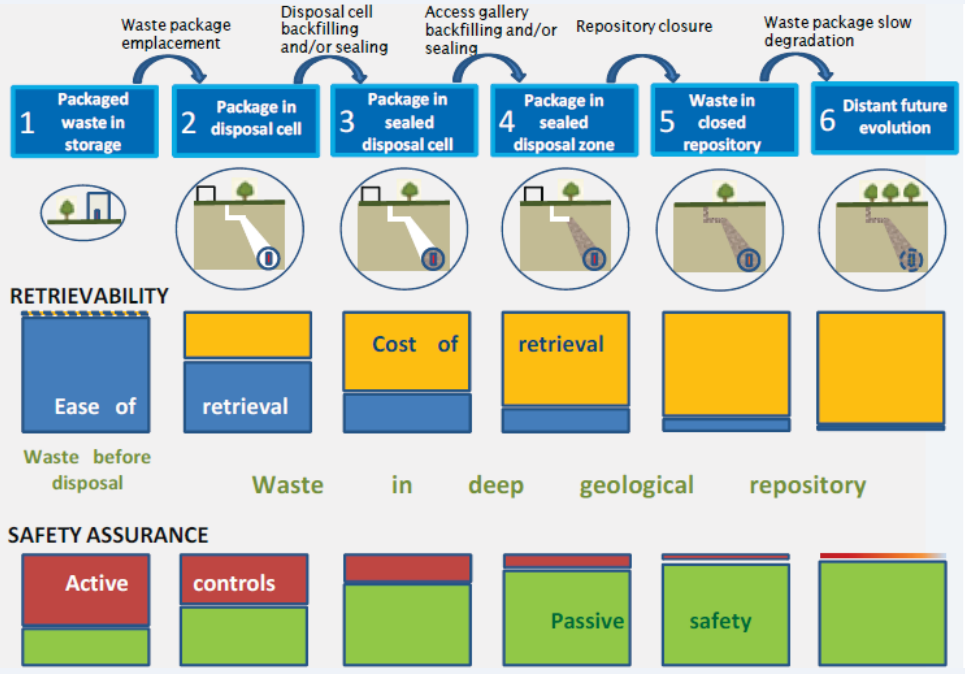
The role of the authors in the main document analysed (proceedings) was to collect the papers of the invited speakers, the presentations of the stakeholders and the results of the groups discussions.

Fifteen countries participated in the R&R project and two international organisations. Regulators, WM agencies, environmental agencies, humanities universities.

Which messages the authors wanted to convey?

For the conference, there was a need to clarify concepts and harmonise the meaning of the specific terms used in order to facilitate a common understanding. In addition, the different stages of waste disposal, the degree and type of effort that is needed to retrieve the waste according to the stages in its life cycle before and after its emplacement in a repository, the evolution of ease and cost of retrieval and of passive safety. Reversibility could be considered as something intrinsic to the operation of the repository, but retrievability should not be considered part of the basic safety concept of the waste disposal in a repository.

The International Retrievability Scale as a tool to support dialogue with stakeholders and to establish a common international framework (R-Scale).



Which were the audience(s)?

The conference was attended by some 180 persons, took place in the city of Reims (France) and was open to all interested parties.

Participants were from civil society stakeholders (local and national), non-governmental organisations, implementers and scientific researchers, regulators, policy makers and social scientists.

Media (live discussions, report, flyer, video, web) used for communication

Live discussions, organised groups discussions and the flyer with the R-Scale.

Direct/indirect communication (one way/two way, static/dynamic)

At the conference, a combination of one-way communication in the form of presentations and two-way communication (direct discussion) during the round tables.

Type of information provided (graphs, explaining text, numbers, indicators, videos)

Leaflet of the R-Scale and abstracts of presentations.

Expectations of the audience

In general it can be said that the audience expected the confirmation of its own "a priori" positions, but it was not reluctant to discuss it.

These attitudes vary in different countries:

- In Canada opponents to nuclear power favour retrievability, pro-nuclear citizens are rather sceptical of it.
- In Sweden it is the opposite, i.e. people with a positive attitude towards nuclear power use favour retrievability, whereas nuclear opponents also oppose retrievability.
- Germany was an exception, with both pro-nuclear and opponents alike considering that a repository should not contain any provision to easy retrievability.

Nevertheless, participants in the discussion groups recognised that R&R concepts might contribute to the acceptance of the repositories, to reach a higher level of consensus, based on trust, as long as these concepts are not used by implementers as a Trojan horse.

Experience – lessons learnt

- There are different approaches to R&R in the different countries.
- The Retrievability Scale developed by the NEA R&R project is a useful communication tool across contexts and a good basis to promote discussions.
- There is strong societal interest in reversibility of decisions or retrievability of waste.
- Reversibility of decisions and retrievability of waste are complex subjects that cannot be considered in isolation from safety and societal issues.
- Further reflection and dialogue are needed, as well as harmonisation of vocabulary.

Did the audience find the information relevant for the message?

Yes.

Did the audience understand the message of the author?

Yes, and they actively participated in the discussions.

Table A.8. Flyer: Engineered barriers and geological disposal, 2012 (reviewer: DBE Technology GmbH)

Reference

www.oecd-nea.org/rwm/igsc/docs/ebs-flyer-a4.pdf.

Role of the author(s)

IGSC members and/or NEA personnel.

Which messages the authors wanted to convey?

The authors want to explain the system of multiple barriers of a deep geological repository and in particular the engineered barrier system (EBS). The description includes the role of the main EBS components like waste form, waste package, buffer and backfill material, and plugs and seals. At the end, a summary of the status of research and development work was given.

Which were the audience(s)?

The public at large and the interested technical and scientific community.

Media (live discussions, report, flyer, video, web) used for communication

Flyer.

Direct/indirect communication (one way/two way, static/dynamic)

One-way communication (authors towards readers).

Type of information provided (graphs, explaining text, numbers, indicators, videos)

Explaining text and one figure displaying an example of an EBS within an underground repository system.

Expectations of the audience

Not applicable.

Experience – lessons learnt

It is in the nature of a flyer that there is only little information related to communication with the exception of an indication in a blue coloured footer on page 1:

"For more information on IGSC activities, visit our webpage at www.nea.fr/html/rwm/igsc.html"

Reviewers comment:

A flyer as such is an adequate medium to transmit important news or messages to a broad audience. However, this requires a detailed mailing list and an appropriate (non-electronic) mailing system.

Did the audience find the information relevant for the message?

Not applicable.

Did the audience understand the message of the author?

Not applicable.

Table A.9. Flyer: The construction and operation of geological disposal facilities for high-level radioactive waste and spent fuel – Challenges and opportunities (reviewer: DBE Technology GmbH)

Reference

www.oecd-nea.org/rwm/igsc/docs/gdf-flyer-a4.pdf.

Context (siting, research, licence application)

Construction and operation of a repository.

Role of the author(s)

IGSC members and/or NEA personnel.

Which messages the authors wanted to convey?

The authors want to convey the message that there has been huge progress in developing national waste management programmes for deep geological disposal of high-level waste and spent fuel and that over the next decades, there will be a shift for some nations to move from RD&D to industrial implementation of repositories. Siting, construction, and operation of a repository may lead to a win-win situation for all stakeholders involved (examples: increase of economic activity in the region, increase of taxes, improvement of educational level, etc.)

Which were the audience(s)?

The public at large and the interested technical and scientific community.

Media (live discussions, report, flyer, video, web) used for communication

Flyer.

Direct/indirect communication (one way/two way, static/dynamic)

One-way communication (authors towards readers).

Type of information provided (graphs, explaining text, numbers, indicators, videos)

Explaining text (two pages) and one figure.

Expectations of the audience

Not applicable.

Experience – lessons learnt

It is in the nature of a flyer that there is only little information related to communication with the exception of an indication in a blue coloured footer on page 1:

"For additional information please consult our website: www.oecd-nea.org/rwm/rwmc.html"

Reviewers comment:

A flyer as such is an adequate medium to transmit important news or messages to a broad audience. However, this requires a detailed mailing list and an appropriate (non-electronic) mailing system.

Did the audience find the information relevant for the message?

Not applicable.

Did the audience understand the message of the author?

Not applicable.

Table A.10. Flyer: Integration Group for the Safety Case (IGSC) – Identity and activities of the RWMC, 2009 (reviewer: DBE Technology GmbH)

Reference

www.oecd-nea.org/rwm/igsc/docs/igsc-identity-flyer-2009.pdf.

Context (siting, research, licence application)

Management of radioactive waste for the long term.

Role of the author(s)

IGSC members and/or NEA personnel.

Which messages the authors wanted to convey?

The authors want to inform about the existence of the Integration Group for the Safety Case (IGSC), the IGSC activities, its mission, the compilation of the membership and the wide range of skills and expertise.

Which were the audience(s)?

The public at large and the interested technical and scientific community.

Media (live discussions, report, flyer, video, web) used for communication

Flyer.

Direct/indirect communication (one way/two way, static/dynamic)

One-way communication (authors towards readers).

Type of information provided (graphs, explaining text, numbers, indicators, videos)

Photos of siting, exploration and construction of repositories and main technical components, as well as a brief explaining text.

Expectations of the audience

Not applicable.

Experience – lessons learnt

It is in the nature of a flyer that there is only little information related to communication. However, the flyer contains a number of references with further detailed information and a link to an NEA web page.

Reviewers comment:

A flyer as such is an adequate medium to transmit important news or messages to a broad audience. However, this requires a detailed mailing list and an appropriate (non-electronic) mailing system.

Did the audience find the information relevant for the message?

Not applicable.

Did the audience understand the message of the author?

Not applicable.

Table A.11. Flyer: Radiological protection and geological disposal – The guiding principles and recommendations of the International Commission on Radiological Protection (ICRP) (reviewer: DBE Technology GmbH)

Reference

www.oecd-nea.org/rwm/igsc/docs/icrp-flyer-2013.pdf.

Context (siting, research, licence application)

Radiation protection.

Role of the author(s)

IGSC members and/or NEA personnel.

Which messages the authors wanted to convey?

The authors want to convey the message that the protection of man and the environment against ionising radiation is the uppermost objective of the implementation of a deep geological repository. In addition, the International Commission on Radiological Protection (ICRP) was introduced as well as its fundamental principles of radiological protection.

Which were the audience(s)?

The public at large and the interested technical and scientific community.

Media (live discussions, report, flyer, video, web) used for communication

Flyer.

Direct/indirect communication (one way/two way, static/dynamic)

One-way communication (authors towards readers).

Type of information provided (graphs, explaining text, numbers, indicators, videos)

Explaining text (four pages) and one figure.

Expectations of the audience

Not applicable.

Experience – lessons learnt

It is in the nature of a flyer that there is only little information related to communication with the exception of an indication in a blue coloured footer on page 1:

"Visit our website: www.oecd-nea.org and www.icrp.org"

In addition, there is a clear statement in the introducing paragraph on page one, saying that the interested public can learn more in consulting ICRP Publication 122.

Reviewers comment:

A flyer as such is an adequate medium to transmit important news or messages to a broad audience. However, this requires a detailed mailing list and an appropriate (non-electronic) mailing system.

Did the audience find the information relevant for the message?

Not applicable.

Did the audience understand the message of the author?

Not applicable.

Table A.12. Flyer: The long-term safety case for geological disposal of radioactive waste – Its concept and continuing evolution (reviewer: DBE Technology GmbH)

Reference

www.oecd-nea.org/rwm/igsc/docs/igsc-safety-case-a4.pdf.

Context (siting, research, licence application)

Repository safety (operational and long term).

Role of the author(s)

IGSC members and/or NEA personnel.

Which messages the authors wanted to convey?

The authors want to inform about the nature and the scope and the essential elements of a safety case. The main message is that a safety case is more than a list of results of model calculations but a synthesis of evidences, analyses and arguments to confirm that a repository for high-level waste and spent fuel will be safe by itself after repository closure. Another important message is that the safety case is a kind of "living document" that has to be updated over the decades that a repository is expected to operate.

At the end, the authors want to provide confidence in the safety case approach.

Which were the audience(s)?

The public at large and the interested technical and scientific community.

Media (live discussions, report, flyer, video, web) used for communication

Flyer.

Direct/indirect communication (one way/two way, static/dynamic)

One-way communication (authors towards readers).

Type of information provided (graphs, explaining text, numbers, indicators, videos)

Explaining text (four pages) and one flow chart.

Expectations of the audience

Not applicable.

Experience – lessons learnt

It is in the nature of a flyer that there is only little information related to communication with the exception of an indication in a blue coloured footer on page 1:

"For more information of safety case development, visit the IGSC web page at www.oecd-nea.org/rwm/igsc"

Reviewers comment:

A flyer as such is an adequate medium to transmit important news or messages to a broad audience. However, this requires a detailed mailing list and an appropriate (non-electronic) mailing system.

Did the audience find the information relevant for the message?

Not applicable.

Did the audience understand the message of the author?

Not applicable.

Table A.13. Flyer: Underground research laboratories (URLs) and geological disposal of radioactive waste (reviewer: DBE Technology GmbH)

Reference

www.oecd-nea.org/rwm/igsc/docs/url-flyer-a4.pdf.

Context (siting, research, licence application)

Research and demonstration.

Role of the author(s)

IGSC members and/or NEA personnel.

Which messages the authors wanted to convey?

The authors want to introduce the benefits of constructing and operating underground research laboratories (URLs). On the one hand, URLs provide researchers and engineers with the possibility to develop and test processes and techniques under realistic, repository-like conditions. On the other hand, interested people may have access to the URL and get a better understanding of what a repository may look like. This – and that is the key message – will build confidence.

Which were the audience(s)?

The public at large and the interested technical and scientific community.

Media (live discussions, report, flyer, video, web) used for communication

Flyer.

Direct/indirect communication (one way/two way, static/dynamic)

One-way communication (authors towards readers).

Type of information provided (graphs, explaining text, numbers, indicators, videos)

Explaining text (two pages) and one photograph.

Expectations of the audience

Not applicable.

Experience – lessons learnt

It is in the nature of a flyer that there is only little information related to communication with the exception of an indication in a blue coloured footer on page 1:

"For additional information please consult our website: www.oecd-nea.org/rwm/igsc.html"

Reviewers comment:

A flyer as such is an adequate medium to transmit important news or messages to a broad audience. However, this requires a detailed mailing list and an appropriate (non-electronic) mailing system.

Did the audience find the information relevant for the message?

Not applicable.

Did the audience understand the message of the author?

Not applicable.

Appendix B. Review of EC projects/studies/documents

Table B.1. Sustainable Network for Independent Technical Expertise (SITEX) project – D5 deliverables (reviewers: FANC – Belgian Agency for Nuclear Control)

Reference

SITEX deliverables:

- D 5.1: Recent approaches for stakeholder involvement.
- D.5.2: Interaction with stakeholders in the technical review in practice.

Context (siting, research, licence application)

Interactions between regulatory function and civil society (SITEX project):

- focus on entire licensing process, regulatory decisions and nuclear safety issues.

Role of the author

Organisations carrying out expertise function within the regulatory body and representatives of civil society.

Definition of expertise function within SITEX project:

"The expertise function contributes in activities carried out in the context of the regulatory review of safety case in order to provide the technical and scientific basis of safety for:

- decisions by the national regulatory body;
- ensuring that regulatory expectations are clearly communicated to and interpreted by the implementer;
- improving the quality of the interactions with civil society in the decision-making process in order to contribute to build a robust review of the safety case."

Which messages the authors wanted to convey?

One of the tasks of the expertise function within the regulatory body is to improve the quality of the interactions between experts and civil society in the decision-making process.

The expertise function has a key role to play in the development of appropriate governance patterns to conduct these interactions that should constitute an opportunity for civil society:

- to have access to different sources of expertise in order to enhance its technical knowledge and capacities;
- to raise its capacity and knowledge in order to engage in a meaningful way along the radioactive waste management decision-making process at local, national or international levels.

Development is needed on clear identification how and when should civil society enter the decision-making process.

Which were the audience?

Civil society, partners from parallel projects as the International Socio-Technical Challenges for implementing geological disposal (InSOTEC) and the Implementing Public Participation Approaches in Radioactive Waste Disposal (IPPA), representatives of implementers (Implementing Geological Disposal of Radioactive Waste Technology Platform, non-governmental organisation), regulators, technical support organisations, independent experts.

Media (live discussions, report, flyer, video, web) used for communication

Reports: see references

Presentations and live discussions (organised behind four roundtables) in the frame of a workshop covering following topics:

- needs for the public to engage in the radioactive waste management decision-making process;
- opportunities for civil society and technical experts interactions.

Papers

Web: http://sitexproject.eu

SITEX II EC project proposal (currently assessed by EC)

Direct/indirect communication (one way/two way, static/dynamic)

Direct (two way, dynamic).

Type of information provided (graphs, explaining text, numbers, indicators, videos,..)

As a basis for discussions presentations have been given on:

- case studies of technical experts interacting with civil society, discussing the purpose of engaging the public;
- SITEX findings regarding the definition of the expertise function and its activities.

Expectation of the audience

Civil society expectation is to take part to the decision-making process at the earliest stage, even before conceptual phase. Open discussion during preparation of strategies to manage the waste from decommissioning phase is required. To ask civil society to co-operate only at the final stage of the nuclear energy cycle without interaction in earlier stages of project development is not acceptable anymore. Moreover, the two-way dynamic communication is essential for a "real" interaction.

Experience – lessons learnt

Key conditions for the regulatory body to gain trust of civil society are: transparency, competence, openness, listening and responding (notably by explaining how interactions with civil society are taken into account in the decision-making process).

Transparency ask to create conditions to give an effective access to relevant and reliable information as well as to independent sources of expertise. Representatives of civil society commonly do not have sufficient knowledge and resources to enter discussions on an equal footing with the implementers of the projects. The availability of supporting independent experts, providing the public with independent review and explanations of the available documentation of the project, is therefore a necessary component of transparency.

In order to facilitate the interactions between the expertise function of the regulatory body and the civil society, it is necessary to develop specific tools and methodologies regarding the involvement of the "concerned" public, and also to take into account the intergenerational aspects of the management of the interactions with the civil society and its expectations.

There is a need for clarification regarding the principle of independency of the expertise function of the regulatory body: it is understood that, no expert or scientists can be absolutely independent because of the necessary co-operation in research areas, or as result of a lack of available researchers in nuclear sector in each country. It is expected that clear guidelines will be drawn in this area.

Civil society expectation is to take part to the decision making at the earliest stage. The public participation during the safety case review process is generally not regulated by legislation (contrary to the participation during the decision-making process). Safety case results are basic determinants for decision making at any stage of geological disposal development. Jointly to the public participation in the decision-making process, specific interactions are therefore needed between the civil society and the expertise function along the safety case review process (also during the pre-licensing phase).

Mutual understanding is required to guarantee a continuous dialogue between the civil society and the expertise function. If there is no common understanding of fundamental issues, it is not possible to discuss more detailed aspects of each stage of the decision making.

The experts should make explicit what is known and what is unknown on a scientific basis, quantifying risks and describing uncertainties.

SITEX network and its potential future interactions with the civil society are expected to bring under the light the particular dimensions and steps of the geological disposal development and to contribute to clarify the very special needs (knowledge, expertise, interactions with the public) at each level and stage, bringing a platform for sharing experience and preparing common ground for safety case review at European level. SITEX network could interact with civil society at different levels of governance and at different steps of the decision-making process. SITEX as a network of independent expertise functions can provide a space for safe discussions among various partners.

Did the audience find the information relevant for the message?

The SITEX workshop was perceived as an appropriate platform supporting the development of future co-operation and interactions with the civil society.

Did the audience understand the message to the author?

It is difficult to estimate if the audience understood the message. However it was pointed out that where understanding and exchange with expertise function is needed to support decision-making process, it is important to inform the audience on following issues:

- decision process, history and rational of already done decisions, subsequent strategic decisions;
- norms and standards determining certain decisions and waste management itself;
- safety principles and requirements;
- position of regulator and regulatory body's experts:
  - regular update on the R&D programme of the expertise function;
  - regular update on the safety case review progress; (i.e. safety concept; safety strategy adopt by the implementer).

The most difficult technical topics are expected to be translated and explained in a simple form.

Table B.2. Performance Assessment Methodologies in Application to Guide the Development of the Safety Case (PAMINA) communication (reviewer: GRS)

Reference

Hooker, P.J. and T. Greulich-Smith (2008), "PAMINA Performance Assessment Methodologies in Application to Guide the Development of the Safety Case. Report on the PAMINA Stakeholder Workshop: Communicating Safety Issues for a Geological Repository", DELIVERABLE (D-N°: D2.1.B.1), www.ip-pamina.eu/downloads/pamina2.1.b.1.pdf.

Context (siting, research, licence application)

EC-funded research project. One part of the project was designed to develop a better understanding of the treatment of uncertainty in performance assessment and the safety case. In this specific task approaches for communicating about confidence and uncertainties in a safety case were evaluated.

The key activity was a workshop which should elicit views on communicating safety issues for a geological repository. The workshop tested particular communication styles and ideas on participants in order to gain some understanding of how public audiences might respond to different approaches.

Role of the author(s)

The work was performed by Galson Sciences, a consultant organisation, in collaboration with the UK Nuclear Decommissioning Authority (NDA).

Which messages the authors wanted to convey?

The authors wanted to test, how different communication styles concerning long-term safety of radioactive waste repositories are acknowledged by the interested public and evaluate their ideas how to present the messages.

Which were the audience(s)?

The workshop was attended by 15 participants drawn from local authorities and stakeholder groups with interests in radioactive waste management issues.

Remark: Cover for costs of any necessary travelling and accommodation was offered in order to encourage members to attend.

Media (live discussions, report, flyer, video, web) used for communication

The workshop tested particular communication styles and ideas on participants in order to gain some understanding of how public audiences might respond to different approaches. The workshop primarily tested communication styles through the use of presentation, poster and video materials.

Direct/indirect communication (one way/two way, static/dynamic)

Direct communication, one way and two way with emphasis on two-way communication.

Type of information provided (graphs, explaining text, numbers, indicators, videos)

Graphs, photographs, explaining text. Posters are used representing a high diversity:

- overview and demonstration of multi-barrier system and running repository systems methods;
- transport and emplacement;
- natural analogues;
- results of safety assessment (very scientific with graphs, dose curves and indicators).

Natural analogue video "Traces of the future", Nagra, 1994.

Participants created their own posters.

Expectations of the audience

Not documented.

But participant concerns were actively sought by the project team prior to the workshop. Participants were asked what they considered to be their three main safety-related concerns regarding the disposal of long-lived radioactive waste and spent nuclear fuel in a geological repository. Some of these concerns were addressed in the workshop presentation materials and in the discussions.

Experience – lessons learnt

Participants commented that communication should be aimed at young people, as they are the future decision makers and managers of radioactive wastes, hence communication should begin in schools. Participants felt that the communication approach needs to be modern and forward-looking, using latest technology, e.g. interactive CD-ROMs and computer games.

One participant suggested that the approach should relate radioactive waste to familiar things in our lives, such as the use of X-rays, nuclear medicine and the generation of electricity, in order to show that it is a by-product of beneficial uses of radioactivity. Participants tended to agree that the related issues of decommissioning, new nuclear build and the resulting wastes from each should not be excluded from the discussion.

If the poster format is used, participants felt that it should treat one key issue at a time. Furthermore, posters should not only present what we do know but should also be open about what we do not know. Participants felt that it is important to be clear about the long-term uncertainties over the performance of the engineered barriers and the ability of host rock to contain the waste safely.

Participants also agreed that thought must be given to ensuring that any communication materials produced are developed to be as accessible as possible, including the use of braille for text boxes, and provision of community language translations.

Some specific lessons:

- The majority of participants felt that a geological repository concept for the United Kingdom should include a commitment to indefinite monitoring and retrievability. This was seen as providing a local community with a sense of reassurance and control over the management of a facility for long-lived radioactive waste. Retrievability was also seen as important in that the radioactive waste might become a future asset as nuclear technology makes advances.
- The posters presented to participants for assessment during the workshop were considered to contain too much text and technical detail to appeal to a lay audience. It was suggested by participants that communication via a poster should focus on one key issue, stating what is known and being clear about the uncertainties.
- While communication of basic technical information (describing radioactive wastes, where it comes from, the nature of radioactivity, and the need for a geological repository) was considered necessary, participants felt that key safety issues, uncertainties and knowledge gaps that become apparent when having to consider repository performance over hundreds of thousands of years should also be presented.
- Communication methods should be aimed at today's young people, who were considered by participants to be the future managers of our radioactive waste. This should be primarily conducted through the education system.
- A communication approach should be modern and forward-looking, using the latest technology (e.g. interactive CD-ROMs and computer games), and should relate radioactive waste to familiar and beneficial uses of radioactivity in the United Kingdom, such as nuclear medicine and the generation of electricity.
- Participants felt that a fresh approach to communicating issues is needed, using lessons from elsewhere, e.g. British Nuclear Fuels Limited used ideas and support from the Science Museum in London in its development of the Sellafield visitors centre.
- It was suggested that a "nuclear industry month" campaign could be run, during which people would visit nuclear sites, see interactive displays, talk to staff and discuss issues. Participants suggested that this could include displays in museums, libraries and schools.

Not too glossy, but professional design is an important element to get it right.

The main messages arising from the stakeholder workshop are set out above. It must be appreciated that these messages are couched within the UK context and the cultures of England and Scotland.

Did the audience find the information relevant for the message?

In general, yes.

Intensive discussion, which elements worked well and which not to deliver the information.

Did the audience understand the message of the author?

Yes.

Table B.3. NAnet (reviewer: GRS)

Reference

Miller, B. et al. (2006), "Network to Review Natural Analogue Studies and their Applications to Repository Safety Assessment and Public Communication (NAnet): Synthesis Report", https://cordis.europa.eu/pub/fp5-euratom/docs/fp5-euratom_nanet_projrep_en.pdf.

Context (siting, research, licence application)

EC project to compile and evaluate the various roles of analogues in a safety case including communication. The aim of this project was to promote a more considered use of natural analogues in safety assessment and public communication.

One work package (No. 4) dealt with specific applications of analogues to communication.

Role of the author(s)

The whole project was performed by implementing and research organisations, as well as by regulatory bodies.

Work package 4 on communication was mainly done by Nirex.

Which messages the authors wanted to convey?

The authors summarise their experiences, with communication of analogues to different stakeholders.

In addition information from other projects (also direct discussions/meetings with different stakeholders) has been included.

Which were the audience(s)?

Different audiences are mentioned and regarded in the report, i.e. the public, communication specialists, decision makers, performance assessment community and other scientists.

Media (live discussions, report, flyer, video, web) used for communication

The range of natural analogues used in publicity material in the last 20 years is very wide. The most commonly used examples relate to the longevity of cement and iron.

Primarily, this information was presented in two main ways:

- first, through a free and widely distributed newspaper;
- second, through advertisements in the local and national press.

Direct/indirect communication (one way/two way, static/dynamic)

Both methods mentioned above are examples of "static one-way communication, in which the overall aim is to convince and hence to improve acceptability.

Type of information provided (graphs, explaining text, numbers, indicators, videos)

The brochures generally assume little or no technical knowledge on the part of the reader, contain limited text and technical information, and are often illustrated.

They present information that their author thinks the public should be interested in, rather than present information about issues the public actually asks about.

They are often generic in style, rather than presenting information on a specific analogue study, and rarely provide bibliographic references to allow an interested reader to obtain more detailed information or gain access to primary technical reports.

Expectations of the audience

The expectations of the audience have not been evaluated. However, it was recognised from discussions with key staff in a number of disposal agencies that these communications have brought very little benefit.

Experience – lessons learnt

This study evaluates particularly the communication of natural analogue results to different stakeholders. The main experiences in communication with the public (non-technical audience) are summarised here.

The public is not a homogenous group. The information needs of such a group will be very dependent on national and local context and culture and will also change over time. Analysis of such transitory and heterogeneous needs would usually involve a major social science effort.

There are a number of characteristics of natural analogues that should make them valuable for communication purposes:

- Natural analogues are directly observable in the environment. They are part of our environment and history. And there is also an inherent attractiveness of nature to most individuals. Most people have some interest in the natural environment and own experiences in nature. Therefore, nature is an effective vehicle for dialogue (see e.g. advertising).

- Natural analogues can help make the timescales of interest to radioactive waste management meaningful. The notion that we are concerned about times far in excess of that for which the sphinx has been in existence has more meaning than a four, six or eight digit number.
- Natural analogues are inherently qualitative. This has often been seen as a weakness since it can make them difficult to use for modelling and quantitative prediction. However, for communication purposes it can be a strength since for most people, life is qualitative and intuitive.
- The fact that natural analogues are the result of a range of environmental processes, operating together on some artefact or material is a direct reflection of "what will happen" and provides a means of observing the integrated consequences.

A general impression from the past use of natural analogues in public communication is the lack of impact that they have had. This may be due to the emphasis on the use of written media, namely to static forms of communication with the objective to convince. Audiences are very sensitive to underlying motivations. Any suggestion of propaganda can undermine the value of the information transfer.

From these observations and from experiences of other activities of the authors (RISCOM[1] project, public consultation) they conclude that successful communication of analogues needs to promote questioning, rather than convince. They propose to use analogues to provide information relevant to questions regarding long-term radioactive waste management. With this information the audience can make their own judgements. This would be a dynamic use of analogues in communication.

There is now quite a lot of experience about the sorts of questions people will ask in the context of radioactive waste management. Based on this and that natural analogues will provide information about the behaviour of natural systems the sorts of questions raised can be classified into four key themes:

- Time: How can one be sure that the repository will work over the timescales involved?
- Depth: How does one know that something so deep underground can be built?
- Process: How does one know what processes will operate in the repository?
- Precedence: Has this ever been done before and how successful has it been?

From communication exercises with students the authors stated that "real people" (i.e. those associated with some aspect of the project content) stimulate discussion with groups of the audience and added greater interest to the project and online resources. This underlines the importance of the information providers as an enabling factor in the communication process.

Did the audience find the information relevant for the message?

Not really applicable, but two direct quotes from students the RISCOM project:

"Should have extra pages at advanced level. Should be graphics and diagrams. It should be made interactive to get the student involved"

"More graphs, diagrams etc.; possibly showing actual means of storage; include negative aspects of nuclear power, waste management, e.g. accidents, potential impacts on health etc."

Did the audience understand the message of the author?

Not applicable.

1. *Transparency and Public Participation in Radioactive Waste Management: RISCOM II Final Report*, http://cordis.europa.eu/documents/documentlibrary/67373851EN6.pdf.

Table B.4. Review of project FP7 MoDeRn (reviewer: SCK•CEN, Euridice)

Introduction and method

Within the IGSC, an ad hoc task group Safety Case Communication has been formed, which will focus on the following four questions:

1. Which knowledge exists/which experiences have been made about the effectiveness/non-effectiveness of different tools for communicating safety case results or certain aspects of it to an interested non-technical audience? (Selected studies and few recent safety cases should be analysed)
2. How can communication based on these experiences be improved and included into a safety case development from the beginning?
3. How might IGSC and FSC contribute to such an improvement of the communication?
4. Does this provide evidence for potential benefits from joint activities of IGSC and FSC for communication improvement?

To get an insight in experiences in communication of technical aspects of the safety case (question 1), the ad hoc group decided to select a limited number of studies for a first review, for which a standardised list of questions was developed. This contribution reviews the Monitoring Developments for Safe Repository Operation and Staged Closure (MoDeRn) project, which was a four-year collaborative research project within the Seventh European Community Framework Programme (FP7). MoDeRn considered how monitoring can contribute to the safety strategy and engineering design of geological disposal facilities for long-lived radioactive waste. Moreover, monitoring is considered a vital tool for public communication, contributing to public understanding of, and confidence in repository behaviour. Because of the societal research dimension and frequent interaction with lay stakeholders throughout the project, it can be seen as highly relevant study to evaluate with respect to stakeholder communication.

Where possible, the review focuses on communication of monitoring results and stakeholder participation in monitoring programmes, but also main lessons learnt concerning communication in a broader sense, its organisation and how it does or does not contribute to transparency, confidence and trust are taken into consideration.

Reference

This review was performed based on a selection of the MoDeRn project deliverables. Because of their scope and/or involved partners, the deliverables listed below are considered the most relevant for evaluating aspects related to communication:

[1] D1.3.1 Monitoring the Safe Disposal of Radioactive Waste: a Combined Technical and Socio-Political Activity.

[2] D1.4.1 Monitoring and the Risk Governance of Repository Development and Staged Closure: Exploratory Engagement Activity in Three European Countries.

[3] D4.1 Case Studies. Final Report.

[4] D5.3.1 Expert Stakeholders Workshop report.

[5] D6.1 Monitoring During the Staged Implementation of Geological Disposal: The MoDeRn Project Synthesis.

Context (siting, research, licence application)

The project united 18 partners from 12 countries and includes waste management organisations, research institutes, academia and one regulatory body. For six countries, the stage of the geological disposal research programme and additional contextual elements are provided as background information in the following deliverables:

- [2] National contexts for Belgium, Sweden and the United Kingdom are provided to set the scene for the focus group discussions with the objective to explore engagement activity.
- [3] The three case studies from Germany (rock salt), France (argillaceous rock) and Finland (hard rock) elaborate on the disposal concept and detailed repository design for a selected or hypothetical site in order to apply the monitoring workflow methodology to a specific case.

It is worth mentioning that the national context (especially the timing) has had an influence on participation of stakeholders in the focus group discussions and their organisation, especially in Sweden and the United Kingdom [2], see answer to question 14.

Role of the author(s)

Various. See answer to question 3.

Which messages the authors wanted to convey?

A key message of the project as a whole is the importance of early involvement of citizen stakeholders in the discussions and the design of the monitoring systems and the monitoring process (aspects related to its organisation and communication).

Which were the audience(s)?

The project synthesis report [5] identifies the target audience explicitly in §1.3:

"The project recognises that different stakeholders may be interested in, or have a specific role to play with respect to, the development, implementation and use of monitoring. Therefore, the report is intended to be informative to a wide range of stakeholders, including:

- waste management organisations, to whom the report can provide guidance on how to develop, implement and use monitoring in support of decision making.
- Safety authorities likely to place requirements on the monitoring approach and who may impose some monitoring as part of licence conditions.
- Designated advisory boards likely to inform national decision makers on waste management issues.

However, owing to the technical context under which monitoring work must be undertaken, a good understanding of geological disposal of radioactive waste is assumed, including a general understanding of the development of post-closure safety cases."

Media (live discussions, report, flyer, video, web) used for communication

All dissemination and outreach activities were grouped in WP5 of the MoDeRn Project and provided as such a platform for communicating the project's results. Two international meetings were managed through this work package: i) the stakeholders workshop with safety, regulatory and advisory authorities; and ii) the international conference on repository monitoring. The work package also included implementation and maintenance of a project website.

In particular, the research activities on participatory processes in repository monitoring made use of various techniques and activities:

- Interviews were conducted with specialists employed by European waste management organisations.
- A workshop with stakeholders was held in which representatives of other types of organisation (mainly regulatory agencies, with a limited number of participants from advisory bodies and public stakeholder groups) discussed the research activities of the MoDeRn project and provided insights into stakeholder views on repository monitoring.
- Workshops involving public representatives from nuclear facility host communities were held in Belgium, Sweden and the United Kingdom. The participants in these workshops had varying degrees of engagement with, and knowledge of, radioactive waste management projects.
- A visit to the Mont Terri URL and the Grimsel Test Site in Switzerland was undertaken with a subset of the public representatives that participated in the host community workshops. This also provided an opportunity for different stakeholder groups to interact with each other.
- Discussions on the role of stakeholder involvement in repository monitoring programmes were held during the end-of-project international conference on monitoring in geological disposal of radioactive waste.

Direct/indirect communication (one way/two way, static/dynamic)

Based on the selected deliverables, the discussions between MoDeRn consortium partners and various stakeholders going from experts to lay people were primarily methodological in nature and dealt with the organisation and the process of communication of monitoring results (what, who, how and when). As a personal judgement from the author, these interactions may be considered direct, two-way and dynamic communication.

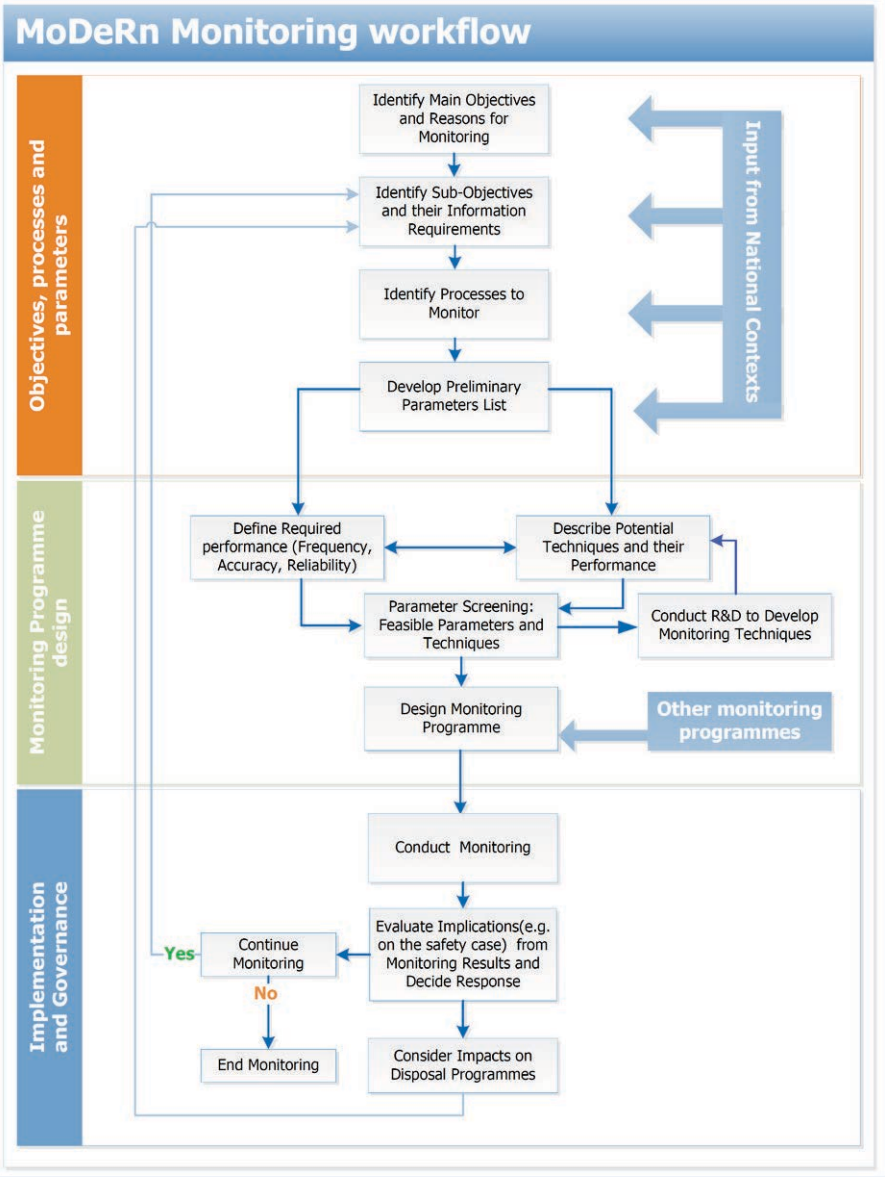
Type of information provided (graphs, explaining text, numbers, indicators, videos)

See answer to question 8. Some specific examples and issues are provided below.

The MoDeRn Monitoring Workflow scheme

Within the MoDeRn project, the monitoring workflow (see Figure 1) is presented as a generic methodology for development and implementation of a monitoring programme. This scheme was considered useful as a central tool for discussions as it provided a method for structuring a monitoring programme and provided an overview of the issues that should be addressed. Nevertheless, [4] reports that explanation of each component of the MoDeRn Monitoring Workflow was needed and that links to the safety case could be added.

Figure 1: The Monitoring Workflow (taken from [5])



Issue of necessity and feasibility of providing raw monitoring data to stakeholders

An issue raised during the expert stakeholders workshop [4] was the feasibility of sharing raw data with stakeholders and potential security issues associated with it. The assurance that the repository is managed effectively and any anomalous monitoring results are appropriately responded to was considered more important than providing immediate public access to raw monitoring data. It was also reported that making large volumes of raw monitoring data available would not necessarily contribute to confidence building, since such data would require significant amounts of processing to rationalise it. It was concluded that monitoring data should not be made available to lay stakeholders without providing the context necessary to understand it [4].

Stakeholder empowerment

In [1] it is argued that it is not so much (or not only) the numbers and figures produced to corroborate claims and models that can support confidence building; but it is rather their accessibility, transparency and meaning. In other words, the process is as important as the results: the process of monitoring and its communication should be transparent and open to public and expert scrutiny. [1] provides examples of how this can be institutionalised, e.g. through the use of an independent body to oversee the monitoring process and to interpret the data, or e.g. through training of lay people to participate in monitoring. Such mechanisms would give confidence that all monitoring data are made available and analysed, and that appropriate responses will be implemented and followed up if necessary [4].

Expectations of the audience

While there seems to be a general consensus and clarity about the purpose of monitoring in the operational phase, this is not the case for the post-closure phase. Since "safety is ensured by passive means inherent in the characteristics of the site and the facility and those of the waste packages" (IAEA, 2006: 4), monitoring and institutional controls are not considered a requirement to ensure post-closure safety. Communicating this to the public is difficult [4] and reconciling the diversity of public stakeholders' expectations with technical and financial constraints will remain an important challenge [1]. When developing monitoring programmes, a dialogue with different types of stakeholders is needed, in order to develop mutual understanding of expectations.

In [1], it is also mentioned that the way in which people view monitoring and what they expect to obtain from it differs according to (among other things) their attitudes towards geological disposal and the basis for long-term safety. Monitoring could therefore be part of the answer to the societal expectation that in order to ensure safety, vigilance should be maintained. Monitoring programmes should be designed so that they remain flexible enough to respond to changing social and regulatory expectations. The latter is the focus of the report "Preservation of Records, Knowledge and Memory across Generations (RK&M) – Monitoring of Geological Disposal Facilities: Technical and Societal Aspects" (NEA/RWM/R(2014)2).

As mentioned above, stakeholders expect that the process of monitoring should be transparent and open to public and expert scrutiny [1].

Experience – lessons learnt

In MoDeRn, monitoring is considered a sociotechnical activity and the project advocates early stakeholder involvement and stakeholder empowerment as key elements to building confidence in a monitoring programme and trust in the people who manage it. Adequate communication between stakeholders plays herein an important role. From the selected deliverables, some related issues are summarised below.

In [1], it is stressed that being unable to rely on sensory data to evaluate risk, citizens are placed in a relationship of dependency on experts and expert systems. Stakeholders feel that there is a need for independent scrutiny of monitoring programmes and results. They also stressed the importance of a clear strategy in place from the outset of implementing a monitoring programme, on when and how the results of the monitoring programme will be published and communicated. [4]

In [1] the difficulty of reconciling the need to monitor the repository evolution with the principle of passive safety by developing non-intrusive monitoring techniques is discussed. Many respondents explicitly referred to post-closure in situ monitoring as unrealistic and potentially counterproductive. It is stressed that the limits of non-intrusive monitoring equipment, and the limits of post-closure monitoring should be clearly communicated. [4]

[1] concludes that the process of monitoring should be transparent and open to public and expert scrutiny. This will have to be built into the institutional context through which roles and responsibilities for long-term radioactive waste management are organised. In [2] it was furthermore explicitly stated that public confidence will not be built by setting up a monitoring programme alone. The broader question of the governance of the repository, from siting to closure is at play. Specifically for monitoring, this would include clarity on who is responsible for monitoring, how and by whom monitoring results are interpreted and how monitoring results are communicated.

More specifically, [2] reports that in first instance a majority of the participants insisted that monitoring results should be made available at all times and for all parameters in real time. After having discussed a number of real and fictitious examples, most agreed that this may not be the best approach. However, it did not change the group's opinion that all monitoring data should be made publicly available. How to put that principle in practice is something that needs further consideration. The following elements were put forward as a starting point:

- frequent periodic reporting of aggregated data, put within the proper context;
- both the implementer and regulator have a responsibility to communicate about these results;
- various levels of reporting are needed to inform different audiences; while the level of detail may differ, the key message must remain the same;
- raw data must be kept and made available on demand, to allow for third-party review;
- a certain delay in the availability of raw data could be considered, to allow for seeming anomalies to be checked and explained, and to avoid unnecessary concern.

Defining the exact content of the monitoring programme (which parameters, how and where to measure them, frequency) the group considered food for specialists. But results should be presented, explained and discussed with concerned stakeholders, and their concerns should be taken into account. The ability to pose critical questions at all times about all aspects of the repository is an essential basis for creating a relationship of trust and for building confidence. As an example, in the cAt project (surface disposal project for low- and intermediate-level short-lived waste in Belgium) the principle was put into practise through frequent interaction, public scrutiny and co-design. [2]

Terminology issues

In projects with mixed audiences, clarification of terms and concepts often requires a lot of time before reaching a common understanding.

One of the conclusions from the work on stakeholder involvement in monitoring programmes is the stakeholder view that monitoring should be a checking process rather than a confirmatory process [5]. The latter is perceived by some stakeholders as arrogant and over-confident [4]. To overcome this, it is suggested to use "performance challenging" instead of "performance confirmation". Moreover, [4] suggests to better explain the relationship of the monitoring programme to the overall repository development programme, especially the safety case and the engineering design, e.g. by adding links to the safety case to the MoDeRn Monitoring Workflow.

A similar issue arose with the term "monitoring" itself, which requires a clear definition in the context of geological disposal. Usually, a distinction is made between in situ monitoring of the actual repository and measurement activities related to the site and system characterisation phase, so that the varying principles driving associated programmes of work are clearly understood, and can be readily communicated to stakeholders. E.g. in [4] it was noted that "monitoring in support of long-term safety need not be limited to the repository location – it could begin with package monitoring during processing and interim storage."

A more technical discussion arose during the workshop [4] about the term "non-intrusive", used to denote all techniques where wires do not provide a potential pathway for rapid transport of radionuclides. Given this definition, non-intrusive techniques would include wireless techniques and remote monitoring techniques. However, wireless monitoring typically employs in situ sensors in conjunction with wireless data transmission. It was recognised that the sensors could affect local conditions within the repository, creating minor perturbations, and therefore, such monitoring approaches might not be considered truly non-intrusive.

Summary

In [4], aspects related to communication to lay stakeholders are nicely summarised as follows:

It is important to communicate:

- What is going to be monitored?
- Why it is important to monitor this parameter?
- How it will be monitored?

Other issues that require clear communication are:

- Definitions to be used.
- The need to monitor baseline conditions at the outset of a repository development programme, in order to obtain an initial understanding of the undisturbed environment of a potential repository site.
- The strategy to respond to unexpected results.

Did the audience find the information relevant for the message?

N/A

Did the audience understand the message of the author?

It can be concluded from the MoDeRn project that understanding scientific graphs or data by lay stakeholders seems not critical for confidence building. The latter rather depends on the level of stakeholder empowerment for independent scrutiny and checks.

14. Recommendations (e.g. successful, not successful)

MoDeRn scope and objectives [4]

In projects with a broad stakeholder participation going from lay people to expert stakeholders, a timely investment is necessary to communicate and define scope and objectives ("The scope of the MoDeRn project requires clarification, particularly regarding the extent to which the project considers post-closure monitoring aspects" [4]), terms, methods and motivations. To some extent, this has been integrated in the project structure and organisation. E.g. i) Deliverables [1] and [2] set the scene and identify attention points to take forward in the project and ii) one of the Workshop's objectives was to involve stakeholders not involved in the project to obtain feedback, challenges and advice [4].

MoDeRn Monitoring Workflow and Case studies [3]

Within the MoDeRn project, a structured approach – the MoDeRn Monitoring Workflow – was elaborated that allows the linking of high-level monitoring objectives to the detailed selection of monitoring technologies and sensor placements. In the case study report [3], this generic methodology was elaborated through a safety-function based approach for the three main host rock types (salt, clay, granite). Such an approach involves mapping of processes and parameters in a structured, transparent and traceable way. This facilitates discussions with both lay and expert stakeholders, and their formal an regular involvement is considered to be essential.

Although [2] refers to the case study report [3] as to include specific scenario analysis aimed at providing guidance on how to handle and communicate monitoring results, in particular when these provide "unexpected" information, the latter remains at the level of purely technical considerations and does not address recommendations w.r.t. communication.

Focus group discussions [2]

Participation interest to the focus group discussions were very much dependent on the country-specific situation at the time:

Belgium: An invitation letter was sent to all members of the local partnerships for the surface disposal of low- and intermediate-level waste (MONA and STORA). The discussions were held during three evening workshops and one "round-up" session, with each 12-14 participants.

Sweden: The Östhammar group did not want to select a small group of people to take part in an activity outside of the formal meetings organised by the municipal organisation. Instead, they wanted the whole municipal organisation to be engaged and also to advertise the event to the general public. The focus group discussions were held as part of a one-day event, to which 29 people participated, of which very few from the general public.

UK: After some organisational difficulties related to the UK's national situation at the time of the MoDeRn stakeholder exercise (late 2011 to early 2012), an initial briefing was held to which nine community stakeholders participated, followed by two half-day workshops, to which four stakeholders participated.

Field-trip to Switzerland [2]

Several participants to the field trips stressed the need to communicate more explicitly about the science that goes on in the labs. Again the importance of bringing people to the labs/URLs was highlighted, as comprehensible summaries of scientific reports were in themselves not considered to be enough. One participant suggested an annual conference at the national level as a way to keep all concerned stakeholders and interested parties informed and up to date with the state of knowledge. However, some doubts were raised regarding the funding for such an event, as well as the ability to attract a broad audience. Another participant referred to popular science magazines as a way to create awareness and to spread basic knowledge about this type of issue.

Particularly with regard to the experiments feeding into the safety case and future monitoring results, several participants indicated the wish to have free access to the raw data behind the reports. That way these data could be checked and validated by others, not involved in the programme and used by anyone who wanted (or needed) to review the concerned reports, e.g. in the case of a licence application. Discussion remains on the extent to which raw data should be made available.

Summary

The main conclusions from the work on stakeholder involvement in monitoring programmes and related recommendations with respect to stakeholder communication are summarised in [6] as follows:

- The opinion that monitoring should be a checking process rather than a confirmatory process was expressed by many stakeholders. Monitoring programmes are therefore likely to be viewed by some stakeholders as being more trustworthy if it is clearly communicated that they are designed from the perspective of challenging that repository behaviour is as expected, and if stakeholders are able to access clear information on how each aspect of repository performance is checked.
- Public stakeholders expressed a view that the checking of repository performance should be comprehensive and linked to an overall science programme. A continuation of research and development on repository monitoring techniques was expected. Waste management organisations could ensure that this view is addressed by discussing with their stakeholders the role of monitoring during different phases of repository implementation, and by communicating the manner in which operational and long-term safety is assured.
- As anticipated, some public stakeholders do have expectations regarding post-closure monitoring, mainly in view of being able to prepare for (and respond to) unanticipated events or evolutions. Individual programmes will need to decide on ways to respond to this expectation. Additionally, communication of the understanding of remaining uncertainties, and a preparedness to allow options for monitoring to evolve and to respond to changes in the expected evolution of the repository (e.g. closure being postponed) could be beneficial to addressing stakeholders' expectations regarding long-term monitoring.
- Monitoring can be characterised as a sociotechnical activity and could potentially contribute to building the confidence of public stakeholders in the safety of a particular repository project, though not by itself. Of course, many other factors will also play a role in building stakeholder confidence, such as the approach to decision-making, and the level of public and stakeholder engagement. Monitoring can contribute to repository governance if it can address expectations from stakeholders, if it is expressed as a practical commitment to maintain a watch over the repository performance, and if there is transparency about the limits of monitoring, including what could realistically be expected in terms of evolution in monitoring techniques.

Additionally [1] and [5] conclude also that, by introducing the notion of retrievability or reversibility into law, some countries are already moving towards an adapted sociotechnical solution: one that still relies on achieving passive safety, but which recognises that this end point may be further away than initially planned and, subject to future societal decisions, may not be final. Such evolutions remind us that we will inevitably pass the burden of decision about final closure to subsequent generations. Acknowledging this requires that we think more specifically about the type of information, knowledge and skills that need to be passed on to future generations, and the role that monitoring might play in meeting the needs of future operators, regulators, decision makers and affected citizens. In this respect, the Swedish focus group discussion reported in [2] briefly reflected on the cultural and symbolic significance of repositories as unique man-made structures. The way they will be remembered and commemorated in future even if they may not need to be actively managed was considered important and historians and archaeologists were seen as relevant experts to involve in these discussions. These types of issues are subject of the NEA's RK&M Initiative.

Table B.5. RISCOM II project (reviewer: SCK•CEN)

Reference

Andersson, K. et al. (2003), *Transparency and Public Participation in Radioactive Waste Management: RISCOM II Final Report*, SKI Report, 2004:08.

Westerlind, M. and K. Andersson (2004), "RISCOM II – Enhancing transparency and public participation in nuclear waste management", paper presented at the EURADWASTE'04 Conference held on 29-31 March in Luxembourg.

Context (siting, research, licence application)

The aim of the RISCOM II project (2000-2003) was to support transparency of decision-making processes in radioactive waste programmes in the participating countries (Czech Republic, Finland, France, Sweden and the United Kingdom) and in the European Union. This was done through application of the RISCOM Model, which was created earlier in the context of a pilot project funded by SKI and SSI.

Role of the author(s)

The primary authors are from SKI and Karinta-Konsult.

Other participating organisations SSI, SKB, Nirex, UK Environment Agency, Galson Sciences, Lancaster University, EDF, Institute for Radiological Protection and Nuclear Safety (IRSN), Posiva, Nuclear Research Institute Řež plc, Diskurssi and Syncho are co-authors of the final report.

Which messages the authors wanted to convey?

The RISCOM II project provides several examples of the implementation of methodologies, insights and theories in the fields of risk communication and organisational theory. The focus is on the process, rather than content. In this respect, 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.

The project also tested an organisation model (the viable system model) to analyse and compare the organisational structures in the Swedish, French and British radioactive waste management systems.

Which were the audience(s)?

Various.

Media (live discussions, report, flyer, video, web) used for communication

In Sweden the project has supported the design of a new hearing format, based on the RISCOM principles, as part of the regulatory review in a critical phase of the site selection programme for a spent nuclear fuel repository.

In the United Kingdom, RISCOM II has reviewed previous experience of consultation processes (e.g. citizens' juries, public meetings, and participatory integrated assessment) which have been used for public participation in environmental and safety issues. An initial set of criteria for evaluating different processes was developed. Particular attention was also paid to identifying any structural conditions, which enhance or constrain effective dialogue.

A schools' website was also developed, aiming to show how information technology can be utilised to engage citizens, especially younger people, in public decision making.

A special meeting format (team "syntegrity" meeting) was tested as a tool for communication between different stakeholders. It is a non-hierarchical approach which enables effective contribution of a wide variety of participants with different viewpoints to the discussion of complex issues.

Direct/indirect communication (one way/two way, static/dynamic)

Traditionally, transparency has meant explaining technical solutions to the stakeholders and the public. The authors state that (p. 7) "it is now widely recognised that one-way information flow about technical solutions is not enough, and that citizens need to be actively involved in two-way communication early in the decision-making process. The RISCOM Model of transparency offers a framework to improve the quality of stakeholders' communications."

Type of information provided (graphs, explaining text, numbers, indicators, videos)

Not applicable.

Expectations of the audience

With respect to expectations of the end-users (decision makers) of the RISCOM transparency model, the report states that "there may be unrealistic expectations that public participation should lead to consensus about radioactive waste management solutions.

- Transparency leads to a higher level of awareness of all aspects of the issue, which should benefit the quality of decision making. In that respect, transparency is more important than consensus.
- It must be understood that world views are deeply rooted in society and its individuals. Often decisions need to be taken in spite of different values but the quality of decisions is increased if the decision makers and the public are aware of the different values, as well as the factual issues."

Experience – lessons learnt

One of the core issue addressed in RISCOM II has been how performance assessment can be made more transparent and more accessible to the general public. A summary is given on p. 72-73:

- To incorporate the value judgements of stakeholders into performance assessment would involve conducting performance assessment by starting from the issues of concern among stakeholders and communicating with them during the performance assessment work. Arrangements should then be made to make visible where values enter the performance assessment and how uncertainties are taken care of.
- Performance assessment should not be communicated by information departments – the real experts need to engage themselves so that people can see that they are honest, open about uncertainties and address the concerns of ordinary people.
- Clearly regulatory standards and criteria are one important area where the principles of transparent decision making should be applied. If the authorities involve the citizens at the stage of developing the regulations, this would be a way to include their values in the framework of performance assessment.
- Successful citizen involvement requires that the experts are truly open-minded and willing to include issues of concern into their assessments. As a consequence they must be prepared to let go of some of their control over the process.
- One should strive for clarification about the factual versus the value-laden domain of an issue. This will increase transparency and set limits on the experts' professional area e.g. by revealing hidden values in expert investigations.
- It is essential that the performance assessment can keep its identity as a scientific and engineering enterprise. Engaging in public dialogue must not dilute the science and steer experts away (in focus or time-wise) too much from their core activity.
- Performance assessment methods are highly structured and rigorous, as is necessary to provide assessments that are robust to scientific peer review. However, the methods could be applied in a manner that allows for more inclusion of the views and opinions of non-experts. This is particularly the case for scenario development and establishing the criteria for judging performance.
- Key to increasing stakeholder involvement and participation is establishing why the performance assessment is being done, who it is for and how it fits into the wider process of decision making. In the absence of these things, it will be very difficult for the wider community to understand the boundaries of the performance assessment and this will affect the effectiveness of their contribution, as well as the contribution of the expert community.
- It may not be possible to make an objective assessment of the true risk of final disposal, but stakeholders may be able to compare the consequences of alternative actions. Such comparisons can be made using value-laden considerations and ethical principles rather than performance assessment in detail. After all, decision makers will need to choose between alternatives on the basis of incomplete and uncertain knowledge.
- 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.
- There seems to be a common misunderstanding about the amount of detail it is necessary to explain radioactive waste management issues in order to enable discussion (between scientists, engineers, stakeholders). For example, issues can be based on comparisons of alternatives rather than assessing absolute risks or levels of safety.

In the Czech study it was found that an environmental impact assessment is a suitable tool for communication rather than performance assessment itself, which was seen as too abstract. Another conclusion was that a wider range of safety indicators and natural analogues may have an important role in the communication of PA.

Did the audience find the information relevant for the message?

Evidence from the UK experiments suggests that the actual use that is made of information within dialogue processes is minimal. This suggests that care should be taken in targeting information resources where they will be most useful such as establishing the context of the dialogue process and its role within any related decision-making process.

Did the audience understand the message of the author?

Not applicable.

Appendix C. Review of national activities

Table C.1. Informative meeting on hydrocarbons in the Gorleben salt dome, and the role of hydrocarbons in the long-term safety of a repository (reviewer: BGR)

Reference

www.youtube.com/watch?feature=player_embedded&v=4d8JZbTAFKo#!.
http://wendland-net.de/post/gorlebendialog-nichts-genaues-weiss-man-nicht-10471.
http://endlagerdialog.de/2012/02/mageres-ergebnis/#more-1131.

Context (siting, research, licence application)

Siting.

Role of the author(s)

Regulator/technical support organisation/independent experts. The meeting was organised by the German regulator for radioactive waste issues, which is the German federal environmental ministry. The environmental ministry is also the superior authority to the federal office for radiation protection, which is the implementer for repositories for radioactive waste according to the German atomic law that was in force at that time (meanwhile the atomic law was changed and the responsibilities have been modified). The ministry engaged three experts to attend the discussion and to answer the questions from the audience.

Which messages the authors wanted to convey?

Technical and scientific information about one particular issue. The experts wanted to inform about the characteristics of existing hydrocarbons as natural constituents of the Gorleben salt dome and possible interactions between the hydrocarbons and a repository for higher activity waste.

Which were the audience(s)?

Local citizens with extensive previous knowledge. The meeting took place in the vicinity of the Gorleben salt dome, which was explored with respect to its potential suitability as a location for a higher activity waste repository. The meeting was tailored to local residents and interested laymen and was open to everyman. All decided opponents against the exploration of the salt dome stayed absent from the meeting due to a preceding appeal of local citizens' initiatives to boycott the dialogue attempt of the ministry. Therefore, only a few individuals, who were not engaged in citizens' initiatives against the exploration attended the meeting. These persons had occupational contacts to geological issues and therefore featured broad relevant knowledge.

Media (live discussions, report, flyer, video, web) used for communication

Live discussion as well as live stream on the Internet. The meeting was announced as a "technical dialogue". In preparation of the meeting, the environmental ministry had asked via internet, to formulate questions with respect to the scope of the meeting. The received questions were addressed during the meeting. Additional questions arose during the meeting.

Direct/indirect communication (one way/two way, static/dynamic)

Direct discussion. Combination of one-way communication in advance to collect questions to be discussed and direct two-way communication (direct discussion) during the informative meeting.

Type of information provided (graphs, explaining text, numbers, indicators, videos)

Oral explanations supported by graphics/diagrams; direct discussion.

Expectations of the audience

The audience expected to get faithful non-biased information on technical issues. Most attendees asked for detailed scientific information, there was only minor interest in general statements about the suitability of the salt dome and the potential dangerousness of the hydrocarbons.

Experience – lessons learnt

After the establishing of organised citizens' initiatives it might be more difficult to initiate serious discussions on technical issues. Activists in organised citizens' initiatives are sometimes more interested in retaining their opinion than in a comparison of arguments.

Did the audience find the information relevant for the message?

Yes.

Did the audience understand the message of the author?

Yes.

Table C.2. Review of ONDRAF/NIRAS Het Veiligheidsdossier, Level 0 (reviewer: University of Antwerp)

Reference

ONDRAF/NIRAS Het Veiligheidsdossier, Level 0.

Context

Licence application.

Role of the author(s)

Supporting organisation.

Which messages the authors wanted to convey?

Confining the evaluation of the participatory method used in the Belgian case to the leaflet wherein the technical information of the safety case is translated into understandable language (Het Veiligheidsdossier, level 0), leads to overlooking key mechanisms of how joint decision making took place in the case of the cAt project. The safety case that ONDRAF/NIRAS filed in 2013 was the technical end result of an extensive co-design (first phase) and consultation (second phase) exercise with two possible host communities. It was extensive both with regard to duration and the amount of stakeholders that were involved. The following will give an overview of past and recent decisions and events and decision-making mechanisms that are key to understanding the workings of the partnerships.

1. Context

After a failed top down and technical approach, a government decision in 1998 obliged ONDRAF/NIRAS to concentrate on existing nuclear areas, volunteering municipalities and to check for receptivity alongside technical conditions. A model for joint decision making with local stakeholders concerning siting and hosting was developed by a group of social scientists. The goal of the new approach was to ensure the future search for a final solution for short-lived low- and intermediate-level radwaste would involve local opinions.

In two Flemish municipalities and in two Walloon municipalities, local stakeholders proved willing to start negotiating along the lines set out in the decision-making model. Three partnerships were created. These partnerships between ONDRAF/NIRAS and local stakeholders then became the initiators for the (technical and social) feasibility studies for a possible waste repository project in each municipality. When ideas rose about possible changes made to the basic concept put forward by ONDRAF/NIRAS, the agency (either through its representatives in the working group or by way of topical experts) came with studies and arguments until consensus was reached. The partnerships disposed of a budget to hire experts and order studies themselves as well. This way of working was later named co-design.

Based on the results of the feasibility studies, the two neighbouring Flemish municipalities (Dessel and Mol) both accepted to become a candidate host. Subsequently, the Dessel site was chosen by the federal government. Both partnerships (STORA in Dessel, and MONA in Mol) remained in place and were actively involved in the further development of the repository project and the drafting of the safety case. The remainder of this text will therefore focus on the two Flemish partnerships only.

2. Co-design (1999-2005)

The partnerships had a very broad range of responsibilities:

- studying the technical concept of the siting plant, as well as considering which accompanying projects could add (socio-economic) value to the siting project;
- communicating about the ordered feasibility studies and the design of the site to the broader population;
- taking a decision concerning the siting of the waste, the design of the site and the conditions under which the siting would be possible to local stakeholders.

Each partnership has the structure of a not-for-profit organisation. Funding comes from ONDRAF/NIRAS. Two paid staff members take care of planning, administration, volunteer management and communication. The amount of active members has fluctuated between 50 and 70 in each partnership throughout the past 15 years.

Members can cast a vote in the general assembly if they officially represent one of the three “local branches”: municipal politics, civil society organisations or economic organisations. ONDRAF/NIRAS is represented in the general assembly as well. Decisions regarding daily operations are taken by the executive board whereas fundamental decisions concerning the organisation as such, its actions and finances are taken during a general assembly.

Working groups consist of citizens with or without affiliation to organisations representing the three local branches. ONDRAF/NIRAS is represented in each working group through at least one fixed member. The working groups discuss in detail various aspects of the project and elements of the feasibility study. They are structured around specific topics (e.g. the repository concept, impact on the environment) and gather on average around ten times a year.

The terms and conditions under which hosting A-level waste was acceptable to local stakeholders and the groups they represented were written down in advisory reports to the respective municipal councils. After five years of studying, both the partnership in Dessel and in Mol advised positively on the possibility to host a repository and set concrete terms and conditions.

3. Co-decision (2006-2013)

By government decision in 2006, the Dessel site was chosen, but both municipalities and partnerships remained first-hand project partners in the next phase. Important to note is that ONDRAF/NIRAS installed a branch in Dessel (2006-2007), close to the future repository site. It was deemed insufficient to have headquarters in Brussels and no tangible presence in the area.

ONDRAF/NIRAS took the lead in putting the designed repository into practice but the lines towards the partnerships were short and used extensively throughout this second phase. It was ONDRAF/NIRAS concern to make the members of the partnerships comprehend the content of the safety case. Therefore, the same approach was used as before: monthly meetings, an expert introducing a subject and room for questions. It is clear however, that the partnerships were depending more on the projects' agenda whereas in the previous phase, it was the other way around. In this matter, the partnerships were informed and consulted but had a smaller role in decision making since major decisions concerning concept were taken previously. The socio-economic compensatory mechanisms demanded by both partnerships were dealt with as well, both in the non-technical working groups and in the steering committee (cf. next paragraph).

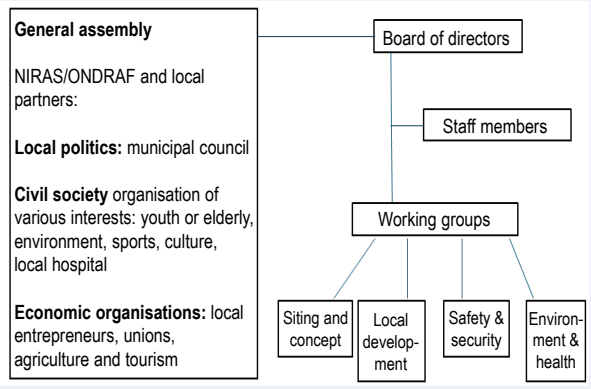
The partnerships shifted from being initiators and agenda setters towards following up the different components of this integrated project. To give the municipalities an advisory role on the one hand and to formalise co-operation and consultation in the second phase, a steering committee was installed in 2007. In three-monthly meetings, the people preparing the safety case provided representatives of the partnerships and the mayors of both municipalities with first-hand information on the progress of the safety case.

4. Messages conveyed

1. Discussions about siting (where, how, under what conditions) have to involve local stakeholders.
2. Local stakeholders are getting the time and the means to organise themselves to do this properly. Their end result will be the blueprint from which we start developing the concrete project.
3. After the decision being taken, the same stakeholder groups remain important partners in the project and will be consulted throughout all the next phases.

Which were the audience(s)?

The partnerships were the first and most salient audience addressed by NIRAS throughout the process. The partnerships were conceived to be representative of a bigger part of the population as can be seen in the figure below.



It was the partnership's role to hand on the information received in the monthly meetings to their less active members via internal communication (mailing lists) and on the other hand to the local population in general. They do this with a newsletter (weekly to monthly) and a printed magazine that is distributed door-to-door in each municipality (more detailed information in the next box).

Both have a website and Facebook page as well.

Media (live discussions, report, flyer, video, web) used for communication

Media used by ONDRAF/NIRAS:

- Websites: a corporate website and a subsite dedicated to the project.
- (digital) Newsletters: a corporate newsletter, a corporate magazine, a magazine especially for the Kempen (area in which host municipality is situated), the cAt-newspaper (distributed in the four municipalities closest to the future repository), the cAt digital newsletter.
- Various information leaflets (for example "Het Veiligheidsdossier") and overview reports (for example "Het Masterplan") in accessible language. Both printed and distributed as retrievable from the website.
- Information meetings (see next box).

Media used by STORA, Dessel:

- FOCUS: a weekly mailing for members with an overview of the most important activities within the partnership or activities the partnership is taking part in, news about the project etc.

- Newsletter: mailing containing more broad subjects, to members and stakeholders. Distributed approximately ten times a year.
- Magazine: door-to-door in Dessel, three to four times a year.
- Site: www.stora.org (French, Dutch, English).
- Facebook page.
- Information meetings (see next box).

Media used by MONA, Mol:

- Newsletter: electronic, three articles about recent and upcoming events that have to do with the partnership and/or the project, three to four times a year, members and non-members (whoever subscribes through the website).
- Magazine: printed, door-to-door in Mol, 12 pages, more broad subjects than in the newsletter, three times a year.
- Site: www.monavzw.be (Dutch).
- Facebook page.
- Information meetings (see next box).

Online community TV: DIGICAT:

- Pilot project (2010 up till now) of the digital interactive network that will accompany the communications centre (planned for 2020).
- Interactive website containing informative movies about the cAt project and movies about the community (past activities, daily life, commemorations, scenery, etc.).
- Content by volunteer community journalists, also members of MONA and STORA.
- Target audience: local citizens interested in community news.
- Site: www.digicat.be (Dutch).

Direct/indirect communication (one way/two way, static/dynamic)

Whereas in the previous box one finds an overview of the channels ONDRAF/NIRAS, STORA and MONA use on a daily and ongoing basis for their general communication, we give an overview of the information meetings related to the safety case alone in this box. As can be seen in the overview, each partnership invited several experts – mostly but not solely from ONDRAF/NIRAS – to discuss different subjects that can directly be traced back to the chapters of the safety case.

They used PowerPoints with graphs, text and numbers, combined with oral explanation, clarifications through e-mail afterwards or a second visit when requested. Members of the working group that were present that same evening could ask questions. Members that were not present could request the record of this particular meeting or ask the staff members for more broad clarifications. One can thus conclude the overall information round related to the (preparation of) the safety case consisted of direct, two-way, dynamic communication.

Information meetings

(The specialist(s) giving the explanation and answering the questions in that particular meeting is/are mentioned between brackets.)

- 5 Oct 2010: MONA-meeting where seismic impact analysis and the impact analysis of an airplane crash in relation to the repository design were explained (Olivier Goossens, ONDRAF/NIRAS).
- 19 Oct 2010: information meeting for both communities organised by the Federal Agency for Nuclear Control AFCN/FANC about the licensing procedure for the repository for short-lived low- and intermediate-level waste.
- 25 Oct 2010: information meeting organised by ONDRAF/NIRAS about organised consultation in the context of the safety case.
- 16 Nov 2010: MONA-meeting where design and testing of the monoliths and the specification of the inspection robot were discussed (Wim Bastiaens, ONDRAF/NIRAS).
- 15 Dec 2010: MONA-meeting where design and logistics of the repository were expounded (Wim Bastiaens, ONDRAF/NIRAS).
- 28 Dec 2010: STORA-meeting where design and logistics of the repository were expounded (Wim Bastiaens, ONDRAF/NIRAS).
- 19 Jan 2010: MONA-meeting where long-term aspects of several components of the repository were clarified (Peter De Preter, ONDRAF/NIRAS, Euridice and Wim Bastiaens, ONDRAF/NIRAS).
- 25 Jan 2011: STORA-meeting where long-term aspects of several components of the repository were clarified (Peter De Preter, ONDRAF/NIRAS, Euridice and Wim Bastiaens, ONDRAF/NIRAS).
- 15 Feb 2011: MONA-meeting where radiological capacity of the repository and the scenario's used for establishing it were elucidated. (Peter De Preter, ONDRAF/NIRAS, Euridice).
- 22 Feb 2011: STORA-meeting where radiological capacity of the repository and the scenario's used for establishing it were elucidated. (Peter De Preter, ONDRAF/NIRAS, Euridice).
- 15 Mar 2011: MONA-meeting where radiological capacity of the repository (part 2) and the models used for making concrete calculations were explained (Dirk Mallants, SCK•CEN).

- 22 Mar 2011: STORA-meeting where radiological capacity of the repository (part 2) and the models used for making concrete calculations were explained (Dirk Mallants, SCK•CEN).
- 26 Apr 2011: STORA-meeting where the radiological capacity of the repository (part 3) and the models used for making concrete calculations were explained (Elise Vermariën, ONDRAF/NIRAS).
- 27 Apr 2011: MONA-meeting where the radiological capacity of the repository (part 3) and the models used for making concrete calculations were explained (Elise Vermariën, ONDRAF/NIRAS).
- 25 May 2011: MONA-visit to the demonstration-experiment (Wim Bastiaens, ONDRAF/NIRAS and Wim Defoort, SECO).
- 14 Jun 2011: MONA-meeting where the waste inventory and criteria of conformity were clarified (Wim Cool, ONDRAF/NIRAS).
- 5 Sep 2011: MONA-meeting where monitoring was discussed (Joris Craeybeckx, Belgoprocess).
- 13 Sep 2011: STORA-meeting where the waste inventory and criteria of conformity were clarified (Wim Cool, ONDRAF/NIRAS).
- 13 Dec 2011: MONA-meeting where the waste inventory and criteria of conformity were clarified a second time to do away with confusion following the first explanation on 14 June (Wim Bastiaens, ONDRAF/NIRAS).

Type of information provided (graphs, explaining text, numbers, indicators, videos)

The general communication of the three protagonist organisations is discussed above. An overview of the information meetings related to the safety case specifically is given as well. We will now conclude with a discussion of the leaflet "Het Veiligheidsdossier".

To prepare the safety case, purely technical matters were at hand. Discussing concepts, making estimations and calculations, building test cases and peer review resulted into a safety case for the repository on four levels. The first and most accessible level consists of a brochure derived from the actual safety report. The brochure wraps up salient information about safety principles, safety strategy and monitoring in language that is understandable for people formerly unacquainted with the project. It briefly discusses all the topics elaborated upon in the information sessions discussed above.

The second level is a summary of the safety report. The third level is aimed at the regulatory agency. Based on this technical information, AFCN/FANC is currently judging whether ONDRAF/NIRAS can carry out the proposed project or whether the waste manager will have to reconsider fundamental aspects before proceeding to the next phase instead. The fourth level consists of in-depth reports supporting the two previous levels.

Expectations of the audience

This was not measured as such but from our experience with the entire project we can say the partnerships wanted to shape the project in a first phase, to be informed about the state of affairs in a second phase; to be enlightened about the technical aspects in understandable language; to be able to ask questions and to hire external expertise; to be consulted in case of changes to prior made decisions.

Experience – lessons learnt

- Citizens involved in long-term participation processes dealing with complex matters like the members of STORA and MONA are bound to become semi-specialists themselves. When measuring whether and how they receive certain messages, one does not measure whether and how the general population has received the same message. It is a key challenge to long-term participation processes to remain responsive to concerns in the wider population and to keep explaining what one takes for granted to people less closely involved.
- Generally speaking and not surprisingly, people interested in the subject come to meetings and are also the ones that keep coming. Interesting but also challenging questions are: why are the others not interested? Should they be? How do we address them? If they wish not to take part in the process, does their opinion count and how then?

Did the audience find the information relevant for the message?

- This was not measured as such but assumingly, the messages came across as various information means and channels were used.
- Before finishing publications such as "Het Veiligheidsdossier" or "Het Masterplan", members of the partnerships were asked to read and comment on pre-final versions.
- The participation process is still ongoing and one of the functions of the partnerships remains informing the wider public about the project and its state of affairs.

Did the audience understand the message of the author?

- Regarding the information meetings related to the safety case, a staff member of one partnership wrote 90% of the members present in the working group meetings understood 90% of what was said. Sometimes, explanations remained too technical, he admitted.
- When it comes to partnership members, ONDRAF/NIRAS efforts to explain and involve can be evaluated positively. Regarding the broader public and their reception of general information and the leaflet "Het Veiligheidsdossier" in particular this was not measured and cannot be done so easily. This because of the points raised in the box experience-lessons learnt.

Table C.3. Review of the licence application for a Yucca Mountain repository (reviewer: US DOE)

Reference

www.nrc.gov/waste/hlw-disposal/yucca-lic-app/yucca-lic-app-safety-report.html
(regulator's website with entire License Application Safety Analysis Report (SAR) prepared and submitted by the US DOE, plus links to formal regulatory evaluation of the SAR).

http://curie.ornl.gov/system/files/documents/167/final_paper_stakeholder_involvement_holm_1_may_2011.pdf
(A critical evaluation of DOE stakeholder involvement programmes).

Context (siting, research, licence application)

Licence application and environmental impact statement(s).

Role of the author(s)

Licence applicant organisation (US DOE Office of Civilian Radioactive Waste Management [RW]/Yucca Mountain Project, which no longer exists).

Which messages the authors wanted to convey?

Operational and long-term safety met regulatory criteria, providing reasonable assurance of public safety during transportation, operations and for the long term up to a million years into the future.

Which were the audience(s)?

Regulatory experts, national and regional experts, affected local, tribal, state governments, congress and the general public.

Media (live discussions, report, flyer, video, web) used for communication

- The Yucca Mountain external website (no longer exists) was an excellent tool to inform all levels of interested parties of both licensing and National Environmental Policy Act (NEPA) activities supporting the environmental impact statements.
  - The Yucca Mountain Program operated three Information Centers that included:
    1. Informational exhibits with working parts that users could manipulate to illustrate processes and effects.
    2. Topical supporting materials (brochures and online resources).
    3. Nevada state accredited continuing education courses.
- Site tours were conducted for members of the public, elected officials, business owners, school youth, senior citizens, scientists, industry professionals, congressional representatives, etc.
- Meetings between the applicant organisation and the 18 affected units of local and tribal governments (AUGs) were held quarterly to discuss issues and identify concerns. These meetings included providing workshops to explain the construction control process, the waste management system review, and the repository design, as well as receiving AUG recommendations for proposed meeting locations on rail alignment and other issues.
- Communications staff conducted annual rural swings throughout Nevada, meeting with local businesses, emergency responders, attending County Commission meetings, speaking with elected officials, etc.

Direct/indirect communication (one way/two way, static/dynamic)

- The website offered two-way communication opportunities by allowing users to submit both questions and comments online. It offered videos, photos, animation, technical document libraries, congressional testimony, contact information and news releases. It was an exceptional website which for a number of years received more than a million hits per month.
- In formation centres and site tours were very successful in terms of allowing the public and others ranging from academics to elected officials to see the extent of the science and engineering involved in assuring safety in every step of the repository programme, the presence of knowledgeable staff always assured two-way communications. Site tours also provided a real perspective on the remoteness of the Yucca Mountain site.
- Scheduled meetings between the applicant organisation and regional government entities assured two-way communication channels were always open, support from surrounding counties was positive and constant, at the state level always negative and constant.
- Many public meetings (some became media circuses) were held to obtain comments on environmental impact statements and their updates and the more effective part of such meetings were the pre-meeting poster displays manned by subject matter experts with whom the attendees could discuss concerns and to whom they could provide suggestions.

Type of information provided (graphs, explaining text, numbers, indicators, videos)

- The website offered site and system descriptions, graphical material, videos and contacts for requesting further information.
- The information centres were opportunities for people to learn facts about radiation, regional geology, and other aspects of repository-related science and engineering. Many displays were sophisticated and interactive.
- Meetings were usually accompanied by presentations and posters manned with subject matter experts, very effective for one-on-one discussions on more focused and technical topics.

Expectations of the audience

- Website: Expectations were generally met. Inquiries requesting additional information generally resolved with a link to the technical document addressing the question.
- Visitor centres and tours were very popular and surveys after tours suggested over 80% came away more positive about the proposed repository project than when they started the tour.
- Scheduled meetings with regional (county and tribal) governments and entities such as the Western Governors Association were vital to maintaining relations with these governmental bodies.
- Public meetings had mixed outcomes, especially when dominated by anti-organisations. Not having the media present was a way to control anti-organisational participation and meeting dominance, and this was accomplished one time by having six public meetings in the state at the same time, with the media, and the anti-groups, choosing not to participate, this finally allowed a greatly reduced but interested public audience to ask questions and listen to answers from subject matter experts at the posters. (Effective but very personnel-intensive and hence not a sustainable approach).

Experience – lessons learnt

- Website: The immense popularity of this website and web traffic statistics indicated it met users' needs by offering the information they sought.
- Visitor centres and tours: Feedback from visitors and tour participants was on the whole very positive, suggesting the right balance of technical content and plain language was employed in communications.
- Scheduled regional government meetings were two-way problem identification and solving meetings and were general very positively received.
- Public meetings were important but were often media circuses citing the most inflammatory speakers in news clips. The opportunity to speak one-on-one with interested members of the public prior to the formal meeting was important and positive, however.

Did the audience find the information relevant for the message?

- Website: Yes. The site was designed to offer information to a range of audiences, from general public to expert level stakeholders. Visitor centres and tours and regional and public meetings: Generally yes, information supported the overall message of assuring public safety.

Did the audience understand the message of the author?

- Website: Generally yes, as already noted, the inquiries for additional information could generally be answered with a link to a more in-depth technical document on the topic of interest.
- Visitors centres, tours and regional and public meetings: Generally yes. Information seemed understood by audiences though not always agreed with in public meetings.

Table C.4. Review of Compliance Certification Application and Recertification Applications for the Waste Isolation Pilot Plant, a US DOE Geologic Repository for Defense Transuranic Wastes in New Mexico (reviewer: US DOE)

Reference

www.wipp.energy.gov/library/cca/cca1996.html (First Compliance Certification Application).

www.wipp.energy.gov/library/CRA/BaselineTool/Index/Chapters_Appendices.htm (First Compliance Recertification Application).

www.wipp.energy.gov/library/CRA/CRA-2014.html (Second Compliance Recertification Application).

www.env.nm.gov/wipp/pdfpermit.html (State of New Mexico Environment Department – regulator).

www.epa.gov/radiation/wipp/reg.html (US Environmental Protection Agency – regulator).

www.epa.gov/rpdweb00/docs/wipp/wipp_cert_eval_0401_execsum.pdf (An external review of the effectiveness of the EPA public outreach process during the time of the first WIPP certification).

[Also see last link under previous page]

Context (siting, research, licence application)

"Licence" application –actually a permit from the State of New Mexico Environment Department (NMED) for hazardous waste disposal (renewed every ten years), and a compliance certification from the US Environmental Protection Agency for repository long-term radiological safety performance (renewed every five years).

Role of the author(s)

Applicant organisation.

Which messages the authors wanted to convey?

Continued compliance with State of New Mexico and US Environmental Protection Agency (EPA) requirements.

Which were the audience(s)?

Federal and state regulatory organisations (experts), state, regional and local (meaning county and city) governments, and the public.

Media (live discussions, report, flyer, video, web) used for communication

- Primary communications approach is the website at www.wipp.energy.gov/index.htm.
- Since this is a radiological operating facility, tours are restricted to select entities and persons such as elected officials and academics.
- Prior to operations public tours were available, very popular, and very effective for showing that safety is the primary concern of those planning this repository.
- Since a fire and underground release mishap in February of 2014 tours have been severely limited for obvious operational and safety reasons.
- Since the mishaps of February 2014 an online web page www.wipp.energy.gov/WIPPRecovery/recovery.html was created to inform interested parties of the progress of recovering the repository from its soot and radioactive contamination given a fire and an unrelated (first time ever in 15 years of operation) release event underground:
    1. Jointly with the City of Carlsbad, the US DOE Carslbad Field Office has been holding public meetings to discuss the events and the recovery.
    2. These meetings were held weekly, then biweekly, and now monthly given that the rate of recovery progress is not so steep anymore and interest is waning.
    3. Live-streaming of these meetings has more participants than are present in the actual meetings http://livestream.com/rrv.
- Public meetings are also held to explain and get public input on change requests submitted to NMED and EPA:
    1. EPA hosts such meetings and US DOE participates with presentations on the technical reasons for the requested change and to assure that analyses indicate no change to long-term safety.
    2. NMED allows the US DOE to host such meetings and to participate with technical presentations to show that the requested change does not violate the NMED permit requirements.

Direct/indirect communication (one way/two way, static/dynamic)

The website is primarily a one-way communications tool but also serves as a two-way communication tool when it is used to collect comments on such items as planned changes and the periodic review of the community communications plan required by NMED, for example. Of course there is an opportunity on the web page to contact the persons listed that can provide more information. The NMED and EPA websites linked above contain the entire decision-making process and the decision bases used by these regulators in deciding to reissue permits and certifications of compliance.

Type of information provided (graphs, explaining text, numbers, indicators, videos)

A variety of media is used on the website and in public meetings. Presentations and videos are the primary tools for public meetings.

Expectations of the audience

Feedback on the website and the public meetings indicate a significant level of satisfaction with the way repository events and status are being communicated currently.

Experience – lessons learnt

After the release event of February 2014, there a few days of silence on the part of the US DOE, something that caused widespread outrage. The first news of the release event was made public by the state university's independent monitoring organisation, which shows the value of having an independent monitoring organisation. Immediately after the public meetings, jointly sponsored by the City of Carlsbad and the US DOE Carslbad Field Office began, and the good relationship between the US DOE and the local/regional governments and its regulators was re-established with time. Lesson learnt: be quick to acknowledge an event and open about not yet knowing exactly what happened.

Did the audience find the information relevant for the message?

Generally feedback is quite positive on both the website(s) and public meetings of various sorts (Town Hall and regulatory-related public meetings).

Did the audience understand the message of the author?

Generally this seems to be the case given the type of feedback being received in both public meetings and from the website.

Table C.5. Review of application by LLW Repository Ltd for the disposal of further radioactive waste at the low-level waste repository in Cumbria, UK (reviewer: Environment Agency)

Reference

www.gov.uk/government/collections/low-level-waste-repository (regulator's website providing an overview of regulation at the site, links to the regulators review of the environmental safety case supporting the application and the issued permit and decision document).

https://consult.environment-agency.gov.uk/portal/npsapp/llwr/dd (consultation portal used during consultation on the permit, containing application documents, consultation documents and the final decision).

http://llwrsite.com/national-repository/key-activities/esc/ (applicant's website containing all application material and the environmental safety case).

Context (siting, research, licence application)

Variation to an existing permit for the disposal of further radioactive waste. The site has operated since 1959. The last update to the permit was issued in 2006, but limited to disposal into one area of the site due to inadequacies in the environmental safety case previously submitted in 2002. The project involved review of the application and environmental safety case submitted in 2011 to support that application.

Role of the author(s)

Environmental regulator.

Which messages the authors wanted to convey?

- Independent regulation of the site and in reaching a decision on the application.
- An open and transparent determination process was undertaken.
- Information about our regulation and our processes: Our role is to ensure that people and the environment are adequately protected, both now and in the future, from any harm that may result from the operation of radioactive waste disposal facilities.
- We are implementing government policy.
- Completion of a robust and detailed review of the application and the supporting environmental safety case.
- That no decision would be taken to permit further disposal of radioactive waste unless we were satisfied that it would be safe for people and the environment now and into the long-term future.
- Information to enable all stakeholders to access and review the application and to understand and be aware of important issues. To encourage involvement and contributions.

Which were the audience(s)?

- the local community and general public;
- local authorities, councils and elected members;
- other relevant regulatory organisations (e.g. nuclear safety regulator, the Scottish Environment Protection Agency);
- relevant government advisory bodies (e.g. on the health aspects of radiation);
- consignors of waste to the site and other operators within the nuclear industry;
- national non-governmental organisations and local pressure groups (e.g. Friends of the Earth);
- relevant government departments (e.g. Department of Energy and Climate Change);
- local and national stakeholder and technical groups (e.g. the local stakeholder meeting and the national nuclear low-level waste strategy fora);
- representative bodies in the nuclear industry (e.g. Nuclear Industry Association).

Media (live discussions, report, flyer, video, web) used for communication

A range of approaches were used at different stages of the project and according to the audience and the material for example:

- A website was established from the outset. This contained basic information on the review, periodic briefs on progress, links to relevant documentation and a "questions and answers" document addressing frequently asked questions. Links were provided to the applicant's website containing all application material and our consultation portal used to gather views during formal consultation steps (two off).
- Emails were used to provide links to all stakeholders in relation to periodic briefs, publication of documents and at the initiation and conclusion of consultation stages. A dedicated e-mail address was established for all communications.
- Two full day "drop-in" sessions were held, one during each of the consultation phases covering the application and then our draft decision. These were held local to the application site and were widely advertised in the local press, by use of flyers, posters, emails and press releases (leading to TV and radio items). These were used to explain our role to the local community and to answer any questions. They were supported by the applicant and the local authority.
- A technical seminar was held soon after receipt of the application to which a wide range of interested parties were invited. This was used to present and share some of the main issues surrounding the application and regulatory challenges. Workshop sessions were used to discuss issues. This event was supported by the applicant and the local authority.

- Tweets were used to communicate key stages and messages.
- A web-based consultation portal was used to host and manage consultations. Consultees could access all the application information on this portal and provide comments, which were made openly available to the public (unless otherwise requested). This portal also hosts our final decision.
- Face-to-face presentations and discussion sessions were provided to a wide range of interested audiences. For example presentations were provided to government advisory bodies, national strategy groups, the local stakeholder forum, local councils and the applicant's staff).
- Periodic written briefs (2-4 pages) were published periodically to update all stakeholders on progress and issues arising.

Direct/indirect communication (one way/two way, static/dynamic)

A mixture was used.

Two-way communications were possible at presentations, drop-in sessions, the seminar and to some extent by e-mail.

Web communication and the web-based consultation portal was primarily one way. However, through our decision document published on the web page and web based consultation portal we addressed all consultation comments received.

Type of information provided (graphs, explaining text, numbers, indicators, videos)

This varied widely depending upon the media used.

Written communications (emails, reports, periodic briefs, web page) were predominantly written text supported by pictures and limited tables or graphs.

Presentations and the seminar were a more even combination of text, pictures and graphs/tables, used to convey the general approach to the review, important findings, the site layout and engineering and technical issues.

The drop-in sessions used a more pictorial approach to communicating information about the site, our review and findings. Handouts were provided offering basic information to take away.

Expectations of the audience

We believe expectations varied across audiences.

We believe more technical stakeholders or those close to the project wished to receive regular updates and access to detailed technical information, but presented in a manner that provided a good overview at any one time of progress. Thus allowing them to seek or identify more detail as they required.

We believe less technical stakeholders or those less close to the project wanted good summary information to enable them to understand the application, our process and ultimately the decision and its basis. Ideally this would be presented in a very accessible way using simple text, non-technical language, pictures and illustrations etc.

There was a clear expectation that we would provide good quality information and make it widely available. Through this information, that we demonstrated our independence in decision making and openness and transparency in our processes.

Interests that arose through the process were very variable with individuals or groups only wanting high-level overview information, to those that wished to discuss or see evidence related to very specific detailed and technical topics.

Experience – lessons learnt

- There is a need to cater for a wider audience with different interests, some detailed and some just wishing to gain a clear overview. A range of approaches are therefore needed, supported by a wide range of good quality materials.
- Significant effort is required to present complex technical information in a simple and clear manner, but this is important.
- It is very beneficial to act early on communications to keep all stakeholders informed from the outset and to "bring them along" with the process and issues, particularly being open very early on any significant challenges or issues of potential concern.
- Significant effort should be put into clarity of messages, which can be readily misinterpreted or misquoted.
- Drop-in sessions, the seminar and presentations were very positive events and enabled good quality one to one and group to group discussion. This facilitated good sharing of information with a wide range of stakeholders in an open and relatively relaxed atmosphere. It appeared that this helped by generating more considered formal consultation responses based upon good understanding.
- There is a need to be aware of stakeholder fatigue if communicating too often and over a long period.
- It is beneficial and positive to be available and accessible to stakeholders throughout the process.

Did the audience find the information relevant for the message?

Generally we received positive feedback. It was evident that some of the more technical information was too detailed for some uses and therefore it was important to produce and use non-technical summaries and to present materials pictorially or in a simpler manner where relevant to the audience.

Did the audience understand the message of the author?

Generally this seems to be the case based upon feedback.

Table C.6. Review of public dialogue project: New nuclear power plants – Reviewing public involvement in reactor design assessments (reviewer: Environment Agency)

Reference

Project reports are published here: www.sciencewise-erc.org.uk/cms/new-nuclear-power-stations-reviewing-how-to-engage-with-members-of-the-public-in-reactor-design-assessments-known-as-the-generic-design-assessment-or-gda.

The public dialogue report can be viewed here: www.sciencewise-erc.org.uk/cms/assets/Uploads/GDA-dialogue-report-August-2015-FINAL.pdf.

The independent project evaluation report (attached) will be published in November 2015.

Context (siting, research, licence application)

The UK government has outlined its commitment to a significant expansion in new nuclear in the UK stating that nuclear power, alongside renewable energy sources, will ensure UK has enough low-carbon electricity in the future.

In 2006, UK government asked the nuclear regulators, Office for Nuclear Regulation and Environment Agency, to consider "pre-authorisation assessments" of new nuclear power stations.

The nuclear regulators developed their generic design assessment (or GDA) process in response to this request.

GDA enables the regulators to begin assessing the acceptability of safety, security and environmental aspects of a nuclear power station design, at a generic level, before site-specific applications are made. It provides the regulators with early influence on the design of new nuclear power stations when it is most effective and efficient. It also helps to reduce project cost and time risks for developers as it enables regulatory concerns to be identified and addressed early.

Role of the author(s)

This was a partnership project involving the UK nuclear regulators: Environment Agency – the lead project partner, the Office for Nuclear Regulation (ONR) and Natural Resources Wales (NRW).

The project was co-funded by Sciencewise. (Sciencewise is funded by the Department for Business, Innovation and Skills (BIS). Sciencewise aims to improve policymaking involving science and technology across government by increasing the effectiveness with which public dialogue is used, and encouraging its wider use where appropriate to ensure public views are considered as part of the evidence).

Which messages the authors wanted to convey?

Public dialogue project objectives:

1. Identify approaches that will address issues and barriers to sharing complex technical information on GDA with members of the public.
2. Inform the nuclear regulators' engagement and consultation approach on GDA.
3. Develop and pilot materials on the GDA that are accessible to the public.
4. Identify potential public engagement process options for GDA.
5. Help the nuclear regulators to pilot an effective public engagement, and for the UK Environment Agency and NRW, consultation approach, during the current assessment of Hitachi-GE's UK advanced boiling water reactor (UK ABWR).

The public dialogue project centred on three key questions:

i) How do members of the public want to be involved in the generic design assessment process?

ii) What do people need to know (what are their concerns/interests?) and how can the nuclear regulators address their concerns/interests as part of the GDA process?

iii) What can the nuclear regulators do to help improve people's trust and confidence in their decisions?

Using the project findings

The findings from the project will be used to inform how the regulators engage with the public during the Environment Agency and Natural Resources Wales' consultation on their assessment of Hitachi-GE's UK ABWR due in 2016.

Which were the audience(s)?

Members of the public.

Media (live discussions, report, flyer, video, web) used for communication

Online national scoping survey

This survey – which analysed 400 responses – was the first step of the overall dialogue process. Its aim was to inform the design of local dialogue workshops, by building a picture of national attitudes to the regulation of nuclear power and the assessment of a new reactor design. It also allowed comparison with the findings from the locally held workshops.

Public dialogue workshops

Three public dialogue workshops, each involving around 20 members of the public were held. The first two (round 1 workshops) were held in the general vicinity of the sites where the UK ABWR is proposed to be built by the developer Horizon Nuclear Power – Oldbury in South Gloucestershire, England and Bangor in North Wales.

The third (final) workshop involved a selection of some of the participants from each of the first two workshops, to enable a deeper exploration of issues.

The workshops were professionally designed and facilitated by a specialist dialogue contractor, with the regulators taking part to provide expert information, respond to questions and hear directly, participant feedback.

Workshop methodology

The two round 1 workshops focused largely on introducing the topic of GDA and discussing initial responses around communicating this with the public.

The round 2 workshop was designed to enable participants to delve more deeply into some of the areas covered in workshop 1, particularly in relation to if, how, and who to communicate with, with respect to the GDA process.

The format of all three workshops included a mix of plenary discussion, presentations and group work at tables.

Participants heard presentations from the regulators followed by structured question/answer sessions. They also reviewed and gave feedback on the regulators' nuclear new build and GDA information (e.g. consultation documents and web pages), as well as developer/operators' information.

Direct/indirect communication (one way/two way, static/dynamic)

This was a public dialogue and therefore involved direct two-way dynamic interaction.

Type of information provided (graphs, explaining text, numbers, indicators, videos)

To provide participants with contextual knowledge about the topic of assessing new nuclear power station designs, the nuclear regulators gave presentations about:

- the role of the regulators;
- the generic design assessment or GDA;
- the UK advanced boiling water reactor design;
- an introduction to radioactive waste management;
- nuclear fission and radiation.

Slides can be viewed here (Appendix 7, pages 50-59).

Participants also viewed regulators and developer/operators' information including websites and leaflets.

Expectations of the audience

Participant feedback taken from the independent evaluation

The majority of respondents indicated that they could take part and contribute as much as they wanted. Those interviewed specifically liked the time allowed and the ease with which they could ask questions and get responses pitched at the right level. The following helped participation:

- comfortable, relaxed, welcoming and safe environment created, no pressure to comment but plenty of opportunity to do so;
- views confirmed and written down – built confidence;
- things were explained well – particularly positive about Environment Agency input;
- the structure provided opportunity for everyone to speak – no question was deemed too stupid.

Responding to the issues raised by the public

At the time of writing the regulators were considering how they could address the findings from the public dialogue when consulting on Hitachi-GE's UK ABWR in 2016. For example, engaging with local communities where this reactor design is proposed to be built, ahead of the consultation, to understand expectations for engagement. Also, the development of information (e.g. infographics) which shows the place of GDA in the bigger picture of developing new nuclear power stations.

Experience – lessons learnt

Summary of impact on workshop participants

Feedback demonstrated that there was substantive learning about technical issues, the nuclear new build process, the role of the regulators and an increase in trust and confidence that the workshop findings will be used to inform the process and materials for the GDA consultation on Hitachi-GE's UK advanced boiling water reactor due in 2016. (Source: independent evaluator's report).

Key lessons/findings include:

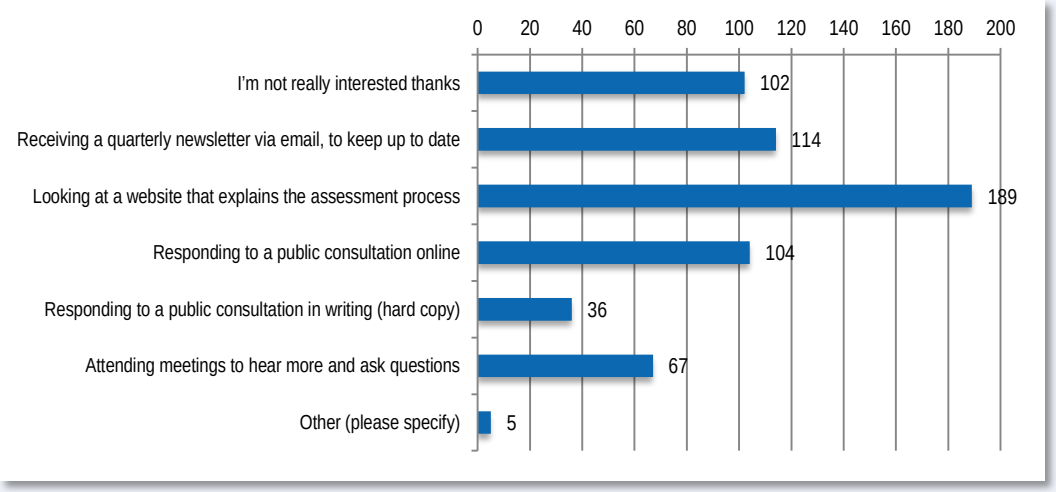
- Given the complexity of the nuclear new build process as a whole, there is a need for the public to be aware of the "bigger picture", where GDA fits into this and the scope and opportunity for dialogue and consultation at key points.
- Be clear about why you are engaging and what difference people's input will make.

  Make it relevant (Generic implies that it is not relevant!) *"What impact is it going to have on the environment and the local area or local people?"*
- There is no substitute for face-to-face engagement for building trust.

  "You cannot figure out sincerity from reading a piece of paper – you need to meet the person."

- Reinforce independent role.
- How (e.g. language and tone) you communicate is as important as the mechanisms that you choose.
- People were more motivated and able to contribute if they received more contextual knowledge.

How to involve people? Survey respondents expressed a clear preference for communication mechanisms for example 47% preferred a website (see dialogue report for list of findings). There were also multiple comments from workshop participants about a range of possible mechanisms for future engagement, alongside specific principles applicable to all of these communication methods: simple language, consistent messaging, graphics and methods tailored to particular audiences. Face-to-face engagement was favoured, although participants recognised the practical difficulties and resource constraints presented by this type of engagement.



The language barrier. The complexity of the often technical language was a key issue for participants, including the phrase "generic design assessment" and the "GDA" acronym itself.

Need for context. There is an apparently low awareness of the topic of new nuclear power, alongside desire from workshop participants for more contextual information about GDA and nuclear power.

"When, where, what, why – I want all the facts about the GDA process. The timescale, why now?"

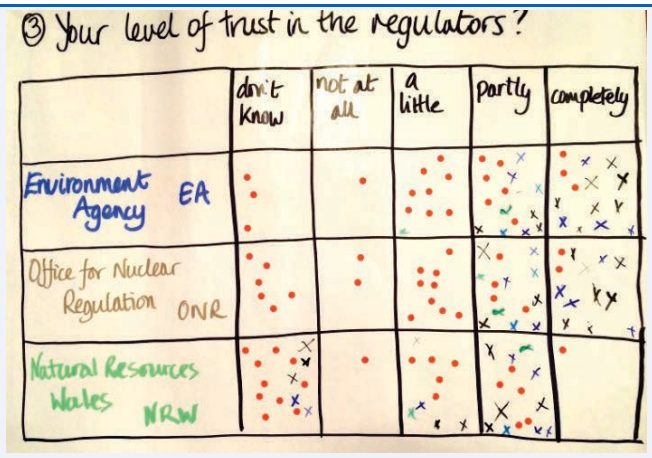
Desire for detail. People want more information on a range of topics. The results of the online scoping survey showed that the top three issues for respondents were safety (81.5%), radioactive waste management (78.3%), and the impact of radioactive discharges on people and the environment (75.6%).

In addition, perceived personal relevance is a strong motivating factor for getting involved – participants wanted to know how it related to their everyday lives.

GDA as part of a story, not an isolated chapter. There is a dilemma surrounding the needs of people wanting more contextual information and those wanting more detail on local implications rather than generic concepts. Both of these things indicate the need to clearly show the pathway from decisions about new nuclear to the local implications of new reactors, with GDA as a pivotal point in that process. It also suggests the need to be very clear about what kind of input is being sought from members of the public, as well as what the scope of the topic covers and does not cover.

Improving trust and confidence in the decisions of the regulators. Initially relatively low levels of knowledge and trust (at the beginning of the workshops, also reflected in the national online scoping survey) were noticeably increased by the end of the first workshop, highlighting the importance of familiarity – both in terms of knowledge and face-to-face contact – as a contributor to trust. For many participants, clarity over the roles and responsibilities of the regulators also seemed to contribute to their levels of understanding and trust.

Flipchart above: on entering the workshop at the beginning of the day, participants were asked to mark their responses (red dots) to four questions. These questions were then repeated at the end of the day ("x"), to see if people's attitudes or understanding had changed as a result of taking part in the workshop.



Reducing barriers to public engagement. Participants made a range of suggestions for reducing barriers to public engagement, including: 1) keep it simple; 2) Innovate; 3) use a range of methods; 4) tap into local resources; 5) drip feed information; 6) ensure accessibility of online information; 7) be aware of context, history and preconceptions; 8) make it personal; 9) reconsider the use of language; 10) clarify what kind of input is being sought and listen to people's views; 11) make it personable; 12) raise the profile of the regulators and their role.

Did the audience find the information relevant for the message?

The findings from the public dialogue indicated that participants had a desire:

- for more context e.g. the bigger picture regarding new nuclear power stations from energy policy to the local implications;
- for more detail on a range of topics e.g. radioactive waste management;
- to understand how it related to their everyday lives.

The project partners were able to address this largely, during the dialogue workshops and also via a document that was sent to all participants following the round 1 workshops, responding to people's questions.

Did the audience understand the message of the author?

Participant feedback – from independent evaluation

Very positive feedback about understanding of the issues with the majority having enough information at the right level to contribute effectively. No one indicated that they did not understand the issues and related discussions. Particular mention was made of the large amount of knowledge gained from the start to the end of the workshop. The presentations in general went down very well and they were considered thorough, clear and pitched at the right level. The presentation about the process of ABWR was very successful.

The following helped:

- good diagrams – projected big;
- the right level of information – not too much;
- the encouragement to question what people did not understand;
- different agencies clearly explaining their role;
- sessions short enough not to lose interest.

"Alan was excellent at explaining nuclear fission"

"the knowledge of the Environment Agency *and Office for Nuclear Regulation was excellent and gave me a complete understanding of all subjects covered"*

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Communication on the Safety Case for a Deep Geological Repository

Communication has a specific role to play in the development of deep geological repositories. Building trust with the stakeholders involved in this process, particularly within the local community, is key for effective communication between the authorities and the public. There are also clear benefits to having technical experts hone their communication skills and having communication experts integrated into the development process. This report has compiled lessons from both failures and successes in communicating technical information to non-technical audiences. It addresses two key questions in particular: what is the experience base concerning the effectiveness or non-effectiveness of different tools for communicating safety case results to a non-technical audience and how can communication based on this experience be improved and included into a safety case development effort from the beginning?

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