Deliverable D10.15: UMAN -

Pluralistic analysis of uncertainty related to human aspects

Work Package 10

Uncertainty Management multi-Actor Network (UMAN)

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What is WP UMAN about?

Decisions associated with Radioactive Waste Management (RWM) programmes are made in the presence of irreducible and reducible uncertainties. Responsibilities and role of each stakeholder, the nature of the RW disposal programme and the stage of its implementation influence the preferences of each category of actors in approaching uncertainty management. EURAD WP UMAN carries out a strategic study about the management of these uncertainties. This study is based on extended exchanges of the experience accumulated in the national RWM programmes by a broad range of stakeholders representing WMOs, TSOs, REs and civil society, as well as on a review of knowledge generated by past and on-going R&D projects, and findings of international organisations (such as IAEA, NEA, etc.).

UMAN discusses the classification schemes and approaches applied to the uncertainties management and identifies possible actions to be considered in the treatment of uncertainties. The relevance for safety of the uncertainties associated with site and geosphere, human aspects, spent fuel, waste inventory, spent fuel and near-field, as perceived by each type of the above mentioned stakeholders, and approaches used by these stakeholders to manage these uncertainties are explored via questionnaires, workshops and seminars, with the aim to reach either a common understanding on how uncertainties relate to risk and safety and how to deal with them along a RWM programme implementation, or, when agreement cannot be achieved, a mutual understanding of each individual view. As result of these activities, UMAN identifies uncertainties assessed as highly significant for safety and associated R&D issues that should be further investigated.

This Work Package (WP) of EURAD includes the following tasks:

- Task 1 - Coordination, interactions with Knowledge Management (KM) WP & integration
- Task 2 - Strategies, approaches, and tools
- Task 3 - Characterization and significance of uncertainties for different categories of actors
- Task 4 - Uncertainty management options and preferences of different actors across the various programme phases
- Task 5 - Interactions between all categories of actors including civil society

Interactions between the different tasks and types of actors including civil society are central to this WP. These interactions take place notably through workshops (Task 4) and seminars (Task 5) where the significance of identified uncertainties (Task 3) as well as possible strategies and options to manage them (Tasks 2 and 4) are discussed.

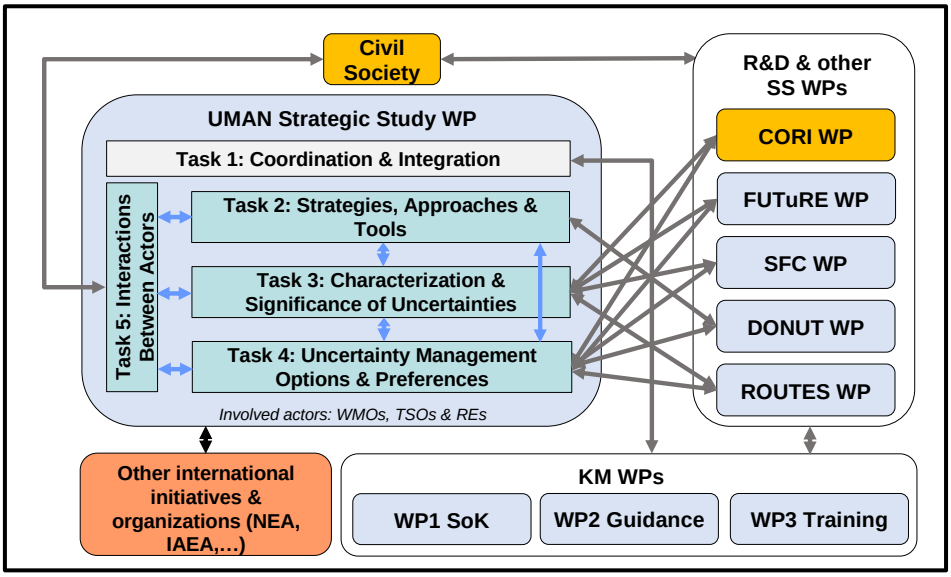

Figure 1 – UMAN WP structure and interactions

Executive Summary

This deliverable provides information about the work carried out in UMAN Task n°5 - *Interactions between all categories of actors, including civil society* in the frame of Subtask 5. 1 – *Preparation, support and reporting of pluralistic analyses*. Task 5 adapted the initial work plan and focused in seminar 3 on human related uncertainties. In this seminar, actors' views on these uncertainties and the management options for the most safety significant uncertainties were discussed together.

Various inputs were used for this deliverable on human related uncertainties but the main material came from a seminar held on 14-15 June 2022 ("UMAN seminar 3. Management of uncertainties related to human aspects"). The report provides a description and interpretation of the seminar and its outcomes.

In Seminar 3, uncertainties related to human aspects were discussed by using different cases. Results from the discussions of the different cases suggest requirements that are sometimes conflicting according to the type of situations:

- Necessity to repack or repair damaged waste packages when reversibility allow it versus the interest to have a staged backfilling to close the facility faster if a war does happen,
- Need to let the public know that security aspects are taken into account, with procedures where public would take part versus not disclosing in detail the measures in order not to facilitate a malevolent action,
- Regarding involuntary intrusion of future generations, only a few stylistic scenarios are considered due to missing information regarding their behaviour versus ethical duty of the generation responsible for generating the waste to speculate on the future to better prepare it.

Therefore the first main conclusion of the seminar is that there should be a "fine tuning" of the requirements, balancing the various aspects, which requires not only technical investigation but also social and political: civil society has clearly a role to play in this respect. This fine tuning may be adapted continuously in order to take into account the evolution of society's expectations and knowledge.

The second main conclusion is that it is worth investigating more in detail the concept of rolling stewardship, as it could be a way to manage interactions with civil society all along the phases of the process of geological disposal.

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Acronyms

ANDRA Agence nationale pour la gestion des déchets radioactifs

CS Civil society

CSI Civil society involvement

DGR Deep geological repository

EURAD European joint programme on Radioactive waste management

FEP Features, events, processes

GDF Geological Disposal Facility

GRS Gesellschaft für Anlagen und Reaktorsicherheit (Society for Plant and Reactor Safety)

IAEA International Atomic Energy Agency

ICS Interaction with civil society

INSAG International nuclear safety advisory group

IRSN Institut de Radioprotection et de Sûreté Nucléaire (French Institute of Radioprotection and Nuclear Safety)

NIMBY Not in my back yard. The NIMBY syndrome refers to the attitude that consists of approving a project as long as it is carried out elsewhere, or refusing a project close to one's place of residence.

NGO Non-governmental organisation(s)

NTW Nuclear Transparency Watch

R&D Research and development

RE Research entity

RWM Radioactive waste management

SA Safety assessment

TSO Technical safety organisation

UMAN Uncertainty management multi-actor network

WMO Waste management organisation

WP Work package

1. Introduction

This report provides information about the work carried out in *UMAN Task n°5 - Interactions between all categories of actors, including Civil Society*. According to UMAN's WP description, the objectives of Task 5 are:

- To develop a common understanding or understanding of the different viewpoints among the different categories of actors on uncertainty management and how it relates to risk & safety and whether and why a safety case is robust vis-à-vis uncertainties.
- To share knowledge/know-how and discuss common methodological/strategical challenging issues on uncertainty management among a broader group of actors.

More specifically, the report is addressing Subtask 5. 1 – *Preparation, support and reporting of pluralistic analyses*, Topic 2: *Pluralistic analysis of uncertainty pictures* and Topic 3: *Uncertainty management option*, focusing the analysis on uncertainties related to human aspects.

This activity consisted in several meetings of preparation and, mostly, in the organisation of the Seminar 3, held on 14 and 15 June 2022. For several reasons developed in the following section, coming from the feedback of Seminar 1 and various activities previously carried out in WP UMAN, it was decided during the preparation meetings to deal with Topic 2 (uncertainty pictures) and Topic 3 (management options) together during the Seminar 3, but focussing on one type of uncertainties, i.e. those associated with human aspects.

2. Conception and preparation of the seminar

The focus of the Seminar 3 has been modified from the initial planning, in a similar way as for Seminar 2, as described hereunder.

In the UMAN Subtask 5.1, the Topic 1 focussed on the "*Meaning for different actors of uncertainty management and of its relationships with risk, safety and the safety case".* It has been mainly addressed through the Seminar 1, summarized in the Deliverable D10.13 [1]. As explained in deliverable D10.14 [2], one feedback of this seminar and other workshops organised by UMAN was the need to discuss the very abstract concepts associated with risk, safety and safety case around concrete examples. Also, when preparing Seminar 2, focussing only on the Topic 2 initially defined as "Uncertainty pictures at different steps of a geological disposal programme" but covering the various specific domains (site and geosphere, human aspects, etc.) would have required to rely on milestones that were not totally finalized. To the contrary, important work had already been achieved on the management of site and geosphere related uncertainties and it offered a panel of concrete examples around which discussion could be held on topics 2 (evolution of uncertainties), 3 (management options) and 4 (pluralistic assessment). It was thus decided for Seminar 2 to dig a specific domain, namely site and geosphere, on concrete examples and scenarios and address in a same meeting the various topics. The results of Seminar 2, held in October 2021, are presented in Deliverable 10.14 [2].

The same approach was decided for the UMAN Subtask 5.1 Seminar 3, i.e., sharing views of different actors on uncertainty management options throughout the different phases of DGR implementation as well as on governance and interactions between stakeholders, with discussions based on concrete examples of uncertainties related to human aspects. The examples have been selected taking account of the uncertainties discussed under workshop 2 of task 4, held on 4, 11 and 23 June 2021. They are issued from the list elaborated under subtask 3.4 (characterization of human related uncertainties).

The preparation of the Seminar notably consisted in establishing the list of uncertainties to be discussed and elaborating the case studies. In order to foster discussion, 9 concrete cases have been created for all uncertainties to be discussed as follows (see also Table 1):

- 8 concrete cases related to the 4 uncertainties extracted from the list of 10 uncertainties identified by subtask 3.4 (characterization of human related uncertainties) as most relevant for further research. The uncertainties were the same as the 4 uncertainties addressed during workshop 2 of task 4. For each uncertainty, two concrete cases have been created;
- One concrete case has been added, as suggested by the war context in Ukraine.

The audience of the seminar has been distributed in 4 discussion groups; each group discussed two concrete cases illustrating the uncertainty, plus the extra case which was common to all groups.

Table 1 details the uncertainties and the 9 concrete cases discussed within the groups.

Table 1 - Types of uncertainties and concrete cases related to human aspects discussed during seminar 3

Uuncertainty addressed	**Concrete case**	**Discussion group**
Public acceptance	Integration of public acceptance in the site selection process	#1
	Characterisation of public acceptance and interactions with the concerned public	
Schedule to be considered for implementing the different phases of the disposal programme	Consequences of postponement on safety	#2
	Safety issues due to a tight schedule	
New knowledge	New uncertainty arising through R&D	#3
	"New" knowledge emerging from monitoring	
Adequacy of safety-related activities in construction phase for the implementation of safety provisions	Construction problem due to a failure in the quality management system	#4
	Accident during operation due to a lack of safety culture	
Disposal security (Additional case)	Security issues linked to a national emergency	All

As for the Seminars 1 and 2, a participation of around 40-50 people was envisioned, gathering various kinds of actors, i.e. those represented in UMAN (half UMAN partners of task 5, half coming from tasks 3 and 4), namely WMOs, Res, TSOs as well as CS representatives including some members of the CS larger group, but also invited people from EURAD consortium and outside the consortium, notably some representatives of the regulatory authorities. An equilibrium between the different types of actors was searched. The seminar was held in a hybrid mode: participants could attend either in-person at IRSN premises or online. It lasted one and a half days.

3. UMAN seminar 3

After a few words of "welcome", a presentation of the agenda of the seminar (see Appendix A), of the rules of the hybrid meeting and of the objectives and methodology of seminar 3, according to the terms of references for participation to UMAN seminars (see Appendix B), the seminar unfolded in two parts:

- presentations of the views of actors on uncertainties related to human aspects, were provided by representatives of WMOs, REs, TSOs and CS on the 4 types of uncertainties selected, i.e. 16 presentations followed by questions an answers,
- discussions in four working groups and restitution of these discussions for general conclusions.

3.1 Part I of the seminar: key lectures on the views of actors on uncertainties related to human aspects

This session aimed at presenting the views of the four types of actors (Waste Management Organisations, Technical Support Organisations, Research Organisations, Civil Society actors) on the 4 identified topics related to human aspects uncertainties.

Each type of actor presented the key uncertainties for each topic and the most suitable options to manage them (meaning reduce, avoid, or mitigate them).

The information provided by each speaker was based notably on the outcome of other UMAN tasks.

3.1.1 Introductory session

As an introduction to the seminar, it was recalled that 4 topics were chosen for the discussion, already discussed in tasks 3 and 4, plus one specifically introduced by task 5 due to the war situation in Ukraine (related to security aspects).

The first 4 uncertainties have been chosen from the list of 10 uncertainties identified by Subtask 3.4 [3] and selected for further investigation by UMAN (Subtasks 3.4 and 4.3). These are:

- Public acceptance of the repository at potentially suitable or projected locations
- Schedule to be considered for implementing the different phases of the disposal programme
- New knowledge
- Adequacy of safety-related activities (in siting, design, construction, operation and closure) for the implementation of safety provisions

The complete list of the 10 uncertainties is recalled hereunder (Table 2):

Table 2 - List of uncertainties selected by UMAN subtasks 3.4 and 4.3 for further investigation

A: Process for the identification of a workable set of repository requirements
B: Continuity of the waste management policy along political changes
C: Robustness of the presently considered safety requirements with regard to the long term
D: Public acceptance of the repository at potentially suitable or projected locations
E: Schedule to be considered for implementing the different phases of the disposal programme
F: Robustness of the safety case vis-à-vis sociotechnical factors
G: New knowledge
H: Adequacy of safety-related activities (in siting, design, construction, operation and closure) for the implementation of safety provisions
I: Robustness of safety performance vis-à-vis possible cyber-attacks or programming
J: Availability of well-educated human resources and relevant experts in radioactive waste management along the repository lifetime until closure

For each of these 4 uncertainties, the presentations were prepared by respectively a representative of a RE, a WMO, a TSO and a Civil Society expert, and reviewed by other representatives of these types of actors so that all views were accounted for. The presentations were structured by the following questions:

- What are the key uncertainties, for the considered type of actor, for the topic and what is their impact on safety?

- What are the available options to manage these uncertainties and the pros and cons of each option, and what are the best options to manage them?

3.1.2 Topic 1: uncertainties related to public acceptance

3.1.2.1 Key uncertainties

WMOs perspective:

The key uncertainties may be expressed in terms of the following questions:

- Will the siting process be successful?
- Are the approvals obtained today stable enough, will there be a reversal in the future?
- What will be the resulting constraints for the WMO on the planning, design and siting of the surface facilities?
- How to meet the expectations of different stakeholders (here including civil society) on various post-closure issues (e.g. post-closure monitoring, radioactive waste recoverability for 500 years) and on the overall decision-making?
- What will be the resulting constraints for the WMO in terms of schedule?

They are influenced by factors such as:

- The “vertigo” of a very long timescale that no one is used to: planning for safety at up to 1 Ma, prediction of site/repository evolution
- NIMBY: nobody likes to get a waste repository near their home
- Prospects for new technologies
- Trust undermining (by lack of transparency, by political games, by misinformation from opponents)
- Hazard/accidents in the first phases
- Interactions between various repository projects

TSOs perspective:

The key uncertainties related to public acceptance are listed hereunder:

1) Impact on the schedule for a radioactive waste disposal project - potential delays:

- Decision-making process and stakeholders engagement process,
- Changes in political circumstances (local, national and international level),
- Safety requirements changes due to:
    - evolution of regulations (e.g. in a decade or two) and
    - requirements from stakeholders,
- Use of additional time for safety improvements and mitigation of safety uncertainties.
- Possible impacts on the safety of storage facilities (due to delays) which increase with time.

2) Impacts of public acceptance during the disposal phases (reversibility of decision after site selection):

- Results of site characterisation and safety case,
- Possible impacts on the safety due to delays,
- Options for change of decision after construction and operation – no real, although there are some initiatives to make this possible.

Research Entities perspective:

First, it should be stressed that the public has the last word.

There are two types of suitability: scientific/technical and public acceptable:

- Technical/scientific uncertainties impact as well public acceptance

- Our decisions should reflect a proper scientific and technical understanding so that the public decisions can respond to the needs of the public.
- However, uncertainties in public acceptance do not necessarily diminish with increasing technical knowledge.

Furthermore, the term "acceptance" appears to research entities orienting in the wrong direction implying a 2-step process:

1) the disposal concept is developed by engineers and scientists and, then,
2) there are the people who shall accept.

Instead we shall develop a process that looks for public consensus fully integrated in the repository project and attributes some power to key actors.

About the safety significance of this uncertainty, research entities consider that these uncertainties do not have a direct impact on safety but, rather, they might have indirect impacts due to a national waste management program being delayed or even cancelled (see under: "schedule uncertainty").

The uncertainty arising from the public acceptance may not necessarily decrease over time. In the planning phase, the degree of consensus of the public regarding the waste management programme might be higher than at the moment of site selection. A new challenge on the consensus will appear when the decision is to be made to start constructing the repository and emplacing the waste.

The following quote illustrates this:

> *"Over the last half-century, implementers of national waste management programs in more than a dozen countries have launched at least 24 efforts to site a deep-mined, geologic repository. In only five of these efforts a site was chosen. Nearly one-half of the initiatives prematurely ended because the projects failed to gain and sustain social acceptability [4]".*
>
> *Actually, in half of the cases studied in the above analysis, uncertainties in public acceptance became so high that the project was cancelled. See also the discussions in the report "Reset of America's Nuclear Waste Management Strategy and Policy [5]*"

In general, there are large uncertainties in the evolution of public consent over the multiple decades of a waste management and disposal programme. There are variations related to what is considered "safe" by different stakeholders, and these perceptions may change over time.

The degree of public consent and involvement can be affected by many psychological, cultural, and societal factors, including political changes, changes in the individual preferences, world views and concerns for future generations, changes in the community priorities, information, communication and unexpected events that are linked to nuclear technologies.

In addition to these factors, it is difficult to measure public consensus, requiring the use of advanced methodologies from the social sciences and humanities (SSH) and the careful design of the experimental conditions.

<u>Civil Society perspective:</u>

First, the **relevance of public acceptance in regard to EURAD and UMAN** was presented:

- It was recalled that EURAD recognises and supports Civil Society Involvement (CSI) in regard to safety, supported by the UNECE Aarhus Convention, and that the UMAN perspective on CSI regarding safety follows this track. Both EURAD and UMAN include safety-related research on public acceptance of a GDF as part of CSI in their goal definitions.
- However, there **is a crucial question to be answered: if public acceptance as part of CSI is inherently related to safety, should it be viewed as an uncertainty or as an uncertainty management strategy? It cannot be both**.

- The premise for answering this question is that acceptance or non-acceptance are the ultimate manifestations of the views of the public on any GDF. In regard to the public itself, there is no higher instance.
- Furthermore, public acceptance or non-acceptance do not only have to be related to safety. Other motives (political, financial, etc.) can play a role.

Then the respective status of **acceptance** and **acceptability** must be clarified: is public acceptance preceded by public acceptability, which would then become a necessary prerequisite for public acceptance, and can public acceptability replace public acceptance?

- Answering both questions in the affirmative would shift the focus from those who bear the consequences of the RWM activities – i.e. the public – to the activities themselves and it could be argued that this is a sort of paternalism (who decides acceptability?). On the other hand, it could also refer to a theoretical framework based on valid ethical approaches.
- Conversely, for the public to accept something that is not objectively from a safety (and any other) point of view acceptable or not to accept something that is, does not make much sense. Public acceptability would at least presuppose minimum agreed on safety standards in RWM. Security considerations would also have to play a role in these standards.
- In conclusion, public acceptability cannot replace acceptance, only supplement it.

Regarding the **relevance of public acceptance in regard to CS involvement**:

- In an open, democratic society, public acceptance of any GDF is a goal in itself.
- As part of an uncertainty management strategy, public acceptance can, in a deliberative process framed by a strong implementation of the Aarhus Convention, confirm sound safety solutions. Conversely, public non-acceptance can be a corrective to unsound safety measures.
- Thus, public acceptance and non-acceptance can change over time, especially if safety measures are perceived as better or proven wrong.
- Also, even if it is seen only as a means to succeed with final disposal of RW – which could be the case by some of the WMOs, TSOs and REs – one could argue that the achievement of public acceptance is one of the main reasons for the EURAD 3+1 dialogue itself.

Who are the stakeholders and how does acceptance manifest itself?

- Who are the **stakeholders** in terms of public acceptance of a GDF? Based on EURAD/UMAN identification of the different categories of actors involved in each phase of a RW disposal programme in terms of safety case-related activities:
  - FIRST CATEGORY: WMOs, TSOs and Res.
  - SECOND CATEGORY (as identified by the first category): RW generators, RW owners, regulators, governments / legislators, ministries, municipalities, state authorities, civil society, environmental actors, NGOs, geological surveys, technical surveys, operating companies, technical consulting companies and miscellaneous actors.
  - The actors and their functions in different phases of a RWM programme depend on:
  - The current phase of the national RWM programme, (ii) the applied approaches and strategies, (iii) the national legislative, regulatory and organisational framework ('national framework') for spent fuel and RWM, (iv) political and administrative systems and finally (v) the stage of adaptation of older RWM programmes to the obligatory international standards.
- About the **public**:
  - Definition of THE PUBLIC in the Aarhus Convention, Article 2, 2(4-5): One or more natural or legal persons, and, in accordance with national legislation or practice, their associations, organizations or groups.
  - THE PUBLIC CONCERNED: The public affected or likely to be affected by, or having an interest in, the environmental decision-making; for the purposes of this definition, NGOs promoting environmental protection and meeting any requirements under national law shall be deemed to have an interest.

  - However, no definition of PUBLIC ACCEPTANCE and the concept does not exist as a legal term.
  - CONCLUSION: “The public”, “acceptance” and “public acceptance” in regard to RWM are to a certain degree context-specific notions which could signify different things dependent on e.g. the perspectives of the actors who need it to start or continue activities or those who will bear the consequences of these activities.
- The big question is: how many of the afore-mentioned actors could partake in public acceptance of a GDF? Who should have moral and legal standing in the decision-making process?

Ethical aspects: **equity, fairness, consensus and consent:**

- Consideration of equity and fairness: in regard to ethical analysis, it makes a difference, if a group of persons accepts a higher level of risk in order to gain advantages, or the risk is put on them by another group of persons for them to gain these advantages. Individual and collective acts are only permissible when they are approved by those whose rights and interests are at risk.
- Consent cannot be obtained from all the affected parties in every situation. But it must be assumed that people, who normally would be unwilling to accept a particular risk, would be inclined to submit to a decision-making process, which is embedded in a fair and democratic structure, respecting the integrity of individual rights.

Finally, the special case of transnational facilities is mentioned:

  - Public acceptance of shared, transnational nuclear facilities, particularly final repositories for RW, probably plays a bigger role in regard to civil society involvement than for national facilities that are not shared. More stakeholders in more countries are in play, the intensity of their concern is deeper and public acceptance has a broader meaning.

3.1.2.2 Management options

WMOs preferences:

The following management options may be used to reduce and mitigate the uncertainty:

- Stepwise process;
- Fair, sustainable, transparent, safety-oriented procedure for the search for and selection of repository sites;
- Continuous, intense dialogue with stakeholders throughout the phases:
  - participation of civil society, young generation involvement; use of serious games that increase the stakeholders understanding of the problematic aspects ;
  - communication always science and solid knowledge based, formal conferences to present and discuss results and questions from WMO at different levels;
  - communication concept that fits into and complement the communication strategy of the governing bodies and the regulator;
- Popularisation of science, with a focus on new generations;
- Search for communes volunteering for hosting a disposal facility, development of local partnerships in preselected localities, addressing their potential economic concerns;
- Independent reviews (by the regulator and its TSO, by other independent experts, e.g. oversight committee);
- Notion of radioactive waste ecosystem that can enhance confidence, because of the management of knowledge in the nuclear network, not only one single actor.

TSOs preferences:

The following management options are considered as the best ones:

- Implementation of a participative and transparent decision-making process at each phase. It is important to develop long-term strategies (e.g. rolling stewardship), also supported by legal decisions to strengthen the position of a potential host community;
- Flexibility of the RW management options (timetable and radioactive waste management options);
- Consideration of alternative scenarios: it is useful to consider the whole RWM-programme with a scenario where the disposal facility construction is finally postponed or abandoned;
- Development of a motivation programme including possible financial contributions and other benefits.

REs preferences:

Trust is major factor:

- Public acceptance cannot be increased simply by adding more R&D or more communication about safety;
- The uncertainty on public acceptance cannot be avoided by the managers of a disposal program;
- It needs to be addressed by a continuous, transparent and rule-based process of stakeholder engagement. The key to management of this uncertainty is the **creation of trust** among the key actors;
- Many examples of past failures can be explained by the absence of trust in the stakeholder engagement process:

> Many national programmes have restarted all over in the past and one may expect similar things in the future. Examples are Sweden, Germany, the US, the UK, France, Switzerland among others. Some of these countries have now developed more stable management approaches of new concepts including public engagement while others still struggle. For a review of past attempts to site repositories, see D. S. Metlay, 2016, [6] and US NWTRB, 2015 [7]

The management by **building trust** needs to:

- Acknowledge, that:
  - Trust is difficult to gain but easy to loose
  - Trust cannot be achieved by objective information on calculated safety of future generations
- Public acceptance cannot be rushed, nor can public acceptance be increased by simply more R&D or communication.
- A trust-building process requires a long lasting continuous dialog independent from future decision points. There is a risk of eroding trust if public involvement is not continuous.
  - For instance, during the process of siting a L/ILW near-surface repository in Romania, the lack of communication between local community at Saligny and the WMO after 2011 brought a mistrust on the implementer intention regarding construction of the repository on that site. The public acceptability was high in the period 2008-2011, and it raised again once the dialogue was re-established.
- The trust-building process requires as well to have clear rules, powers, and responsibilities, engaging all actors.
  - For example, the definition and maintenance of transparent and clearly defined site selection criteria was a very important step in the restart of the German waste management program. Elected representatives of the citizen (nationales Begleitgremium) have the legal power to oversight the waste management program of BGE
- A continuous and iterative trust-building process involving stakeholders reduces the uncertainties on delays of programs due to the lack of public acceptance.

We should take into account the feedback from **examples of lost trust in managing public engagement**, namely:

- The Asse mine in Germany,
  - Formally it was never intended as a real repository but just as a test site for disposal on land operated by the German ministry of research (other countries at that time still disposed waste in the ocean).
  - Yet, after large waste volumes from industrial production have been disposed off without clear permission, trust from the public has been lost and a law was issued to retrieve all the waste. This retrieval process may last until 2060, thus, much longer than the waste emplacement.
  - A place for interim storage must be found avoiding transport all across the country
  - Strong opposition
  - There may be as much radiological risks during retrieval and surface storage as they are in disposal.
  - It is an example of the close link between public acceptance, clarity and transparencies in objectives, trust, regulations, sticking to rules, uncertainties, and safety.
- The accident in the US WIPP repository
  - An example, how, by non-respect of waste acceptance criteria by individual workers and by insufficient controls, public confidence may get lost.
  - This accident had impact in the public dialog creating mistrust in repository projects worldwide.

Two **points of disagreement** with other actors are emphasized:

- Research entities disagree to the optimism of WMO and TSO driving for mitigation by implementation of “good risk management strategies”, “best practice”, “robust planning”, etc. Optimism may lead to overconfidence about operational safety and procedural approaches, which may result in managers being caught by surprise if a real problem (event/accident) arises, as shown with the accident at WIPP.
- Like for any complex industrial project, accidents at a repository project will happen. It is thus preferable that managers are prepared to have to deal with “normal” and even “heavy” accidents.

Civil Society preferences:

The example of the decision-making process in the United Kingdom for the implementation of the geological disposal, working with communities, is worth being mentioned. Six phases are identified in achievement of public acceptance of site selection for a GDF:

1) **Initial discussions on forming a working group** (WG). The WG identifies the geographical area in which the RWM delivery body will seek potentially suitable sites for a GDF and invites all relevant principal local authorities;
2) **Community partnership**. Including community members, organisations, the RWM delivery body and at least one relevant principal local authority. The Community Partnership shares information with the community and finds answers to questions about geological disposal, the siting process and how the community could benefit;
3) **Community partnership agreement**. Signed by the prospective members of the Community Partnership and setting out the principles of how they will work together;
4) **Community partnership funding**. The U. K. Government makes funding available annually for each community that forms a Community Partnership;
5) **Right of withdrawal**. A community can withdraw from the siting process at any time (‘*municipality veto*’) up until it has taken a Test of Public Support;
6) **Test of public support**. Before a decision is made to seek development consent from the U.K. government, there must be a Test of Public Support by the community to demonstrate it is willing to host a GDF. Relevant principal local authorities on the Community Partnership will have the final say on when to undertake this test. For this test, there are currently three main mechanisms that could be used: a local referendum, a formal consultation or statistically representative

polling. if new methods to test public opinion emerge in the future, the Community Partnership may wish to consider a different approach.

Two vital questions are identified:

- How does the afore-mentioned framework obtain a **long-term perspective and an intergenerational dimension**?
- What **means of persuasion** are legitimate in order to gain public acceptance? Money, other benefits, etc.? Are support programmes in preselected localities legitimate and if so, what should they contain?

3.1.3 Topic 2: uncertainties related to the schedule to be considered for implementing the different phases of the disposal programme

3.1.3.1 Key uncertainties

WMO perspective:

These uncertainties have been described by the following questions:

- Is the planned schedule robust enough?
- What are the consequences of potential delays of initial construction of the repository?
  - in terms of costs, funding, and human resources (potential loss of skills and knowledge)
  - in terms of robustness of the decision for construction (e.g. changes of support at the national political level and/or of the local decision makers (jobs))
  - in terms of relations with the waste producers (e.g. need for extended interim storage)
- What are the consequences of potential changes in waste packages shipments schedule (quicker or slower)?
- What are the consequences of programme (??) delays on safety (longer interim storage, delayed transition to full passive state…)?

The uncertainty on the schedule has an impact on safety through waste packages ageing and rock and structures behaviour.

Factors that influence the schedule are:

- The actual schedule is the result of a mixture of technical constraints and of strategies of the various actors, with sometimes opposite interests, leading to unreducible uncertainties;
- Multiplicity of official regulators and how they are involved (nuclear, radiation, environmental, …);
- Conditions for agreement of the safety case by the regulator, resources to judge the safety case;
- Political uncertainties.

TSOs perspective:

Delays (e.g. delayed decision, lack of resources) in or a sudden stop of the program (e.g. due to economic breakdown, war) may or will have a negative impact on the safety:

- They prolong the need for long lasting maintenance (in particular due to ageing processes) and active measures to ensure safety and security of the facilities (both storage and disposal facilities);
- They may lead to insufficient interim storage capacity,
- Possible impacts on the safety of the repository could be critical if delays are experienced during the construction, operation and closure phases (not in the siting phase),
- They increase costs, which may lead to poor execution of future activities due to lack of resources,

This results in increasing burden on future generations.

They are related to:

- the decision making process (multiplicity of official regulators and how they are involved (nuclear, radiation, environmental, …)) and safety requirements changes,
- political and societal changes.

Research Entities perspective:

First, it is noted that worldwide essentially all waste management programmes have experienced large delays, and uncertainties in schedule continue. The associated uncertainties need to be considered in a stepwise management strategy considering both social and technical criteria.

Regarding the factors influencing the uncertainty on the schedule, it was noted that:

- the concept of retrievability (that can be added to a disposal concept to increase public acceptance) may have a strong impact on schedule.
- schedule uncertainty concerns also the provision of sufficient financial and raw material resources, human resources, transport and construction licences and the availability of appropriate technologies. These other uncertainties may evolve differently.

About the implications of the schedule uncertainties on safety, the REs pointed out the following:

- As geological disposal is a long-term radioprotection measure, any delay in the programme has an impact on overall radiological risk.
  - Inability to implement the disposal strategy will increase the time of vulnerability of surface storage.
  - However, from public debate one has often the feeling that geological disposal is considered riskier than continued surface storage
- Extended surface storage of spent fuel potentially may modify the stability of the cladding, impacting necessary transport precautions, authorizations, waste acceptance procedures at the repository and the repository design.
- There is for example the schedule of closing the repository. Just by non-decision of future decision-makers to close the repository as planned, schedule may largely shift, leading to significant safety implications.
- There are also other impacts on schedule caused by war (about every 70 yr in Europe there is war), financial crisis etc., which all can have strong impacts on vulnerability of installations, etc. These impacts are of arbitrary nature and may occur at any stage of the programme.
- During construction, the schedule may shift due to discovery of formerly undiscovered faults or water pathways, also missing materials, with the right specifications may retard the program.
- Response to public concerns on safety may lead to more redundancy to some safety functions of an already safe concept.
- Foreseen provisions for retrievability require compromises with respect to accessibility. Such provisions are not neutral as regard to the operational safety.
- Delaying the disposal program has not only negative safety consequences (extended storage of spent fuel, accumulation of waste stockpiles….) but due to longer cooling of exothermic wastes it leads to smaller disposal space requirements, which also need to be managed in repository planning.

Civil Society perspective:

The following aspects highlighted by subtask 3.4 [3] have been recalled:

- *The actual schedule is the result of a mixture of technical constraints and of strategies of the various actors, with sometimes opposite interests, leading to unreducible uncertainties.*
- *Multiplicity of official regulators and how they are involved (nuclear, radiation, environmental, …)*

- *Conditions for agreement of the safety case by the regulator, resources to judge the safety case*
- *Political uncertainties*
- *Impact on safety through waste packages ageing and rock and structures behaviour,*

and the following comments were made:

- To what extent should uncertainty on schedule be considered as an uncertainty for safety?
- Postponing decisions can be a condition for improving safety (precautionary principle), taking appropriate time to manage unexpected events or uncertainties
- Differences of views between several authorities involved in the decision might be at the origin of disclosure of problematic aspects of safety (e.g. the Swedish context and the copper corrosion issue)
- However postponing decision requires an appropriate plan B, in order to prevent waste packages ageing and rock and structures behaviour …

3.1.3.2 Management options

WMOs preferences:

The following management options are identified:

- Robust planning, anticipation of delays, flexibility measures (e.g. buffer steps), careful study of the interdependencies between the phases;
- Stepwise approach offering flexibility at each step;
- Robustness of the design against variations of the schedule;
- Intense and continuous dialogue with stakeholders, including neighbours along the waste transportation routes;
- Upstream qualification (outside the critical path): testing of developed approaches and methods before applying them directly to the site selection process, testing of new technologies, industrial pilot phase;
- Monitoring of time sensitive construction steps;
- Knowledge ecosystem;
- Reversibility and retrievability: this is a management option for addressing the uncertainties related to acceptability, schedule and new knowledge, but it creates also uncertainty.

TSOs preferences:

These uncertainties can be reduced and mitigated but cannot be avoided throughout all phases of the disposal facility life cycle (need for risk analysis).

The best options to manage them are:

- Stepwise approach, robust planning, intense participative and communication activities with stakeholders,
- Flexibility measures with appropriate technical and other resources availabilities (management system),
- Monitoring (of the consequences of delays) and developing continuous plans for the mitigations,
- Implementation of disposal program should be able to face changes in schedule (delays or early decisions/actions), including repeated transfer of responsibility to the next generation.

Research Entities preferences:

Schedule uncertainties can only be “managed” if:

1) all key stakeholders are involved in the decision process,
2) one accepts upfront that the schedule will strongly evolve, and

3) any actual schedule is considered only as a guide. One must expect significant delays in the schedule as the normal evolution of the project, thus requiring managers and scientists to accept it as an irreducible uncertainty and move forward. Past experiences have shown sufficient evidence of schedule changes (at the scale of several decades) so one cannot be reasonably optimistic that they can be avoided.

Civil Society preferences:

Again, a quote from subtask 3.4 is recalled:

"Management options:

- *Stepwise approach, robust planning, intense communication with stakeholders*
- *Flexibility measures*
- *Monitoring (of the consequences of delays)"*

And the following comments are provided:

- Stepwise approach should provide due time in order to give proper attention to setting the safety conditions for reaching a new step.
- Stepwise approach should be embedded in a Rolling Stewardship (RS) perspective required by a multi-stakeholder and intergenerational governance, this could involve e.g. :
  - Scheduling a license renewal procedure every 10 years, in order to update the DGR safety case review according to monitoring results and to incorporate updated stakeholder's views
  - There might be big and small steps, leading to foreseen or unforeseen direction.
- Flexibility (reversibility, retrievability, proper funding for alternative options should be part of RS provisions)
- Proper provisions to maintain safety while postponing is requested

3.1.4 Topic 3: uncertainties related to new knowledge

It is recalled that "New" means here that the knowledge:

- may have emerged by research and monitoring
- but also is new only for certain actors:
  - New for actors that would benefit from having it (unknown knowns)
  - or known by certain actors but not taken into account (ignored knowns)

New knowledge is generated through RD&D activities, technology development, etc. and does not refer solely to the monitoring aspects.

3.1.4.1 Key uncertainties

WMOs perspective:

Basically, the new knowledge emerged continuously from research, while monitoring brings increased robustness in the safety assessment (consolidates existing knowledge),

…but it may also create suspicion on the adequacy of the solutions that are implemented along a disposal programme.

This uncertainty may be described in terms of two questions:

- Will new knowledge emerged from research and monitoring raise new safety issues?
- Is the available knowledge duly taken into account?

The development of new evidences, knowledge or techniques may lead to necessary adaptations and optimisation; it may challenge the safety case.

TSOs perspective:

The key elements for TSO in this context are the following:

- New regulatory requirements may be adopted based on new knowledge.
- Misunderstanding of new situation within stakeholders may lead to distrust and non acceptance.

REs perspective:

Assuming sufficient research capacities (both in human resources and critical infrastructures) are invested in all fields (including, in radiochemistry, materials science, geochemistry, geomechanics), new knowledge will continuously be created over the 50 to 100 years of the disposal program. This new knowledge will optimize the repository and improve the operational and long term safety if it is not ignored, for example, if it is used to improve the barrier system or barrier redundancy.

Although some laboratory or computational experiments may be designed to provide new understanding on phenomena of potential safety implications, the significance to safety of new knowledge cannot be known a priori. Rather, this will need to be assessed in the context of specific disposal programs. For this reason, a process of how to manage new knowledge during the 50-100 years of repository operations should be already designed and applied.

New knowledge may be without negative significance for the disposal safety if the expected change in the foreseen repository behaviour remains within the realm of selected bounding cases and safety margins.

Civil Society perspective:

The possibility of new knowledge is inherent to a safety analysis of a long-term process.

New knowledge does not undermine the credibility of the safety review, on the contrary it does contribute to reinforce it.

The question is therefore the extent to which new knowledge can receive due attention in the Rolling Stewardship in order to reinforce safety of the implemented solutions all along the disposal programme.

3.1.4.2 Management options

WMOs preferences:

- At policy level, fair comparative assessment of the GDF and its alternatives: same safety criteria, taking into account the technology readiness level (TRL)
- Reversibility of decisions, that is among others based on potential new knowledge
- Robustness of the safety assessment: conservatism, fuzzy sets, deterministic approaches, scenario analysis (including “what if” scenarios), completeness of FEP catalogues, international exchange etc.
- Iterative process: systematic approach on how to identify new findings, what are their impact on safety, and when shall the safety analysis be renewed. Periodic safety reviews. Return on experience.
- Qualification processes:
  - Qualification of new technologies before their implementation on the repository;
  - Making new and old technologies work together (check differences, study the reasons and the ways to manage it)
  - Industrial pilot phase for monitoring and anticipation of new knowledge
- Strong safety culture and strong regulator (i.e. fully independent and with enough resources to address new issues in a reasonable schedule)
- Implementation of a comprehensive knowledge management strategy that mobilises the various tools recognised for their effectiveness: communities of practice, focus on not only explicit but also implicit and tacit knowledge, inter-generational coaching…

TSOs preferences:

The best options to manage the uncertainties related to new knowledge are:

- Conservatism, robust system, risk analysis (risk matrix, scenario analysis, etc.),

- Systematic approach on how to identify new findings (knowledge), what are their impact on safety, and when shall the safety analysis be renewed, including development of new legal requirements:
  - Regular updating and implementation of the R&D programme,
  - Management system with experience feedback programme,
  - Audits and safety culture.
- Prescribed period of relicensing every 10 years should also be linked with the obligation to establish a monitoring process for new development and exchange with international experiences,
- A stepwise and flexible decision-making process where the validity of assumptions made at one phase is verified during subsequent phases,
- Interpretation of these impacts to the society.

REs preferences:

There are many examples where, due to unavoidable missing knowledge, additional (conservative) safety margins are taken into account as a management strategy for the missing knowledge. An example is the ignorance of cladding stability as barrier in spent nuclear fuel in European repository projects (it is considered in the US program). New knowledge would then allow to "relax" some of the safety margins.

Better understanding of Pu solubility maybe without impact on the predicted doses from a repository, if predicted migration distance go from meters to tens of meters. Even the credibility of calculations might not be significantly increased due to the esoteric nature of the calculation procedures.

The better understanding of Pu solubility may lead to a better judgement of a criticality risk. While limiting the Pu inventories in disposal location might be a good management strategy for this "uncertainty in new knowledge", once better knowledge is available one may allow to put more Pu-containing waste into a disposal place.

New knowledge may be of significance to safety in any phase. Yet, to be useful, new knowledge must be systematically incorporated as the safety case and safety assessment are revised periodically (e.g., every 10 years). As new knowledge is incorporated, one can expect that some uncertainties of safety significance will decrease as a program progresses.

A last example: we may not be entirely sure whether bituminous waste drums would catch fire during disposal if put too close together. Thus, in the absence of such knowledge, one needs to take severe fire protection provisions and keep drums separated. Better knowledge of nitrate contents of each drum may reduce this uncertainty and may allow relaxing some of the imposed constraints.

New knowledge may also identify new risks, which were ignored before in repository planning or construction or safety analyses. While this cannot be avoided, the identification of this "new" risk (if important) shall be considered as beneficial for the overall programme even if it may lead to needed changes of the planning or construction (which changes cannot be managed before new knowledge is generated). Not always will it be possible to provide provision in planning and construction for all foreseeable "new" risk by employing sufficient safety margins.

Finally, the representatives of REs stress two points of disagreement:

- They strongly disagree to the statement saying that "uncertainty regarding the occurrence of unexpected new findings / knowledge may be very difficult or impossible to reduce. Safety-relevant unknown unknowns need to be avoided or reduced as much as possible."
- Here, "new knowledge" is considered only as negatively impacting safety, whereas, in fact, most knowledge can be considered as potentially increasing safety. Of course, new knowledge may show that a system initially considered as safe enough may now show, that this is no longer the case (e.g., variability found in the geological properties). But, in such case, it is not safety itself

that would be negatively impacted by new knowledge but only the false hypotheses about safety made before this new knowledge became available.

Civil Society preferences:

A structure has to be implemented to produce new knowledge and consider its relevance for the DGR (esp. in the far future). Possibly the periodic safety reviews and the renewal of the licenses could be used as points in time to introduce and discuss new knowledge in a democratic, participatory way.

- Such a structure has to be linked to Rolling Stewardship.
- Resources to produce new knowledge have to be ensured (might be a task for research policy)

The transparency of the monitoring results is a key dimension in order to create conditions for new knowledge to fully contribute to reinforce safety.

The scheduling of periodic safety reviews open to public review associated with Environmental Impact Assessment is also requested.

3.1.5 Topic 4: uncertainties related to adequacy of safety related activities for the implementation of safety provisions

3.1.5.1 Key uncertainties

WMOs perspective:

The uncertainty on the adequacy of safety related activities has an impact on both long-term and operational safety:

- Long-term safety: Inadequate safety-related activities in the construction phase potentially affect long-term safety functions of individual components and as a consequence may affect the performance of the whole system in the long-term.
- Operational safety: Inadequate safety-related activities in the construction phase may cause local instabilities (roof falls, collapse of drift face) with consequences to conventional and radiological safety in the operational phase.

Description of the uncertainty was made in the form of questions:

- How to ensure that the safety provisions taken into account in the safety assessment are adequately implemented?
- How robust is the safety assessment vis-à-vis any potential inadequate implementation of the safety provisions?

Factors that influence the adequacy of activities could be:

- Socio-technical aspects :
    - interactions between human and technology
    - interpretation of rules, ignorance, laziness, greed or malice,
    - changes in organization and safety culture, lack of knowledge management, inadequate training

TSOs perspective:

The key uncertainties identified are:

1. Uncertainties on the proper implementation of safety-related activities during construction can have a major impact on both operational and long-term safety
2. A representation of potential construction errors in the Safety Assessment is expected when these errors are safety-relevant and cannot be excluded by the qualification programme, return on experience, …:

- This can be done through conservative assumptions/parameter values,
- specific scenarios and
- by including a poor quality construction FEP-category in the FEP database

3. Socio-technical aspects are at the root of this type of uncertainty:
   - interactions between human and technology
   - interpretation of rules, ignorance, laziness, greed or malice,
   - changes in organization and safety culture, lack of knowledge management, inadequate training

REs perspective:

Construction have long-term and operational safety impacts including deviations from the intended procedures and impacts of unknown consequences of intended procedures as well as accidents caused by geomechanical movements. Unknown consequences may occur as the actual construction work will encounter many issues in the local environment: local changes of rock properties, geomechanical issues, unexpected presence of fluids.

Not everything can be tested before and any repository is in some way a “first of a kind” realization. Any deep mine and as well any repository bear the risk of deadly accidents linked to the interplay of rock mechanics and excavation activities, to unintended fluid movement etc.

The safety significance depends on the role the construction work plays in the barrier system of the repository architecture, but it depends also on the local heterogeneity of rock properties.

With more advanced evolution models, more detailed input data on waste or void spaces or 3D fracture view will be necessary. Construction may in future be accompanied by detailed video mapping and digital twins. This may create new uncertainties relative to preexisting knowledge, where such data where not generated

While the uncertainties in construction activities are of course principally linked to the construction phase, the safety impacts of procedures concern also the operational and closure phases. Some impacts may even occur in the long term (post-closure phase), like for example unexpected fluid pathways are created or high gas pressures cannot be dissipated due to inappropriate construction works.

Also, it needs to be considered that construction (e.g., drilling of galleries) in one area of the repository goes in parallel to waste emplacement in other areas. This coexistence of construction and emplacement phases creates many organisational problems, the most important of which may be that the safety culture of miners and of nuclear technicians is not the same.

Techniques and tools will also change over time, all this learning and improvement will also have unintended and sometimes negative safety implications. It is important to build a strong resilience into the system and of course, strong oversights, audits, etc.

As far as the consequences of construction uncertainties on long-term safety are concerned, one needs to guarantee that the impacts stay within the domains considered as complying with safety expectations, but potential deviation may in some cases only be identified after the construction has been realized.

- Corrective measures would need to be analyzed and engaged on a case-by-case basis concerning the safety significance.

As far as communication is concerned, one shall avoid the illusion of being able to create a repository construction enterprise that will have no unintended safety impacts, accidents, etc. In an industrial megaproject operating over 50 years this cannot be avoided and is “normal”. Therefore, one needs a resilient organisational structure with construction and safety culture that is compatible with this reality, a real learning organisation instead of one, which just applies schematic procedures and insists on compliance.

Between licensing of construction and the actual construction work, there may be decades. This delay may have important consequences:

- New information on the geology may have become available (see new knowledge)
- New software at the time of licensing may have been outdated at the time of construction
- Deviations from a licensed concept may lead to a loss in thrust and imply legal consequences

Civil Society perspective:

The representatives of CS acknowledge the importance of socio-technical aspects at the root of this type of uncertainty and emphasize the role of an enlarged safety culture as a precondition for ensuring continuity of the safety-related activities (see below: management options).

3.1.5.2 Management options

WMOs preferences:

- **Quality assurance**: quality assurance system, traceability, audit of the QA system itself
- **Extensive use of expertise and return of experience:** return on experience from similar activities; each step accompanied by expertise in the different fields (SA, mining, civil engineering…);
- **Safety culture**, mutual understanding of different perspectives/core business (mining vs RP);
- Safety management based on the identification of the **key specific components and activities** that are important with regards to safety
- **Monitoring and inspections**
- **Robust design with regards to safety**:
  - Multi-barrier system, redundancies/diversity, avoidance of common failure modes, defense in depth;
  - Field of human factor separately evaluated in the Periodic safety reviews
- **Independent oversight**: strong regulator, transparency
- **Introduction of new technologies with much care** when they become available: we cannot compare two technologies with different levels of maturity (TRL). Cf. topic “new knowledge”…

TSOs preferences:

The best options to manage this type of uncertainty are:

1. Quality management system and active implementation of safety culture (not just administrative measures),
2. Return on experience from similar activities, continuous learning, international exchange, regular update of R&D programme
3. Monitoring, experience feedback programme (experience gained during construction, international experience, industrial experience and experience from the operation of nuclear facilities), vigilance in involvement of independent peer reviews,
4. Use of proven techniques (BAT); those that are new and need future confirmation through experimental tests should be demonstrated through a qualification programme,
5. Implementation of the Defence in Depth principle: preventing and detecting deviations, maintaining performance (safety margin), monitoring, multi barrier system,
6. Audits, Safety culture, Human factor area to be separately evaluated in the Periodic Safety Reviews.

REs preferences:

REs fully agree to treat the uncertainties in the context of an overall socio-technical system and to point to the need of knowledge management. It takes however a lot of collection of good practices, etc. until full credit from this system can be taken. It is important to insist on a strong safety culture among workers

in the repository. However, given safety may be perceived differently between a miner and a nuclear technician, it is important that the industrial culture of the WMO mixes both aspects in a joint culture.

As concomitant construction/emplacement may occur over a period of 50 or more years, it is difficult to always keep a high level of alert across several generations of workers. Workers will remain involved in the construction site for several decades which will become part of their everyday life environment and thus they will create their own habits, some of them of potential safety significance. As the Ewe proverb goes: “A fish is the last to acknowledge the importance of water”.

One needs to provide an humble resilient approach

Be aware that construction workers will not exactly follow the plan, create their day-to-day life environment in the mine, put beer bottles, where they should not, grow chicken, settle conflicts, get inattentive for construction risks if nothing has happened for 10 years

An important and extremely valuable activity would be to create a common understanding of the operational and long-term safety implications of repository construction as an industrial megaproject over 50-100 years or more.

Civil Society preferences:

The implementation of an enlarged safety culture appears to be a precondition for ensuring continuity of safety related activities.

The term 'Safety Culture' was first introduced in INSAG's Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident, published by the IAEA in 1986 [8]:

> *“Safety culture is that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance.”*

The Safety Culture is addressing the first circle of nuclear actors involved in nuclear safety: governments, regulators, operators, researchers & designers at institutional and individual levels. It involves legal, technical, financial, organisational, individual, ethical and social aspects. This is illustrated in Figure 2 (see below).

The Task 4.2 of the EU project SITEX II (http://sitexproject.eu/index_2.html) was dedicated to think about an enlarged safety culture to support very long-term interactions with society. Whereas, on one hand, the corporate safety culture is expected to be implemented in compliance with INSAG recommendations and on the other hand, societal safety culture may be defined as *“..a set of values, references, through which the different actors of the society can assess together the degree of assurance that the safety objective is reached…*”, there are elements of safety culture that can be shared by both the organisations in charge of RWM and society: priority given to safety, principles of optimization, defence-in-depth… SITEX-II therefore pleads for *“…a common set of values, principles and references governing safety…”.* This is a prerequisite.

Furthermore, conditions and means for a very long term intergenerational governance are that:

- The civil society takes part in the decision-making process right from the beginning;
- There is time to consider and discuss the issue in depth before coming to a considered view.
- Transparency is key : transparency of information, decision-making process, transparent reporting of participants’ views…

The importance of trust is emphasized:

- Public support can be generated through trust and trust can be generated through public engagement;
- More trust is required to support engagement;

- Trust should not be considered as a condition for the acceptance of a particular technical solution but as a condition for managing high complexity[1]

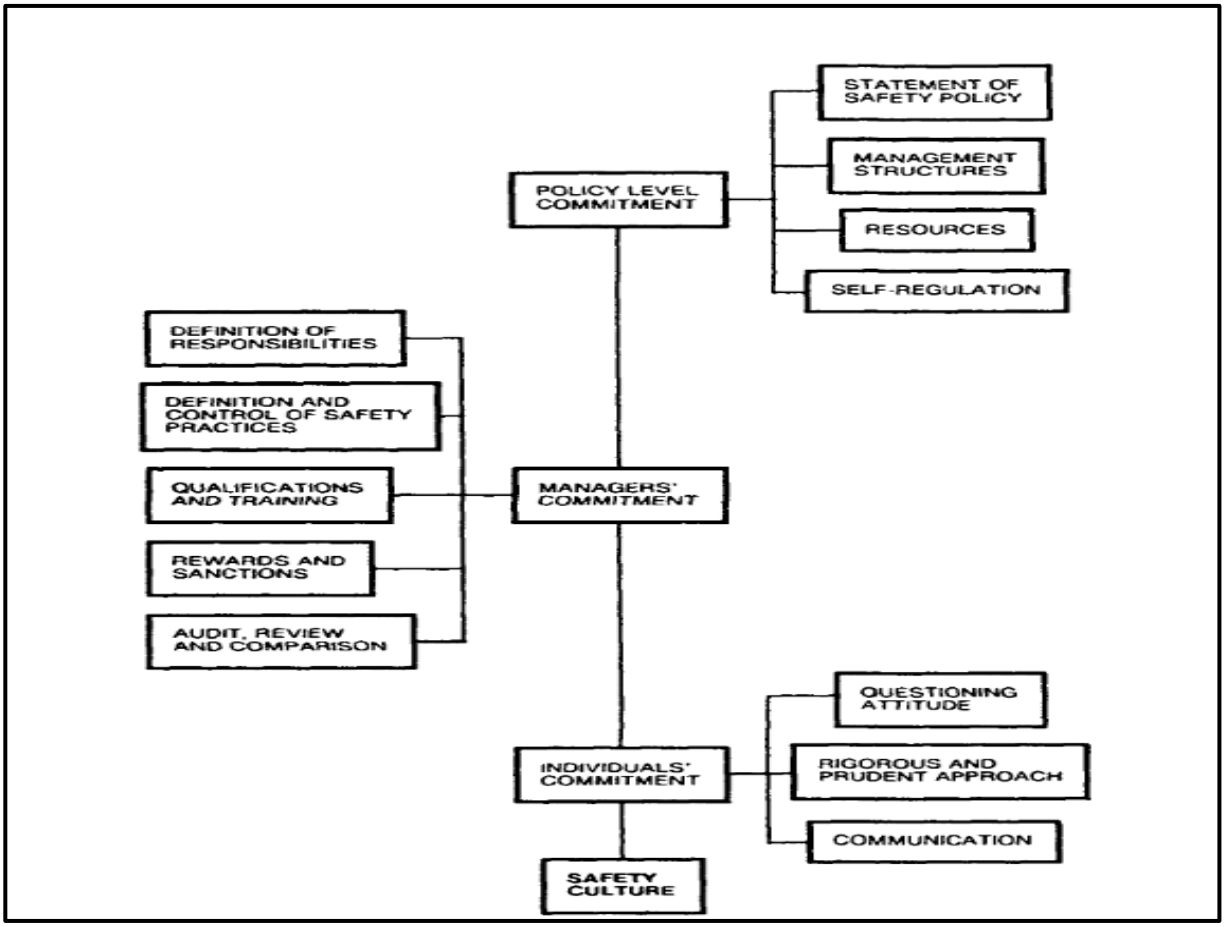

Figure 2 – Safety culture illustration [9]

As a conclusion:

- Safety Culture is a very promising concept in order to sustain trustworthy interactions among the concerned categories of actors in the context of long-term RWM processes involving uncertainties but also need for flexibility according to progress & errors necessitating reorientation along the process
- Safety Culture is typically a sociotechnical concept
- Further research is needed to update the Safety Culture Concept to the specificities of RWM In order to:
  - Encompass the very long term dimension of RWM processes;
  - Include Civil Society at international, national and local level, along the development of the Safety Case within a Rolling Stewardship perspective;
  - Develop the specific requirement vis-à-vis Civil Society as a genuine contributor to the quality of RWM decisions, in the perspective of the Aarhus Convention.

[1] See Luhmann, Niklas, *Trust and power* , John Wiley and Sons (1979)

3.2 Part II of the seminar: working group discussions

Discussions in working groups were based on concrete cases linked to the human-related uncertainties presented in session 1. The concrete cases illustrated the issues related to the four selected topics: public acceptance, schedule, new knowledge and adequacy of safety-related activities, plus the concrete case on security aspects.

3.2.1 The concrete cases

The nine concrete cases were presented by Julien Dewoghelaere, Mutadis (France), as UMAN task 5 leader. Each working group was proposed to discuss 3 concrete cases: 2 concrete cases related to the type of uncertainty allocated to the WG, plus the concrete case related to security aspects, common to all WGs.

3.2.1.1 Uncertainty on public acceptance

Concrete case 1: Integration of public acceptance criteria in the site selection process?

"At the beginning of the site selection process, two municipalities have been identified as having potentially suitable sites.

One municipality has optimal geological conditions (best long-term safety in terms of risk) for implementing a geological disposal facility (GDF) for radioactive waste. The local elected representatives are against and want to veto. The second site has sufficient geological conditions to safely hold radioactive waste, but not so optimal compared to the first site. Local elected representatives are inclined to accept the facility.

The national legislation concerning radioactive waste management (RWM) stipulates that the selection of the best possible site is not limited in time and should take into account both scientific and societal factors. It must also be validated by a vote of the national Parliament."

Concrete case 2: Characterisation and interactions with the concerned "public"

"During the site selection process, a municipality has been identified as the most suitable site (from a long-term safety point of view).

The local elected officials of the municipality declare themselves in favour of welcoming a GDF. The landowners of the proposed area are divided: some of them are already in negotiation with the waste management organisation (WMO) to sell their land; while others, with the support of some of the local community's members, are against the implementation of such a facility. Their strong local resistance is well mediatized and generates debates at regional and national levels."

3.2.1.2 Uncertainty on schedule to be considered for implementing the different phases of the disposal programme

Concrete case 1: Consequences of postponement on Safety

"One year before the operational phase of the geological disposal facility (GDF) starts, there are active discussions concerning the choices for future national energy policies, due to an energy crisis. The government is about to sign contracts for building new Nuclear Power Plants. This decision will have an impact on the nuclear waste inventory needing disposal. The Parliament demands clarification on the management of this new waste before the beginning of the operational phase.

For this reason, the government decides to postpone the beginning of the geological disposal's operation for at least four years.

The postponement could have consequences on safety: storage facilities are reaching their end of life and becoming difficult and expensive to maintain. The situation raises strong concerns among civil society and scientists regarding safety."

Concrete case 2: Safety issues due to a tight schedule

"Five years ago, an underground research laboratory was opened at the site selected for the GDF. This will be used to investigate a few geological questions which remain open, prior to further construction and operation. A small amount of radioactive material is authorized for use in these experiments.

The research laboratory was supposed to operate for 10 years as part of a pilot phase, but a new government recently came into power and overruled the plan (which has been endorsed by the safety authority) to speed up the implementation of the geological disposal and give the operational license in the following year.

As the implementation of waste disposal starts, data from the waste packages used for experimentation begin to show unexpected and problematic data. A strong polemic is raised, first among scientists and then within all society. Shall we stop the licensing and follow the initial plan regarding the pilot phase, or should we continue operation while having a specific attention to this data?"

3.2.1.3 Uncertainty related to new knowledge

Concrete case 1: New uncertainty arising through R&D

"During the development of the safety case for a geological disposal facility (GDF) in country 'A', new international scientific results indicate a major role played by a particular type of organic matter, potentially leading to enhanced radionuclide mobility. Those results come from a ten years interdisciplinary survey done by academics focusing on environmental issues, not directly linked with geological disposal (GD).

Nevertheless, their results could apply to GD, as the presence of those organic elements could raise the speed of radionuclide migration through the GDF's geological barrier. It causes active discussions among actors concerned with research on GD at an international level. Some actors state that there should only be a minor additional research project (of 1 or 2 years) to check the limited impact of this new uncertainty. Others consider this issue necessitates a more demanding research programme (at least 5 years) to remove the uncertainty.

In the country A, there is no consensus on the correct way to manage this issue: should this emerging uncertainty be included in the assessment of the safety case and, if so, how? Should an experimental programme start in country A? In the meanwhile, the debate spreads out to civil society organisations that express strong concerns about the impact of this issue on the GDF safety."

Concrete case 2: "New" knowledge emerging from monitoring

"During the development of the safety case for a GDF, a question is raised about legacy waste from military programmes during the 1970's & 80's: should it be included in the GD inventory and how? Because of the sensitive nature of the waste, it is not very well-characterized. After long discussions, the choice is made to include the wastes in the inventory with dedicated monitoring in the set of 5 galleries where they will be stored.

During the operational phase, as 2 galleries out of 5 are filled in, the results of monitoring show abnormal data related to the behavior of these legacy waste packages: the containers seem to be deforming and swelling, causing important safety questions regarding workers. It is decided to stop operations with this legacy waste and to further investigate. Once the public is informed about the situation, a very strong polemic raises causing a major trust issue regarding the whole assessment process."

3.2.1.4 Uncertainty related to the adequacy of safety-related activities in construction phase for the implementation of safety provisions

Concrete case 1: Construction problem due to a failure in the quality management system

"After 5 years of the Geological Disposal (GD) construction phase, there is a change of concrete vault supplier. The supplier's cessation of activity is due to accusations of quality failures due to fraudulent

activity by other clients. For this reason, an additional quality control is requested to check the vaults which have been already installed.

After investigation, the accusations of fraud are also confirmed for the GD facility: a significant part – almost 20% – of the concrete vaults are made with inappropriate materials. Those products are therefore more vulnerable than planned. This problem has not been detected by the verification tests undertaken under the facilities quality management system during the construction phase.

The operator stops the construction phase in order to ensure worker safety and evaluate the impacts on long-term safety, during which they need to find solutions or alternatives. Once the public is informed about the situation, a strong polemic raises causing a major trust issue regarding the whole quality management process for the facility."

Concrete case 2: Accident due to a lack of safety culture

"A first section of the GD facility has been built and is under operation, while a second section is under construction. The explosion of a waste package occurred in the first section and was detected late because some of the contamination monitoring sensors were out of order, causing misinterpretation of the data. The package that exploded was later found to be non-compliant with the waste acceptance criteria for the facility due to presence of reactive materials. The galleries were empty of personnel at the time of the explosion and the contamination of workers was therefore fortunately negligible.

After this accident, the GD facility was shut down, with significant underground contamination requiring decontamination. Maintenance operations on the walls of the galleries are also necessary because of the explosion.

An investigation is conducted by the national safety authority which highlights the failures that are the causes of the accident. The study identifies certain technical choices in the handling of the waste packages, as well as well as the established maintenance procedures for the sensors not being followed. The study identifies the root cause as being due to a poor safety culture having developed following recent staff changes and cutbacks and recommends a strong improvement of the safety culture for all persons and activities concerned with the GD facility: reinforcement of the quality management system, review of the monitoring systems, certification of workers and materials, interactions between the different services oriented towards improvement of safety, etc. Civil society and workers organisations are invited to be associated with these discussions on safety culture."

3.2.1.5 Security issues linked to a national emergency

Additional case : Security issues linked to a national emergency

"During a bilateral war, the attacking country encounters difficulties in progressing into the territory of the defending country. The autocratic leader of the attacking country decides to launch an attack on a nuclear power plant in a region he almost controls and causes a blackout in the whole region. Fortunately, the attack did not generate contamination but showed the attacking country was ready to win at all costs and would not follow the international principle of non-aggression of civil nuclear facilities in all circumstances, even during war.

Despite these bad conditions, the defending country continues to resist. The autocratic leader of the attacking country threatens then to bomb all the industrial facilities of the defending country, including the geological disposal of nuclear waste that is still in the operational phase, if the defending country does not surrender in the coming month.

The government and the national safety authority of the defending country gather all the concerned actors to try to find measures to solve or at least mitigate this security issue. The international community is shocked and also concerned and organize discussions to see how to help the defending country and to prevent in the future this type of security uncertainties."

3.2.2 Discussions in subgroups

The participants were divided into four subgroups (see Appendix C), each gathering various kinds of actors and from different countries (regulators, WMOs, REs, TSOs and CS) designing a moderator and a rapporteur.

For each of these concrete cases, a set of questions had been prepared to foster the discussion. For example, regarding the case #1 about schedule uncertainty discussed in working group #2:

"According to you, does this type of scheduling uncertainty need to be represented and assessed? If so, how?.

According to you, how should the risk to safety of this unplanned postponements be mitigated in the project?

According to you, what kind of governance would you foresee to manage this situation? How should policy / inventory changes be dealt with in dialogue with civil society?

…."

The questions used are recalled through the presentation of the restitutions hereunder (chapter 3.3). The mention "according to you" is not repeated, however.

3.3 Part III of the seminar: restitution of working group discussions

The rapporteurs of the subgroups presented a synthesis of the results of the discussions held during the working group sessions. As the cases were different for all the groups, except for the last case, related to security, hereunder the discussions are presented group by group for 2 cases each, and the discussions on the last case are presented together

3.3.1 Working group 1: uncertainty related to public acceptance

3.3.1.1 Concrete case 1: Integration of public acceptance criteria in the site selection process?

At the beginning of the site selection process, two municipalities have been identified as having potentially suitable sites.

*One municipality has **optimal geological conditions […]** for implementing a geological disposal facility (GDF) for radioactive waste. The local elected representatives are against and want to veto. The second site has **sufficient geological condition**s to safely hold radioactive waste, but not so optimal compared to the first site […]*

How should the site selection process be designed to avoid or mitigate such a situation? What kind of institutional rules (on transparency and public participation notably) should be implemented to manage this type of uncertainty?

- Strong application of the Aarhus convention and institutional mechanisms for public participation; International rules (often sites near borders),
- Stepwise selection process. Inform largely the public in the first step, before selecting a site
- Dialogue between all possible stakeholders, including civil society
- Public acceptance cannot be forced, we can only be transparent, inform, organize participation, allow questions to be answered, then get a certain level of acceptance.
- If people think that they cannot really participate, it creates problems

Veto is not a good solution, but…

- If there is a veto, in Germany no municipality would agree. A lot of work would be spent without result.

- DGR is not that different from other subjects, where dissent of the municipality maybe overruled if it is the general interest.
- Cf. Swiss approach:
  - in a preliminary stage, the cantons were asked: all vetoed.
  - 2 levels of decision: veto possible at regional level, but not cantonal, i.e. local interests duly heard and taken into account at local level, but without veto.
- veto should be used also in a positive way to involve the population. Gives a power to reconsider. It will help apply the Aarhus convention.
- If there is no other solution, the decision should be made at the national level, i.e. veto may be overruled by the government.

Does "public acceptance" need to be represented and assessed in the site selection process?

- Yes. If acceptance is not reached, there will be an issue. It is the most important thing. But the question is « how? ».
- What public acceptance means is not clear. We should first define it, but it is difficult. Here are some thoughts:
  - Acceptance implies to avoid social disturbances.
  - Acceptance is a process
- It can be measured (ask people at a certain time), but if it is done wrongly, it can be biased

Should public acceptance criteria be integrated into the site selection decision for a GDF?

YES!

Do you foresee any other management options?

About benefits:

- Raise benefits for the local stakeholders
- Explain local people what are the benefits for them (economical and so on)
- Corruption is a bad way to create acceptance (benefits for a limited number of people); if benefits are clear for all, it's different.

Other comments?

About optimal vs sufficient:

- Difficult to claim what is the best only on the basis of geology. E.g. extra barriers may be planned, if everybody agrees, it could be considered.
- Optimality should integrate all the aspects, including social. Otherwise; it is a wrong interpretation of the optimization principle.
- Searching for the best site is not a solution: you never know if there is no other site that would be better.

3.3.1.2 Concrete case 2: Characterisation and interactions with the concerned "public"

During the site selection process, a municipality has been identified as the most suitable site (from a long-term safety point of view).

The local elected officials of the municipality declare themselves in favor of welcoming a GDF. The landowners of the proposed area are divided […)

Preliminary comments:

Legal aspects are important in this case. Expropriation is a possible means. It is better not to choose private land, when possible.

In such situation, how should the concerned "public" be defined? On what criteria?

- The public and the concerned public are defined in Aarhus convention.
- The first level of the public involved is: who is at risk, who will benefit or not from the facility. It is the core of the public (it is like an onion, with core and skins).
- The public is people who are living there and directly influenced by the repository.
- In transboundary sites, the public is both local and international (close, on the other side of the border).

Amongst institutional scientific bodies (WMO, TSO, RE, etc.), who are the actors involved in the management of the situation? What could be their roles?

- Here we have both a legal and a scientific issue. For scientific aspects, all actors are involved.
- The national citizen oversight committee may support the municipality.
- Don't forget the psychological part: there is always a personality behind public (personal goal, mindset). It is always interesting to know the goals of individuals.
- There are always personal interests involved. If there is somebody who takes care of the business plan of the landowners, who takes care for their future, it helps. E.g. by proposing exchange of land in order to allow people to continue running a business elsewhere.

What management options do you foresee to handle the situation?

- There are two ethical attitudes that may lead to different solutions : protect the least well-off / the majority (Rawls criterion / utilitarian approach)
- It is more a question of management skills than of options: ability to investigate the concerns, the needs, ability to negotiate, to act as a mediator
- Again, it is like an onion: every layer needs to be managed in a different way. We need to show people how we build the safety case, give them insight on what we are doing. Explaining gets them more involved.

What type of stakeholders should be involved in the site selection process?

- In this case, mainly landowners and political, + community, municipality, national citizens oversight committee as a support
- We should also talk about the stakeholders we want to have: active, motivated, participating, solid, respectful…

What level(s) of interactions is (are) relevant to incorporate this issue of public acceptance? Should one level be prioritized over another? According to what criteria?

- There are four levels of interactions: personal, shared focus, dialogue for shared activity, collective action.

Could a regular dialogue with civil society contribute to managing this type of situation? If so, how?

- YES, all agree. A regular dialogue could avoid such a situation; to talk is always a good solution.
- Local partnerships in Western Europe are very good example for good dialogue. In Central and Eastern Europe, there is no partnership, then confrontation.

3.3.2 Working group 2: uncertainty related to the programme schedule

3.3.2.1 Concrete case 1: consequences of postponement on safety

One year before the operational phase of the geological disposal facility (GDF) starts, there are active discussions concerning the choices for future national energy policies, due to an energy crisis […]

For this reason, the government decides to postpone the beginning of the geological disposal's operation for at least four years.

The postponement could have consequences on safety […]

Does this type of scheduling uncertainty need to be represented and assessed? If so, how?

The first part of the scenario seems very likely (e.g. in France, while license application is awaited in the next months, the French government is currently thinking about the construction of up to 14 new NPPs) and raises questions on how to deal with it.

The implementation of a geological disposal is by nature rather uncertain and thus leads to successive postponement.

How should the risk to safety of this type of unplanned postponement be mitigated in the project?

It is important to anticipate the consequences of a new energy policy in terms of RWM:

- Ensure the safety of storage facilities, notably regarding the ageing of waste forms (retrievability) and of the engineered barriers (maintenance);
- Minimize the waste volume to be produced when deciding new projects;
- Anticipate the needed disposal capacities, notably for geological disposal.

What kind of governance would you foresee to manage this situation? How should policy / inventory changes be dealt with in dialogue with civil society?

In the first place, institutional organisations (WMO/RB/TSOs) have an indirect influence on energy policy and should help to anticipate the RWM issues.

The Civil society should be involved in the following two questions:

- Is there a need for a postponement? Postponement can be seen either as an issue for storage capacities, or as an opportunity to make good decisions (more time to find consolidated positions);
- Is there a need of a new geological disposal facility?

What stakeholders should be involved to deal with this postponement issue? Should civil society be included in the discussion related to energy policy and safety of surface facilities?

Local communities hosting the storage and supposed to receive the DGR should be involved in the discussions.

A good understanding of the level of risk and what is planned to mitigate is a condition for accepting.

- Is there a current safety issue in storage conditions?
- What are the plans to ensure that the « rescheduling » will be respected?
- What are the concerns about the ageing of waste forms & level of risk & environmental impact assessment (monitoring of storage conditions / impact of internal & external factors / radiological profile)
- Extended SWOT analyses would be needed.

Do you think that a regular dialogue with civil society would contribute to managing this type of uncertainty? If so, how?

Yes, of course civil society can have a strong impact in these exchanges in order to point some subjects sometimes we might forget due to the process already implemented. This is illustrated by

an example in France: a few years ago, IRSN lead a review about Cigeo that included meetings with the civil society during the review process. This helped to raise some questions that hadn't been tackled at first, for example the fact that the reprocessing policy in France would mean maybe at one point that spent fuel could be in the inventory, which was not really taken into account in this kind of file.

3.3.2.2 Concrete case 2: Safety issues due to a tight schedule

Five years ago an underground research laboratory was opened at the site selected for the GDF […].

The research laboratory was supposed to operate for 10 years as part of a pilot phase, but a new government recently came into power and overruled the plan (which has been endorsed by the safety authority) to speed up the implementation of the geological disposal and give the operational license in the following year.

As the implementation of waste disposal starts, data from the waste packages used for experimentation begin to show unexpected and problematic data. A strong polemic is raised […].

Does this type of scheduling uncertainty regarding the pilot phase need to be represented and assessed? If so, how?

This situation would demonstrate no independence of the regulatory body. A "good regulator" would have to prevent this situation to happen. This seems unlikely in a democratic country.

However, a tight schedule due to e.g. industrial constraints might have impact on the safety.

How should this uncertainty, related to tight schedule, be managed?

The first role of the regulator (and TSOs) is to control and slow down the implementation if needed.

A strong civil society, provided with appropriate resources, can be an advantage in case of a lack of independence of the regulatory body.

How should the new problematic data be managed?

Monitoring might not be enough. A new programme would be needed in order to confirm or not the problematic data.

We should start again the pilot phase and pursue the R&D.

An international workshop, including CS, should be organised to assess the situation.

What kind of governance would you foresee to manage this situation?

Resilience of the democratic system (Parliament, WMO, RB/TSO, REs, CS) relies on safety culture in practice and should overcome such crisis.

1- Role of WMO: should say « we're not going to do that »

2- Role of RB/TSOs. The parliament should also be able to oppose the government decision.

3- If things go wrong (due to a weak regulatory body?) it would need a stronger civil society (which means funding and competences), to be able to assess the situation with the help of research entities.

Important to have access to independent research/expertise.

International workshop, including civil society, to assess the situation.

What stakeholders should be involved in the discussion process on the monitoring data?

If there is no answere here, I suggest to delete the question.

Do you think that a regular dialogue with civil society would contribute to managing this type of uncertainty? If so, how?

It is important for the civil society to have a direct access to the (raw?) data.

3.3.3 Working group 3: uncertainty related to new knowledge

3.3.3.1 Concrete case 1: new uncertainty arising through R&D

During the development of the safety case for a geological disposal facility (GDF) in country 'A', new international scientific results indicate a major role played by a particular type of organic matter, potentially leading to enhanced radionuclide mobility. […] It causes active discussions among actors concerned with research on GD at an international level. […] In the country A, there is no consensus on the correct way to manage this issue […] In the meanwhile, the debate spreads out to civil society organisations that express strong concerns about the impact of this issue on the GDF safety.

The questions asked to the group are presented hereunder. The group addressed them altogether. The comments and answers are presented accordingly.

Should this type of new knowledge be considered and incorporated into the safety assessment? If so, how?

How could we anticipate the emergence of new knowledge before the safety assessment start?

How should we manage this kind of uncertainty?

What kind of governance would you foresee to manage this situation?

How should we balance the different views and approaches regarding the necessity of additional research on the GD issues?

Do you think that a regular dialogue with civil society would contribute to managing this type of uncertainty? If so, how?

Comments and answers to the questions:

- First, this case raises several questions:
  - What is the phase of the site selection process?
  - How many sites are identifies, or what different types of geological formation are proposed?
  - Is the new issue the same for all host communities?
  - Have the communities volunteered, and how does new knowledge affect the technical assessment of suitability?
- Yes, new knowledge should be incorporated as it could have an impact on trust. What is hypothesis and what is real knowledge should be understood. Some research according to available resources should be performed, also research at affected community (fear, impact, new social studies) and this should be interacted with stakeholders.
- A question is whether such uncertainties were already handled prior to the emergence of the new knowledge and whether some assumptions were made. If there are already analyses which would make it possible to assess if it really matters and what impact it could have. When planning the Safety Assessment it is important to consider all different scenarios (in order to have a robust system), or to use the envelop calculation with the worst case scenario (like to account for chlorine migration). Discussion is always needed, but between countries there are slightly different views on how, with whom and also what.
- It is important how you communicate on new knowledge to understand the implication of findings properly. This is an international issue and it should be debated. It is important to inform what happens next, what will be done. Here we see the role of an expert body, like the CORWM

committee in UK, to be used and consulted on what to do, like changes of inventory, changes of other issues. It is also important how far the process with geological disposal is, like in UK, where there is still a lot of time. CS is interested in the topics, but local communities do not necessary want to dig into details, only want to have transparency and feel honesty. How to do this? Perhaps we should also look at different good examples of interactions (like in Sweden and Finland). High-level conversation should be used rather to have details. Wide transparency is recommended, like forum with exchanges.

- One has to explain what the new knowledge means to the public: similar safety cases already exist specially about the organic (complexity, impact, consequences). Are new data relevant for repository from the safety point of view? Impacts on the migration should be collected, a small research project should be launched with gathering of the information and assessing what are the consequences. It should be handled within the concept; if there is a big impact, a bigger research project should be performed. Results should be communicated within the safety community, with regulators. How to communicate to public is a challenge: you can assume the worst case and if the impact is big, then you need to present it to the public.
- Here, new knowledge has been revealed, but it is not really sure that it has impact on the safety case. If it is necessary to include new knowledge, it has to be studied. But it may also be unproductive as there are time schedules, and the geological repository has to be designed robust so that small changes do not impact the safety.
- Governance depends on national legislation, what institutions exist in the country. But in such case international exchange is definitely worth, as it helps balance different views. It was also observed that some international organization could downplay the perceived risk. So the context is very important and should be taken into account.
- Discussion opportunities are: different directions, local to global, with variety of the groups, also pluralistic, being fair, honest, open, …
- This case raises also the issue of the best site vs the site available: we do not know perfectly what geology is and can add to safety.
- The historic origin of nuclear energy and the context of nuclear with lack of transparency has an influence. It is at different levels in different countries, but it sets the context.
- The Swiss case is an example worth to have in mind: the civil society in Switzerland has the final word and can say no also at the end. Preparation has to be very good from the beginning to provide all potential answers to the public (who will decide at the end). Even later with sufficient signatures (now 100.000 required but may rise to 250.000 signatures in the future because of increased population) the public can reject the location. Also, if there is a decision by regulators, it could influence the site selection. And this is communicated to the public.

3.3.3.2 Concrete case 2: “New” knowledge emerging from monitoring

During the development of the safety case for a GDF, a question is raised about legacy waste from military programmes […]: should it be included in the GD inventory and how? Because of the sensitive nature of the waste, it is not very well-characterized. After long discussions, the choice is made to include the wastes in the inventory with dedicated monitoring in the […] galleries where they will be disposed.

During the operational phase […] the results of monitoring show abnormal data related to the behavior of these legacy waste packages[…] causing important safety questions regarding workers. It is decided to stop operations with this legacy waste and to further investigate. Once the public is informed about the situation, a very strong polemic raises causing a major trust issue regarding the whole assessment process.

The questions asked to the group are presented hereunder. The group addressed them altogether. The comments and answers are presented accordingly.

How should we manage the existence of remaining uncertainties during the safety assessment? How should this type of uncertainty in waste characterization be considered in the safety assessment?

How should we manage this kind of uncertainty? What should be the role of monitoring to manage this type of uncertainty?

What kind of governance would you foresee to manage this situation?

What conditions are needed to ensure trust for all actors in the assessment process?

How should we deal with the appearance of new abnormal data? Which actors should be involved in the decision process following this appearance?

Do you think that a regular dialogue with civil society would contribute to managing this type of uncertainty? If so, how?

Comments and answers to the questions:

- This case refers to accident management, also typical for other industries, and it should be addressed accordingly. Why it happened and what happened should be investigated, to receive license for continuation of operation. Even for legacy waste, waste acceptance criteria (WAC) should be fulfilled. The chemical and physical content should be available. Which parameters differ? Are the waste producing heat or gas? Some information should be known already from the storage and related monitoring. Stop of operation should be communicated. Analyses have to performed, why was it not known before, what happened and how to approach the explanation should be provided to the public (by regulator and operator).
- This is a crisis situation and procedures should be established for this. There might be a severe loss of trust. Are that waste really suitable for GDF? This should be answered by those in charge and the public should be informed. The main findings should be presented to the public. Dialogue with civil society is useful and should be carried out. It is necessary to investigate the arguments of different opinions at the beginning (also opponents) and how the decision was taken.
- The project should have some robustness to changes that appear during construction. It is a very usual procedure. It is envisaged in the safety case additional margin for such uncertainties.
- It is the case of an emergency which preparedness should be planned before, including the mitigation process. Having clear plans to return to a safe state and how to manage the situation. WAC are vital and monitoring have to prove that it is safe (with test, verification and assurance for long term radiological safety). Any of the container might fail even if safety margins are used. No shortcuts should be allowed even for such legacy waste. Preparedness for such events is needed, as said, in the emergency planning.
- In terms of particular waste, there is a lot of different waste (military and weapons programme, complicated waste). WAC and what will be accepted will be a big discussion. It is expected to characterize the waste as much as possible. There is a lot of thinking on proper pathways and alternatives. Rigid procedure should be applied.
- Military waste is not normally part of the civil RW management (also excluded at the international organizations like IAEA) and will be definitely under specific attention.
- Also waste from small producers is particular and usually not standard – special WAC have to be discussed and should be communicated.

3.3.4 Working group 4: uncertainty related to the adequacy of safety related activities

3.3.4.1 Concrete case 1: Fraud

After 5 years of the Geological Disposal (GD) construction phase, there is a change of concrete vault supplier. […Suspicion of fraud leads to] an additional quality control [on the] vaults which have been already installed [that shows that] a significant part – almost 20% – of the concrete vaults are made with inappropriate materials […] This problem has not been detected by the verification tests undertaken under the facilities quality management system during the construction phase.

The operator stops the construction phase in order to ensure worker safety and evaluate the impacts on long-term safety […]. Once the public is informed about the situation, a strong polemic raises causing a major trust issue regarding the whole quality management process of the facility construction.

Does this "implementation uncertainty" need to be represented and assessed?

You need to take it into account. So yes, all expected and possible unexpected things, if you know things about it.

What kind of rules should be implemented to manage this type of uncertainty?

How should the quality management system be designed to avoid or mitigate such a situation?

Do you foresee any other management options?

What kind of governance would you foresee to manage this situation?

What conditions are needed to ensure trust for all actors in the assessment process?

Could a regular dialogue with civil society would contribute to managing this type of situation? If so, how?

Comments and answers:

- Civil engineering problem can have huge consequence. There are margins in the design: are they enough?
- It is a high problem that it was not detected in the qualification system: it is a safety culture issue. The quality management should be renewed regularly. Bad habits should not settle.
- There should be zero tolerance for fraud. The rule should be to strengthen the verification system. There should be a control of the contractors, there should not be any doubts of integrity.
- Also there is a need for a strict public procurements regulation, and conflict of interests' regulation. It is not uncommon that criminality occurs, like for the case of Stocamine (in France), where there has been fraud and silence about fire.
- When the choice of the contractor is carried out on competition, we have a process to follow, defining best values, on economic factors. However, the cost is only one element of the value. The formula for how you actually weight the value can be a lot more complex than just based on the price, it may include the technical merit, sustainability, the carbon impact, etc. If it were written that the cheapest wins, you risk this kind of situation even for honest institutions.
- With regard to this quality management system, proving and testing should be done, in situ. It could be done by WMOs and by regulators as well. From civil engineer point of view, there should always be some probes from concrete taken, to confirm the strength of concrete, by independent parties.
- When the problem is discovered, it has to be reported in a way defined before the problem happens. CS is represented in a way defined before the project.
- The civil society would need to know what the problem is, and what occured, and what are the steps to prevent this to happen again. After information has been presented, there could be a public hearing. CS may know more than organisations, could have new ideas on the process.
- European regulatory bodies did a whole assessment across Europe a few years ago; they found the most important factors in independence of regulators, and a big problem was the contractor's appointment procedure. We could focus on this and fruitfully lead to pluralistic appointments. The appointment process is key for independent parties.

- WMOs cannot directly discuss with CS on concrete, but rather on standards, and on the orientation of works to safety. The hope is that a regular dialogue will give feedback, and also some change in the processes.
- What about discussing also with workers unions?
- Any changes made during construction to the disposal, should be reviewed, but how? Regarding license construction: whole safety report re-analysed? Here, should licence be withdrawn?

3.3.4.2 Concrete case 2: accident due to a lack of safety culture

A first section of the GD facility has been built and is under operation, while a second section is under construction. The explosion of a waste package occurred in the first section and was detected late […]. The package that exploded was later found to be non-compliant with the waste acceptance criteria […].

After this accident, the GD facility was shut down, with significant underground contamination requiring decontamination. Maintenance operations on the walls of the galleries are also necessary because of the explosion.

An investigation is conducted by the national safety authority which highlights the failures that are the causes of the accident. […] The study identifies the root cause […] and recommends a strong improvement of the safety culture for all persons and activities concerned with the GD facility […]. Civil society and workers organisations are invited to be associated with these discussions on safety culture.

Does this "co-activity situation" need to be represented and assessed in the safety case? If so, how?

How should the quality management system should be implemented to avoid or mitigate such a situation?

What kind of rules should be implemented to anticipate and manage this type of situation?

Do you foresee any other management options?

What kind of governance would you foresee to manage this situation?

How can an appropriate shared safety culture be developed among all actors?

Could a regular dialogue with civil society would contribute to managing this type of situation? If so, how?

Comments and answers:

- Here, among sociotechnical human aspects, the most important thing is the waste acceptance criteria (WAC)
- We can see all aspects of KM here, particularly in the structure of organisations. This happened in the UK recently, due to a big merge of two agencies. How do you change the habits of people?
- How should the quality management system work: for example, what if a package dropped?
- Here, the monitoring is out of order: lack of adequate monitoring! There should be better sensors. And also the non- compliant material that was used, was it due to incompetence, bribery, or also economical interest?
- This co-activity question is relevant and good, and it may cause some considerations for the part under construction. Some empathy for the workers: impacts on them?
- Procedure with the sensors, I wonder if there is a problem with the regulators, if they are not in control of the situation: maybe the root cause.
- Safety culture in the facility that produced the waste and send the package to be operated?
- Of course, we need to monitor everywhere it is possible.

- You can easily notice that your measuring technique is not working. The proper improvement of monitoring system is: putting more sensors, in case one of sensors is not working, so you will still have data. You shall not let some sensors being out of order!
- There are aspects here showing there is no real possibility to whistle blow, or to intervene and getting things fixed, so there is a real problem of governance, and poor safety culture.
- The rule is to manage the situation better, yet there is a shortage of experts, and so a need for training more younger people. In Switzerland, young people are not willing to go there because it is not seductive anymore.
- For the system itself, of course the sensors have to be changed before they fail. The answer is to control, to check. Controllers has to be renewed regularly.
- What about plugging directly sensors to regulators and TSOs, so they can double check, and CS can also be informed? Then WMOs would be motivated to inform well, and a routine will be established to check everything is working.
- A shared safety culture is also at an inter-institutes level (role of TSOs), and at an international level. Shared safety culture among all actors, WMOs, regulators, civil society, everyone has to be informed, at the end providing institutional help. Everyone should know what is required!
- There is a need to have good dialogue between all actors. Events can help to get to know each other better. Have to make sure people know the responsibility to take it seriously. And for example, this would help about changes of people in the different organisations? What about to accept, to agree to get students in organisation so that young people would see and discover: internship, partnership.
- Most of the time, CS enforces orientations of works towards safety, so it is interesting to have them in the process. CS helps for the safety of disposal, so it should be informed about the accident. If accident occurs, we need to make sure there are mechanisms and ways so that CS is alerted.
- It could be to give good public hearings and meetings in order to see the management of the facility, the representatives of workers and the persons who want to be responsible for society around them. This also would increase the motivation of the company to keep a better safety culture. They have to face the people, more than only the data.
- Yet, regarding a regular dialogue with CS, Sweden's example is mentioned: about the copper canister, dialogue has lasted for 20 years, but the regulator did not take the point of view of civil society into account, so the dialogue is beneficial only if there are some outcomes!
- What about the German process? There is an interesting job with CS in the siting process, with the notion of feedback for safety in order to explain if things are important and why. There is a real dialogue in the two ways: WMOs are participating in the process, and out of this, expectations are changing.

3.3.5 Discussions on the security case in all groups

During a bilateral war, […] the autocratic leader of the attacking country decides to launch an attack on a nuclear power plant in a region he almost controls and causes a power shutdown in the whole region. Fortunately, the attack did not generate contamination but showed the attacking country was ready to win at all costs and would not follow the international principle of non-aggression of civil nuclear facilities in all circumstances, even during war.

Despite these bad conditions, the defending country continues to resist. The autocratic leader of the attacking country threatens then to bomb all the industrial facilities of the defending country, including the geological disposal of nuclear waste that is still in the operational phase, if the defending country does not surrender in the coming month. […]

The questions provided to foster discussions were:

Does this "security uncertainty" need to be represented and assessed in the safety case?

What kind of rules should be implemented to manage this type of uncertainty?

How the facility should be designed to avoid or mitigate such a situation?

Do you foresee any other management options?

What kind of governance at national and international level would you foresee to manage this situation?

Could a dialogue with civil society contribute to managing this type of situation? If so, how?

3.3.5.1 Working group 1:

Comments*:*

- It is reality in Ukraine at present. In Chernobyl accident, waste have not been damaged. The only thing is to prevent this kind of situation.
- In case of war, there are many other facilities that may be targeted by bombs, with high environmental impact.
- For NPPs the security concerns are part of the safety case, especially after 9/11.
- EPRs in Finland and France are designed to resist plane crush. However NPPs cannot withstand bombs attack.
- This is an argument for a DGR. A DGR is a solution against bombs attack.
- Anyway, if the aggressor controls the land, they can blow it up.

Does this "security uncertainty" need to be represented and assessed in the safety case?

- NO (it is a security issue, not a safety issue; in a war situation, the regular safety case is not the proper tool.)

3.3.5.2 Working group 2

Does this "security uncertainty" need to be represented and assessed in the safety case?

- Relevant considering the Ukrainian/Russian situation

What kind of rules should be implemented to manage this type of uncertainty?

- Scenarios should be taken into account in the safety demonstration, considering possible effects of a war (such as the abandon of a facility)

How should the facility be designed to avoid or mitigate such a situation?

- Sheltering / Options to quickly close the facility

Do you foresee any other management options?

What kind of governance at national and international level would you foresee to manage this situation?

- Diplomatic role of IAEA, steps against the attacking country, give visibility to what happens.

Could a dialogue with civil society contribute to managing this type of situation? If so, how?

- Hard to investigate by the CS, due to defence purpose and subsequent confidentiality.

3.3.5.3 Working group 3

Comments*:*

- This is really very close to the current situation. We did not discuss this risk before enough. Managing security of high radioactivity legacy waste should be part of the safety case. After the war in Ukraine, you realize how little power international organizations like IAEA or other

international communities have. In terms of facility design, possibly some rethinking could be done (like minimizing the surface concentration of waste or distributing waste to several locations). What can this mean for IAEA and other bodies? Not sure what actions can be done.
- Such scenario should be addressed also from the current experience. The safety/security rules could be envisaged but if they are not respected, it cannot bring anything.
- Perhaps the Geneva convention should be reviewed and include all other nuclear structures (now limited to NPPs). Safety of the current structures should include also assessment of structures for nuclear attacks (like repositories, or on site storage of spent fuel).
- This is a real crisis management case and no one has foreseen such situation. Also, there is no guarantee that further provisions would be respected, as there is a tradition (for 30 years now) that the nuclear facilities are used in war conflicts (and even attacked - bombed).
- Safety cases should include new items of security uncertainty, some sort of stress test should be added (and it is proposed by NTW to EC/ENSERG). Management of current information is very important.
- This is a difficult issue, all kinds of external threat need to be taken into account. There is a need for questions for the whole society: where and how to store the risky waste, should even the NPPs be relocated below ground, risk compared to what – risk of reactors? In Sweden there is a centralized SF storage underground.

3.3.5.4 Working group 4

Comments:

- The public has to know it, and society has to accept or not this risk.
- If there is direct war, there are direct attacks. A certain dictator made it explicit: things were attacked that were never attacked before.
- What kind of rules to manage this type of uncertainty? No rules, because of war. How to prevent it: the deeper would be better?
- This should be represented and assessed in the safety case, this has been obvious in the history of nuclear power that this problem is typical, and has been overlooked and yet not assessed in the safety case. IAEA repeated in the media that this is unprecedented, but it is not true, it happened already before in other decades. Statutes of IAEA should be saying that safety is the priority of this agency, and not promotion of nuclear, which is the case today.
- I have been thinking about this during my whole life. When I was young, I was already told this: if there is war, NPPs should be shut down immediately.
- NPPs are planned to resist a collision with a large airplane, yes, that's important. But what for missiles? Should resist!
- It's really a tough question, and this is a threat for every person on this planet, and every ecosystem and living thing.
- I really don't know if this will be taken into account in the safety case. In the case of the World Trade Center, it was not thought of in the construction! Maybe in the future we have to think about it.
- On safety case: only possibility of WMO, or also action of international organisation for international safety guidelines? What about the military participation to safety case, in this security-safety situation?

- What can we do? So sanctions on the aggressor, on maximum level.
- CS can have a really strong role in the discussions, so there are no big secret.
- We could do many things, but that could be expensive!
- Giving the facility a possibility of quick close, no need to backfill. A kind of quick storage possibility. Then the retrievability of waste becomes harder.

- There are things we could do, like the stage backfilling, doing quick storage underground: interesting idea.
- Maybe options to block the tunnels more quickly, also! Putting explosives next to the entry.
- There might be another option about taking abroad, to another country?
- For a geological site, you are underground, it is already a good thing. But for installation on surface?
- So we need to think a kind of review, or reconsideration of risks catalogue we are developing today.
- About disposal itself, more depth, additional protection barriers?
- Governance : emergency plan developed at international level, standardisation of construction and design
- Dialogue with civil society is necessary, even if confidential. The civil society should be informed that facilities are protected in case of such event.
- Possible idea of a shared International fund for this situation!

4. Synthesis and conclusions of Seminar 3

4.1 Synthesis of the seminar's findings

4.1.1 Public acceptance

4.1.1.1 Characterization of this type of uncertainties

For all participants, the uncertainty related to public acceptance has an impact on the success of the siting and on the schedule of the project.

The impact on safety is mostly indirect: it is related to the delays in the national waste management programme, e.g. ageing in the interim storage facility. Public acceptance or non-acceptance do not only have to be related to safety. Other motives (political, financial, etc.) can play a role.

Acceptance and acceptability are close notions but are not equivalent. The project must be acceptable before being accepted, both are necessary.

4.1.1.2 Management options

Public acceptance should be achieved through a process integrated in the stepwise development of the project, not a second phase taking place after the phase of design of the repository. This process should attribute some power to key actors. CS should be involved in this process from the beginning, as the requirements of the repository may be modified through the process. This requires fair communication and a transparent decision-making process.

As part of an uncertainty management strategy, public acceptance can, in a deliberative process framed by a strong implementation of the Aarhus Convention, confirm sound safety solutions. Conversely, public non-acceptance can be a corrective to unsound safety measures.

Trust is necessary, not only for acceptance but as a means to address complexity. Continuous dialogue is necessary to maintain trust. Independent reviews contribute to building trust.

Other management options include a motivation programme, with possible financial contributions and other benefits. The benefits need to aim a community (community partnership) and be transparent to all in order not to undermine trust.

Vigilance on safety has to be maintained all along the development of the programme, which is a real challenge. Anyway, like for any complex industrial project, accidents at a repository project will happen. All actors should be aware of that and managers should be prepared to deal with such events.

The acceptance process should integrate ethical aspects of equity and fairness. Consensus cannot be achieved, but it must be assumed that people who normally would be unwilling to accept a particular risk, would be inclined to submit to a decision-making process that is embedded in a fair and democratic structure, respecting the integrity of individual rights.

4.1.2 Schedule

4.1.2.1 Characterization of this type of uncertainties

The uncertainty on the schedule has an impact on safety through waste packages ageing and rock and structures behaviour. It may lead to insufficient interim storage capacity. The uncertainty may also concern the schedule of closing the repository: just by non-decision of future decision-makers to close the repository as planned, schedule may largely shift, leading to significant safety implications. Delaying the disposal programme provides also longer cooling of exothermic wastes, leading to smaller disposal requirements.

Postponing decisions has also positive effects on safety if the extra time is used to improve safety. However postponing decision requires an appropriate plan B in order to prevent the negative effects (packages ageing, rock structures behaviour…).

Schedule uncertainty concerns also the provision of sufficient financial and raw material resources, human resources, transport and construction licences and the availability of appropriate technologies.

This results in increasing the burden on the next generations.

4.1.2.2 Management options

It is acknowledged that the uncertainties can be reduced and mitigated but cannot be avoided throughout all phases of the programme.

Stepwise approach and robust planning with intense participative and communication activities with stakeholders seem the best options for all participants. Robust planning means also that proper provisions to maintain safety while postponing are set.

In case of schedule modification issue, each of the various stakeholders (WMO, RB/TSO, REs, CS) has a role to play, and in a democratic system the parliament should also be able to oppose the government decision. The civil society should be involved in the discussions, this being prepared by a regular dialogue along the programme. The various questions raised by the postponement issue should be addressed using tools like SWOT analyses.

4.1.3 New knowledge

4.1.3.1 Characterization of this type of uncertainties

In the case of new knowledge arising, the consequences depend on the stage of the programme. If new knowledge comes early in the programme, the consequences may be limited as there is a lot of time to adapt the design of the repository.

Legacy waste, especially when coming from military activities, may be not very well characterized. This may have safety consequences.

The emergence of new knowledge may also cause a major trust issue regarding the whole assessment process.

4.1.3.2 Management options

Margins in the safety case aim at addressing known unknowns, thus cover at least partially the possibility of new knowledge. If nevertheless the new knowledge creates a safety issue, a dedicated research project should be launched in order to gather the information and address the consequences. The results should be communicated within the safety community.

The waste acceptance criteria (WAC) aim at keeping the characteristics of the waste within a safe, well-known domain. Even for legacy waste, they should be fulfilled.

Communication to the public is always a challenge but is needed. Involving CS early in the programme reduces the risk of large impact of the new knowledge, as it may bring the focus on less investigated aspects. CS are interested in the topics, but local communities do not necessary want to dig into details, only want to have transparency and feel honesty. The role of an expert body that may be consulted on what to do is very important. If the consequences of the new knowledge are not specific to one national programme, discussions at international level are highly relevant.

4.1.4 Safety-related activities

4.1.4.1 Characterization of this type of uncertainties

The uncertainty on the adequacy of safety related activities has an impact on both long-term and operational safety. It comes from socio-technical aspects. This issue is increased by the co-activity between construction activities (mining, civil engineering) and waste emplacement (nuclear) that have two different cultures. Furthermore, any repository is in some way a “first of its kind” realization.

Failures in the implementation of safety-related activities may come from reduction of vigilance. They may come from lack of knowledge transmission.

4.1.4.2 Management options

The importance of the safety culture is acknowledged by all participants. Namely, a very important thing is the waste acceptance criteria (WAC). More generally, the activities that are important for safety should be identified and controlled by the quality assurance system.

Maintaining the performance of the quality assurance system is essential. Among the tools available to ensure that there are: implementation of the Defence in Depth principle, peer reviews, audits, human factor area separately evaluated in the periodic safety reviews, regular renewal of the controllers, knowledge management, monitoring...

There should be zero tolerance for fraud.

Monitoring should be performed everywhere it is possible, with redundancy.

The safety culture should be shared among all actors as a precondition for ensuring continuity of the safety-related activities. Here also, CS involvement is essential.

4.1.5 Security

4.1.5.1 Characterization of this type of uncertainties

Most of the participants agreed that the issue of security in case of war goes beyond the safety case of a DGR, as a war would raise a lot of other issues. In a similar way, there is a broad international consensus in the regulation that voluntary intrusion after closure is not part of the safety case, because our ethical duty is not to protect future generations against themselves. However this statement must be moderated: because of their geographical situation, Finland has included the possibility of aggression for years. Finland has protocols in case of war, for the repository, the interim facilities or for the encapsulation plant. The radiation spread if the whole facility is absolutely destroyed is also described by radiation models.

4.1.5.2 Management options

Features of the design could be defined in order to address such possibility, e.g. early closure (without backfill), making a potential retrieval more difficult.

The weakness of international institutions in this type of case has been noticed, and perhaps the necessity to review the Geneva convention; however, sanctions against the aggressor of nuclear facilities seem possible.

There are limitations to what can be disclosed to the civil society regarding security aspects, but it should be informed in general that such scenario is taken into account.

4.2 Conclusions of the seminar

In Seminar 3, uncertainties related to human aspects were discussed by using different cases. A first conclusion is that the different cases suggest requirements that are sometimes conflicting. For example:

- in a situation where a waste package had for example exploded and released radioactive gas, if the level of reversibility of the design of the system allows the packages to be taken back out more easily, that's beneficial if you do need to repack or repair them for some reason;
- on the contrary, in the security case, you might want to have something like a staged backfilling because then you can close the facility faster if something like a war does happen to break out.

A similar conflict of requirements may be observed regarding the need to let the public know that security aspects are taken into account, with procedures where they would take part, but not disclosing in detail the measures in order not to facilitate a malevolent action.

Similarly again, regarding involuntary intrusion, because there is a missing scientific basis to speculate what future generations will be and what they can make, only a few stylistic scenarios are considered. On the other hand, as we are the generation that is responsible for generating the waste, we have also an ethical duty to think and to speculate on the future in order to prepare for what may exist in long term.

Therefore there should be a “fine tuning” of the requirements, balancing the various aspects, which requires not only technical investigation but also political: civil society has clearly a role to play in this respect.

This fine tuning may be adapted continuously in order to take into account the evolution of society’s expectations and knowledge.

Another conclusion is that it is worth investigating more in detail the concept of rolling stewardship, as it could be a way to manage interactions with civil society all along the phases of the process of geological disposal. This rolling stewardship would be a proper framework for adjusting the requirements as stated above.

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Agenda

WP 10-UMAN

UMAN seminar 3- Uncertainties related to human aspects

Agenda
14-15 June 2022
Hybrid meeting: IRSN premises

This Seminar is organized by Mutadis with the support of an expert's team from task 5 of the UMAN project.

After seminar 1 offering a global picture and seminar 2 digging one domain of uncertainties namely "Site and Geosphere Characteristics", seminar 3 will dig a second domain of uncertainties addressed in UMAN, the uncertainties related to the human aspects. The human uncertainties are defined on a very large basis: the uncertainties related to human activities during the different phases of a geological disposal programme. As it is too large for enabling fruitful discussions, it was necessary to do a focus and select key topics to be further analyzed.

The aim of seminar 3 is to discuss the views of different types of actors on the following topics based on concrete cases:

- Public acceptance
- Schedule to be considered for implementing the different phases of the disposal programme
- New Knowledge
- Adequacy of safety related activities for the implementation of safety provisions (with a focus on construction phase)

First Day - 14 June 2022

Introduction

9:15 **Welcome of participants, presentation of the seminar n°3 team and rules of the hybrid meeting** – Julien Dewoghelaere (UMAN Task 5 leader), Mutadis, France

9:20 **UMAN pluralistic seminars: objectives and methodology of seminar 3** – Julien Dewoghelaere (UMAN Task 5 leader), Mutadis, France

Session 1 – Views of actors on uncertainties related to human aspects

This session aims at presenting the views of the different types of actors (Waste Management Organisations, Technical Support Organisations, Research Organisations, Civil Society actors) on the 4 identified topics related human aspects uncertainties. Each type of actor will present the key uncertainties for each topic and what are the most suitable options to manage them (meaning reduce, avoid, or mitigate them). The provided

information will be based notably on the outcome of other UMAN tasks. The presentations will constitute material helping for the discussions that will take place during the Working Groups session.

9:30 **Views on uncertainties related to public acceptance** (10 minutes per actor)
- for Waste Management Organisations: Jean-Noël Dumont, Andra, France
- for Technical Support Organisations: Nadja Zeleznik, EIMV, Slovenia
- for Research Entities: Bernd Grambow, CNRS, France
- for Civil Society: Niels Henrik Hooge, NTW, CS experts' team, Denmark

10:20 **Views on uncertainties related to schedule to be considered for implementing the different phases of the disposal programme** (10 minutes per actor)
- for Waste Management Organisations: Jean-Noël Dumont, Andra, France
- for Technical Support Organisations: Nadja Zeleznik, EIMV, Slovenia
- for Research Entities: Bernd Grambow, CNRS, France (Research Entities)
- for Civil Society: Gilles Hériard-Dubreuil, Mutadis, CS experts' team, France

11:00 Questions and answers (elements of clarification)

11:10 10 minutes break

11:20 **Views on uncertainties related to new knowledge** (10 minutes per actor)

- for Waste Management Organisations: Jean-Noël Dumont, Andra, France
- for Technical Support Organisations: Nadja Zeleznik, EIMV, Slovenia
- for Research Entities: Bernd Grambow, CNRS, France (Research Entities)
- for Civil Society: Gilles Hériard-Dubreuil, Mutadis, CS experts' team, France

12:00 Questions and answers (elements of clarification)

12:10 **Views on uncertainties related to adequacy of safety related activities for the implementation of safety provisions** (10 minutes per actor)
- for Waste Management Organisations: Jean-Noël Dumont, Andra, France
- for Technical Support Organisations: Nadja Zeleznik, EIMV, Slovenia
- for Research Entities: Bernd Grambow, CNRS, France (Research Entities)
- for Civil Society: Gilles Hériard-Dubreuil, Mutadis, CS experts' team, France

12:50 Questions and answers (elements of clarification)

13:00 End of the session 1

13:00 – 14:00 Lunch

Session 2- Working Groups session

During this session, the participants will be split in 4 Working Groups with a moderator and a rapporteur coming from the UMAN team. Each working group will be composed pluralistically (representatives of different types of actors) and will work on one topic related to human aspects uncertainties. Each topic will be illustrated by 2 concrete cases that will constitute the basis of the discussion.

WG n°1: Public Acceptance
Moderator: Bernd Grambow, CNRS, France (Research Entities)

Rapporteur: Jean-Noël Dumont, Andra, France (Waste Management Organisation)

WG n°2: Schedule to be considered for implementing the different phases of the disposal programme
Moderator: François Marsal, IRSN, France (Technical Support Organisation)

WG n°3: New Knowledge
Moderator: Julien Dewoghelaere, Mutadis, France (Civil Society expert)
Rapporteur: Nadja Zeleznik, EIMV, Slovenia (Technical Support Organisation)

WG n°4: Adequacy of safety related activities for the implementation of safety provisions (with a focus on construction phase)
Moderator: Alexander Carter, NWS, United Kingdom (Waste Management Organisation)
Rapporteur: Alexis Geisler, NTW, France (Civil Society expert)

14:00 **Description of the working groups' session and presentation of the scenarios**– Julien Dewoghelaere (UMAN task 5 leader), Mutadis, France

14:20-17:30 **Working groups session**

17:30 End of the first day

Second Day - 15 June 2022

Session3- Restitution session

9:15 **Introduction of the session**, Julien Dewoghélaëre (UMAN Task 5 leader), Mutadis, France

9:20 **Working groups results presentations (15 minutes per group)**

The rapporteurs of the 4 working groups will present a synthesis of the results of the discussions to be held during the working groups sessions.

10:20 10 minutes break

10:30 **Synthesis Discussion** - All the participants will have the opportunity to comment and discuss the results of the discussions.

11:45 **Conclusive remarks** – Julien Dewoghélaëre (UMAN Task 5 leader), Mutadis, France

12:00 End of the Seminar 3

Appendix A. UMAN Seminar 3 Terms of reference

European Joint Programme on Radioactive Waste Management

Terms of reference
UMAN Seminars

In order to ensure fruitful discussions in mutual respect, it was suggested to elaborate terms of reference that will be agreed by all the participants in the UMAN Task 5 seminars. These terms of reference establish a set of prerequisites to attend the seminar, notably based on elements of the procedure for establishing the group of CS representatives involved in EURAD that have been validated by the EURAD PMO and Bureau.

1- The participants in the UMAN seminar will have to support the EURAD vision hereunder and commit to contribute constructively to the exchanges that will take place in EURAD, respecting the goals of EURAD described hereunder:

EURAD vision:

"A step change in European collaboration towards safe radioactive waste management (RWM), including disposal, through the development of a robust and sustained science, technology and knowledge management programme that supports timely implementation of RWM activities and serves to foster mutual understanding and trust between Joint Programme participants"

EURAD goals:

- "Support Member-States in developing and implementing their national RD&D programmes for the safe long-term management of their full range of different types of radioactive waste through participation in the RWM Joint Programme;
- Develop and consolidate existing knowledge for the safe start of operation of the first geological disposal facilities for spent fuel, high-level waste, and other long-lived radioactive waste, and supporting optimization linked with the stepwise implementation of geological disposal;
- Enhance knowledge management and transfer between organisations, Member States and generations."

2- The participants in the UMAN seminar recognize that the objective of the seminar is to foster a common understanding or understanding of the different viewpoints among the different categories of actors on the management of uncertainties associated with the management of radioactive waste and how it relates to safety.

3- It is not intended to reach a consensus. Rather, the discussions during the seminar will seek to allow for a nuanced understanding of the issues at stake and a better understanding of the arguments of the various participants, without prejudice to their position with regard to a particular option.

4- The seminar will promote the clarification of the implicit elements leading each actor to establish his choices and preferences, while creating a climate of mutual listening and respect for the views of each participant. The discussion will be based on a freedom of expression of views. The plurality of categories of participants, or at least a plurality of views, experiences and professional profiles, is therefore desirable to foster an in-depth discussion that takes into account a wide range of issues.

5- The animation of the seminar will require pluralistic and transparent governance, i.e the organisation of the seminar and the facilitation of the discussions will be done by a pluralistic team gathering representatives of different categories of actors (WMO, TSO, RE and CS).

Appendix B. Lists of participants

Participants of the seminar

Anayeva	Oksana	CS larger group	Ukraine
Bartol	Jeroen	Covra	Netherlands
Becker	Dirk	GRS	Germany
Beuth	Thomas	BASE	Germany
Carter	Alexander	NWS	United Kingdom
De Butler	Malcolm	NTW	France
Deleruyelle	Frederic	IRSN	France
Depaus	Christophe	Ondraf	Belgium
Dewoghelaere	Julien	Mutadis	France
Dumont	Jean-Noel	Andra	France
Frieling, Gerd	Gerd	Base	Germany
Geisler	Alexis	NTW	France
Gilli	Ludivine	FSC, AEN	International
Grambow	Bernd	CNRS	France
Haverkamp	Jan	NTW	Netherlands
Havlova	Vaclava	UJV	Czech Republic
Henrik-Hooge	Niels	NTW	Denmark
Heriard-Dubreuil	Gilles	Mutadis	France
Holt	Erika	IGSC/VTT	Finland
Ikonen	Ari	Envirocase	Finland
Ilett	Doug	Environment agency	United Kingdom
Ivanov	Ivan	TU Sofia	Bulgaria
Justinavicius	Darius	LEI	Lithuania
Konvalinkova	Hana	CS larger group	Czech Republic
Lheureux	Yves	CS larger group	France
Marignac	Yves	Negawatt	France
Marsal	François	IRSN	France
Mattews	Philip	CS larger group	United Kingdom
Mauro	Christiana	CS larger group	Italy
Mihoc	Peter	CS larger group	Slovakia
Mikšová	Jitka	Suro	Czech Republic
Natunen	Jari	CS larger group	Finland
Parotte	Céline	CS larger group	France
Pfingsten	Wilfried	PSI	Switzerland
Simeonova	Albena	CS larger group	Bulgaria
Solovyov	Oleksandr	SSTC	Ukraine
Strusinska-correia	Agnieszka	BGE	Germany
Surkova	Maryna	FANC	Belgium
Swahn	Johan	MKG	Sweden
Wales	Colin	NTW	United Kingdom
Zeleznik	Nadja	EIMV	Slovenia
Zuidema	Piet	Chief Scientific Officer	Europe

Participants of the working groups

WG 1 - Public Acceptance				
Name	**Forname**	**Organisation**	**country**	**Remote/phycially (1)**
Henrik-Hooge	**Niels**	**NTW**	**Denmark**	**1**
Dumont	**Jean-Noel**	**Andra**	**France**	**1**
Becker	Dirk	GRS	Germany	remotely
De Butler	Malcolm	NTW	France	1
Depaus	Christophe	Ondraf	Belgium	1
Frieling, Gerd	Gerd	Base	Germany	remotely
Surkova	Maryna	FANC	Belgium	remotely
Simeonova	Albena	CS larger group	Bulgaria	1

Moderator: N. Henrik-Hooge Rapporteur: J.-N. Dumont

WG 2 - Schedule to be considered for implementing the different phases of the disposal programme				
Name	**Forname**	**Organisation**	**country**	**Remote/phycially (1)**
Heriard-Dubreuil	**Gilles**	**Mutadis**	**France**	**1**
Marsal	**François**	**IRSN**	**France**	**1**
Bartol	Jeroen	Covra	Netherlands	1
Ivanov	Ivan	TU Sofia	Bulgaria	1
Wales	Colin	NTW	United Kingdom	1

Moderator: G. Heriard-Dubreuil Rapporteur: F. Marsal

WG 3 - New Knowledge				
Name	**Forname**	**Organisation**	**country**	**Remote/phycially (1)**
Dewoghelaere	**Julien**	**Mutadis**	**France**	**1**
Zeleznik	**Nadja**	**EIMV**	**Slovenia**	**1**
Ikonen	Ari	Envirocase	Finland	remotely
Mattews	Philip	CS larger group	United Kingdom	remotely
Mihoc	Peter	CS larger group	Slovakia	1
Pfingsten	Wilfried	PSI	Switzerland	remotely
Solovyov	Oleksandr	SSTC	Ukraine	remotely

Moderator: J. Dewoghelaere Rapporteur: N. Zeleznik

WG 4 - Adequacy of safety related activities for the implementation of safety provisions (with a focus on construction phase)				
Name	**Forname**	**Organisation**	**country**	**Remote/phycially (1)**
Carter	**Alexander**	**NWS**	**United Kingdom**	**remotely**
Geisler	**Alexis**	**NTW**	**France**	**1**
Deleruyelle	Frederic	IRSN	France	1
Havlova	Vaclava	UJV	Czech Republic	remotely
Lheureux	Yves	ANCCLI	France	remotrely/1
Mauro	Christiana	CS larger group	Italy	1
Natunen	Jari	CS larger group	Finland	1
Strusinska-correia	Agnieszka	BGE	Germany	remotely
Swahn	Johan	MKG	Sweden	remotely

Moderator: A. Carter Rapporteur: A. Geisler

	Regulatory body
	Civil Society representative (CS)
	Reseearch Entities (RE)
	Waste Management Organisation (WMO)
	Technical Support Organisation (TSO)