NEA
NUCLEAR ENERGY AGENCY

FORUM ON STAKEHOLDER CONFIDENCE

INTEGRATION GROUP FOR THE SAFETY CASE

Managing uncertainty in siting and implementation – Creating a dialogue between science and society

Second Joint Workshop, 9 October 2019

In 2017, the Forum on Stakeholder Confidence (FSC) and the Integration Group for the Safety Case (IGSC) held a Joint Workshop on Safety Case Communication. The Working Group on Public Communication (WGPC) also participated. The workshop served as a platform to identify specific topics and working approaches for future collaboration between the working groups. One of the topics identified was "Managing uncertainty".

This led to a second workshop, which specifically focused on this topic. A Programme Committee with members from the IGSC and FSC bureaux was responsible for the organisation of the joint workshop. This flyer compiles the results and general findings of the workshop.

Objectives

- **FSC**: To better understand what types and areas of technical uncertainties exist and how they are addressed.
- **IGSC**: To better understand how uncertainties are perceived by different stakeholders and what role they play in debate, participation, governance and decision-making.
- **For both**: To develop joint views on ways towards better communicating and addressing uncertainties in repository siting and development and in radioactive waste management governance.
- **Short-term**: Publishing the results of the workshop.
- **Medium-term**: Organisation of a third workshop with local stakeholders.
- **Long-term**: Nuclear Energy Agency (NEA) status report (e.g. "Communication of uncertainties during siting and implementation – ideas to improve the dialogue between science and society").

Programme

After an introduction by the chairs of the IGSC and FSC, presentations were given by David Brazier, Anne Eckhardt and Behnam Taebi. Three rounds of discussion with the World Café-method followed. The workshop ended with a conclusion by the IGSC and FSC chairs.

Participants

A total of 79 participants from the IGSC, the FSC and the WGSC from 18 countries, including 14 representatives from 3 international organisations (NEA, Organisation for Economic Co-operation and Development [OECD], International Atomic Energy Agency [IAEA]). Two external speakers: Anne Eckhardt (Switzerland) and Behnam Taebi (Belgium).

Conclusions from presentations

How uncertainty is communicated in the media

– David Brazier, Technical Specialist, Environment Agency, United Kingdom

Uncertainty is rarely discussed in the media unless it is associated with a particular event or risk, where uncertainty is taken to mean "not knowing". To scientists however, uncertainty is more about how well something is known and care is taken to distinguish between different types of uncertainty.

"Uncertainty" is an overused word in the media and its use is not neutral – it is framed as a negative attribute. To be in a state of uncertainty is not pleasant, especially when it relates to health issues with indecision on what action to take. Or, in the economic context, the phrase "business does not like uncertainty" is often heard. More sophisticated discussions of uncertainty can be found in popular science writing and journalism, but even here, uncertainty can easily be weaponised to create a persuasive case for paralysing decision making by casting doubt on the reliability of claims, arguments and evidence; both in terms of preventing the introduction of a technology or practice but also in attempting to persuade decision-makers to continue with an existing practice, e.g. the historical campaign to encourage smoking by the tobacco industry.

Uncertainty is also unintentionally inflated by media reports due to the common practice of adopting false equivalence in reporting both sides of a debate, where the quality of arguments and evidence often goes unchallenged by the reporter, and where a rigorous, consensus-based argument is typically balanced against ill-informed popular opinions or unorthodox views.

Risk perception: Perspectives on risk and uncertainty

– Anne Eckhardt, Managing Director, risicare GmBH, Switzerland

Uncertainties are a key element, which have to be considered in the safe disposal of radioactive waste. Uncertainty occurs where information is insufficient, not precise or unambiguous enough to demonstrate that a disposal system will meet safety requirements. Important sources of uncertainty in the context of geological disposal are natural variability, the complexity of the repository system and the long periods of time over which safety has to be demonstrated.

Research on risk perception reveals that unknown risks – and thus risks associated with uncertainties – are feared more than known risks. Uncertainty tends to be perceived as a threat

- if data and results on the safety of disposal are contradictory;
- if there is disagreement between experts;
- if confidence in the communicating institutions is low;
- if information on the risks of disposal is perceived as downplaying these risks.

To deal with uncertainties in the context of final disposal, a structured approach should be chosen that allows different forms of uncertainty to be weighed against each other. Ideally, uncertainties are openly communicated to the public, while at the same time demonstrating competence in the safe management of radioactive waste. Increased involvement of the interested public in dealing with uncertainties offers, among others, the chance to address and involve younger people.

Ethical uncertainties and nuclear waste disposal

– Behnam Taebi, Associate Professor, University of Delft, Netherlands

Some risks such as those associated with nuclear waste disposal cannot be simply calculated as the probability of occurrence times the effect because they are complex risks with tremendous uncertainties. The type of uncertainties concerned include scientific uncertainties (how the models predict the future), technical uncertainties (how engineering systems will behave in the future) as well as ethical uncertainties. Ethical or normative uncertainties are situations in which there is no one unequivocal right answer to the moral quandary in risk-related decisions. In nuclear waste disposal, we are bound to deal with at least four categories of normative uncertainties: evolutionary, conceptual, theoretical and epistemic normative uncertainties. As an illustration for one of these categories, the evolutionary normative uncertainties, or a situation when we do not know which moral norm applies, because both the technology and the perception of what is considered good in society could evolve. In the Netherlands, for instance, there is a time lag of one and a half centuries between the first production of commercial nuclear waste (in the 1970s) and the final disposal of all waste underground, which should be complete by 2120, according to the Dutch National Plan. Since the 1970s, a lot has changed in how we think that nuclear waste should be disposed of, our understanding of the health and environmental impacts of radiological risks as well as how we perceive our responsibilities to future generations. Sustainability and our responsibilities to future generations have been added to the scholarly and policy vocabulary. In 2020, it is beyond contention that we need to dispose of nuclear waste such that it avoids undue burdens on future generations. It is reasonable to assume that these developments – both the advancements in science and engineering and our perception of what is considered to be good – will continue to evolve in the next 100 years. Therefore, in discussions on siting and implementation of nuclear waste disposal, we need to account for normative uncertainties.

World Café

The World Café enabled a dialogue among all participants. Four designated facilitators had specific questions to discuss with participants in a group setting. The participants switched groups twice so that each new group could build on the discussion of the prior group. At the end, each facilitator presented the results of the discussions.

Results of group 1

What does the term uncertainty mean to scientists? Especially with regard to siting and implementation?

- For scientists, dealing with uncertainties is business as usual. This applies in particular to research activities, which by definition address uncertainties or lack of knowledge.
- Scientists have different roles in relation to repository programmes; and therefore may also have varying interests by which they are driven.
- Within the safety case framework, scientists often distinguish between epistemic (related to knowledge subjective, reducible) versus aleatory (stochastic, irreducible) uncertainties. However, it is not always possible to draw a sharp dividing line between the two.
- A more pragmatic approach for addressing uncertainties is to distinguish between:
  - Uncertainties concerning the future system evolution ("scenario uncertainties").
  - Uncertainties concerning phenomenological understanding and the ways it is transferred into models ("model uncertainties").
  - Uncertainties concerning the data used ("parameter uncertainties").
- All the above must first be identified and their relevance for safety assessed. Dependent on the outcome of the assessment and the means available, they might then be reduced (by research), avoided or mitigated (by siting or design decisions aiming at robustness). However, there will be remaining uncertainties.
- A comparison was made between a bottom-up approach which attempts to embrace "all" conceivable uncertainties versus a top-down approach which first asks about the potential to jeopardise safety. This distinction is comparable to the distinction between bottom-up and top-down approaches in scenario development (cf. *Methods for Safety Assessment for Geological Disposal Facilities for Radioactive Waste* (MeSA) report and IGSC scenario workshop, see "Further reading") and may also be applicable to other categories of uncertainties.
- Dealing with uncertainties is one of the main drivers of repository programmes. At decision points in a repository programme, remaining uncertainties in the current safety case inform decisions about siting, design, and research and development in a stepwise iterative approach directed at implementation.
- A strong safety culture is essential for achieving this and interested stakeholders need to be aware of this iterative process of addressing uncertainties.
- However, there are uncertainties not accounted for by this approach:
  - Unknown unknowns.
  - Uncertainties arising from outside the scope of a safety case (e.g. concerning political influences, changing policy decisions, changes in economics or technology). These uncertainties can be significant and play an important role in public discourse.
- Also, the role of emotions and different risk perceptions, in particular fears concerning (perceived?) human hubris, needs to be taken into account when broadening the scope (from specialists/scientists to other parts of society).
- However, this should not necessarily be seen as a problem. In contrast, dialogue and open communication leading to discourse can be seen as a means of enriching the process.
- The way uncertainties are seen and accounted for depends on the scope. An example is retrievability: while it might make the system less robust from a technical point of view, it can also be seen as a precaution with respect to unknown unknowns. In the discussion, diverging views were expressed concerning the appropriate scope for a deep geological repository safety case.
- Concerning the role of uncertainties vis-à-vis siting: it is about more than just siting. After siting it comes to hosting a facility. Dialogue on uncertainties needs to continue!
- Important questions:
  - When addressing uncertainties, how to prioritise? Who decides? (Views expressed include that uncertainties potentially leading to high consequences should have priority, and that expected/plausible evolutions and states should have priority rather than less likely or less plausible ones when optimising the system.)
  - Dependent on scope and attitude/perception, especially concerning unknown unknowns, the paradigm of passive safety might be put into question.
  - We cannot take care of everything. How safe is safe enough?
- It seems that specialists (scientists) may prefer to address known unknowns, while non-specialists may be more focused on unknown unknowns. However, the two converge when addressing scenario uncertainties.

Results of group 2

What does the term uncertainty mean to members of civil society? Especially with regard to siting and implementation?

- It is very difficult to separate uncertainty from risk. When discussing uncertainty, the discussions usually would drift back to risk. This appeared to be a common theme with the other groups too.
- The perception of uncertainty is often that of not knowing.
  - » The term "uncertainty" translates to "I don't know" in Swedish.
  - » Some languages do not even have the word uncertainty (e.g. some indigenous peoples in Canada).
  - » Most experiences with uncertainty are negative (e.g. political uncertainty).
  - » One way to help discuss and perhaps counteract the negative perception of uncertainty is to put it in context of the big picture (e.g. a specific uncertainty may deal with only a small part of the whole system).
- There are things that may result in a better understanding or acceptance of uncertainty.
  - » Communities near a nuclear power plant tend to understand the concept of uncertainty better. It is not that there is less uncertainty, it is just that the people are more accustomed to dealing with uncertainty.
  - » Those that see benefits from something such as a nuclear facility tend to better understand the concept of uncertainty.
  - » Uncertainty is better handled when people can have some control over it (e.g. you can take an umbrella if a rain forecast is uncertain).
  - » There tends to be less comfort with uncertainty in passive systems. This may be the result of having more comfort when something is being actively monitored (i.e. the system is controlled and efforts can be made to prevent/mitigate undesirable outcomes).

  - » Some people do not consider uncertainty in contexts in which they have only had positive experiences (e.g. using a microwave oven).
  - » The general public is not willing to accept risk/uncertainty if there are no benefits. If there are benefits, they may be more likely to accept risk/uncertainty (e.g. x-rays in medicine).
- The best way to facilitate understanding of uncertainty is communication.
  - » We need to realise people have different understanding and definitions for the term "uncertainty".
  - » We need to explain that uncertainty is a normal part of the process.
  - » We need to understand what level of uncertainty is or is not acceptable.
  - » There is a real need to have a dialogue.
- Younger/future generations may be well-equipped to handle uncertainty.
  - » A person's early experience of uncertainty may be negative (e.g. first day of school).
  - » Young people may be prepared to deal with uncertainty (e.g. unprecedented access to information, Google).
  - » Younger generations tend to be more future thinking (i.e. how to make the world better).

Results of group 3

What uncertainties is society willing and able to accept and under which conditions?

1. Society

- It is a general point that "society" encompasses the whole spectrum of views and opinions and that you cannot please all people all the time.
- Some people want guarantees of safety, not assurances of "acceptable risk". There is no risk-free solution to nuclear waste – it presents risks now, above ground.
- Concerns can also be country-specific, or city/municipality specific.
- What society is willing to accept, changes with time. For example seatbelts were integrated as standard inclusions for back seats and smoking restrictions have increased and become common practice.
- Society generally accepts familiar uncertainties (risks) where there is a perceived benefit or perceived level of control e.g. driving, smoking, medical procedures, working at a nuclear plant.
- Familiarity does not always mean acceptance (consent vs. imposition).
- Benefits and risks are not equally distributed. Risks are distributed in time and space from the benefits. Societal benefits (national good) vs. locally affected individuals.
- Medical treatment and electricity supply are accepted but not the associated responsibility for managing the wastes. Greater need for public understanding of rights and responsibilities.
- There is a wider acceptance of uncertainties (risks) with chemical waste management compared with nuclear.
- Trust and/or transparency are necessary conditions for acceptance of uncertainties associated with nuclear waste.

2. Scandinavian examples

- Finland: decision in principle was taken 20 years ago. How much do we need to know now? It was accepted that there would be a progressive reduction of uncertainties in a step-wise manner. High trust in political system and the regulator (Radiation and Nuclear Safety Authority – STUK).
- Finland: public concerns focused on impact to children and grandchildren (~150 year time frame of concern – not uncertainties over 1 000+ years)
- Sweden: high trust in authorities (government, regulator, implementer).
- Sweden: Land and Environmental Court decided "we" do not know enough now. The Court requested more evidence on performance of the copper canister. How representative is the Court of public concerns? They are not experts in copper but they saw the controversy in the media. Experts do not always agree – this generates uncertainty in the public's mind.
- The implementer (Swedish Nuclear Fuel and Waste Management Company – SKB) has to manage and take responsibility for all uncertainties, not just the ones discussed in the media. We need to explain how we are addressing the uncertainties that really matter, as well as those that are raised by the public: putting uncertainties into context.
- Sweden: non-governmental organisations and municipalities want to be involved through the entire licensing process.

3. Uncertainty and the media

- Climate change and sustainability are higher up the media agenda.
- Media is sensitised to risks of terrorism and nuclear accidents – inflating the (relatively small) risks.
- Uncertainty can be weaponised to cast doubt on claims, arguments and evidence.
- Media can distort or disseminate false information – this generates uncertainty.
- There are few positive case studies (stories/dramas) on nuclear – but lots of dramatic or frightening examples.

4. Other

- Younger generations may not be so accepting of the need for geological disposal compared with older people who have experience of the nuclear power industry. Need to communicate the benefits of a repository.
- Uncertainties increase with time but the radiological risk diminishes over time due to natural radioactive decay. Water quality may be the main long-term concern.
- Does "further research" reduce uncertainty? Research can reveal "surprises" e.g. unforeseen complexities and associated uncertainties.
- Public hearings can involve the public in the decision-making process – even the safety assessment (Canadian example – public can suggest choice of habitats and foodstuffs in biosphere assessments). Extended peer review beyond the scientific community can increase confidence.
- What are the regulatory requirements for managing or communicating uncertainty?

Results of group 4

What are good examples of communicating uncertainty and why? What can we learn from these from the disposal of radioactive waste?

1. Weather

- A probability of rain is presented, so that the audience can take informed decisions. The forecaster is generally trusted as an honest information provider as they have no particular axe to grind (independent).
- Extreme weather events (e.g. flooding, earthquakes, and tsunamis) may be described, for example, as a "one in a hundred year event". This information may be helpful for future planning (e.g. where to build/not build), again enabling the recipient to understand the risk and make an informed decision.
- In Switzerland "hazard maps" provide information on the risks of certain areas to inform building development decisions.

2. Caesium in mushrooms (Finland)

Government communication concerning caesium present in forest mushrooms; which was stated as having no significant health impact, with the further advice that any risks could be reduced by cooking the mushrooms. This was regarded as a clear message also providing practical advice. Finnish people continue to enjoy their mushrooms (more so than had they been advised to cook all mushrooms).

3. Life expectancy when critically ill

- Doctors are careful about how to communicate (and some medical websites allow the user to specify the level of information they wish to receive), which may range between best and worst outcomes or a simple life expectancy – respecting the stakeholder's right to clear information, but also the fact that they may not wish to know all the details.

4. Travel and traffic information

- Information on traffic intensity and navigation systems has improved in the last decade – providing advance warning of problems that may enable the recipient to take appropriate mitigation.
- Warning signs (such as for rockfall) allow the information recipient to accept the risk and travel anyway or find an alternative route.
- Generally people give little thought to the risks of travel as they are more focused on the benefit of getting to where they want to go. Where there is fear (e.g. a fear of flying) it may be more related to the level of control and known experience rather than a rational decision based on evidence.

5. Green electricity (Germany)

- The majority of people see the benefits and are prepared to accept the risk of loss of energy supply (when no sun or wind). This attitude may change at the first blackout!

6. Cigarettes

- "Smoking kills" – direct, sensationalist communication on cigarette packets. This is designed to promote certain behaviour (stop smoking) rather than giving unbiased information to enable an informed decision.

7. Health issues – vaccination

- Poor and imbalanced communication concerning the risks of vaccination for children led to fear and negative consequences (significant drop in vaccination rate leading to epidemics).

8. Environmental (plastics)

- Sensationalist communication gains interest and engagement, particularly from younger generations. This type of communication is effective in changing behaviour and habits.

Relevant learning for communication regarding radioactive waste disposal:

- Provide clear information that enables people to make good decisions in the face of uncertainty.
- People will feel they have more ownership of a decision if they reach the conclusion themselves (being guided by clear information, rather than being told what to think).
- Uncertainties are likely to be seen as more acceptable when presented in a context that is familiar to the audience.
- Explain what is being/can be done to reduce uncertainty, or when you may expect to have more information.
- Present uncertainties openly and competently (to reduce the risk of uncertainty being used by detractors to cast doubt).
- Keep the disposal system flexible for as long as possible in order to be able to respond to changing uncertainties.
- Use graphical presentations where possible, do not overly quantify.
- Recognise that sometimes the audience may not want to know all the details.
- Trust in the information provider is essential. There will be more trust in independent experts; enable communities to engage their own experts.

Some lessons learnt

- Uncertainties and unresolved issues should be addressed openly and competently to build confidence. If stakeholders perceive that uncertainties are being downplayed, they are more likely to interpret the uncertainty as a threat.
- Stakeholders want to receive information they can trust, in order to be guided in coming to their own decision (which may include a risk assessment based on the uncertainties). They want to be able to form their own view as to whether risks are acceptable and, where possible, to have some control in mitigating the risks.
- In order to trust technical information, stakeholders first need to trust the integrity of the information provider.
- Uncertainties are part of daily life; in particular they are "business as usual" for scientists. It is worthwhile to communicate that repository development is not an exception in that respect.
- It is important to distinguish between risks (potential for harm) and uncertainties (lack of knowledge) in communicating about safety.
- Not all uncertainties are the same – stakeholders may be willing to accept some uncertainties but not others; hence, it is important to understand stakeholder values and concerns. Uncertainties should always be presented in a context to which the stakeholder can relate. The more familiar an uncertainty, the more likely it is to be accepted (e.g. uncertainties regarding travel, weather, medical X-rays).
- Different generations can have different approaches to accepting uncertainty – it may be easier for younger people to accept uncertainty.

Further reading

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The Forum on Stakeholder Confidence (FSC) was established by the NEA Radioactive Waste Management Committee (RWMC) in the year 2000 and fosters learning about stakeholder dialogue and ways to develop shared confidence, informed consent and acceptance of radioactive waste (RW) management solutions. The FSC provides a setting for direct stakeholder exchange in an atmosphere of mutual respect and learning.

The Integration Group for the Safety Case (IGSC) is the main technical advisory body to the RWMC on the deep geological disposal, particularly for long-lived and high-level radioactive waste. The mission of the IGSC is to assist member countries to develop effective safety cases supported by a robust scientific-technical basis. In addition to the technical aspects in all developmental stages of repository implementation, the group also provides a platform for international dialogues between safety experts to address strategic and policy aspects of repository development.

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