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Pluralistic view of human-related uncertainties and their management – outcome of the European Joint Programme on Radioactive Waste Management (EURAD) strategic study UMAN (Uncertainty Management multi-Actor Network)

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PLURALISTIC VIEW OF HUMAN-RELATED UNCERTAINTIES AND THEIR MANAGEMENT – OUTCOME OF THE EURAD STRATEGIC STUDY *UMAN*

14.09.2023 • A. Strusińska-Correia, A. Göbel, F. Lemy, D. Diaconu, V. Detilleux, J.-N. Dumont, N. Železnik, J. Mikšová, H. Vojtechova, T. U. Kaempfer, X. Li, J. Grupa, B. Haverkate, M. van Gemert, J. Dewoghélaëre

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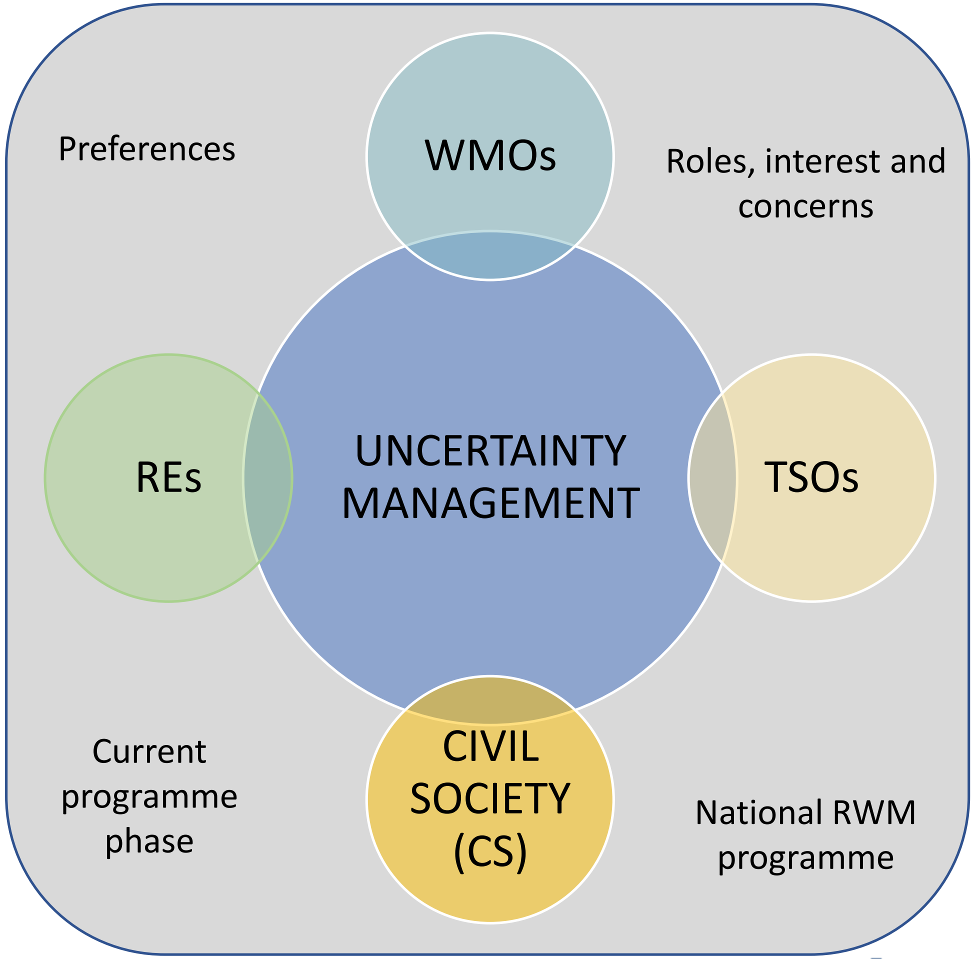
UMAN: UNCERTAINTY MANAGEMENT MULTI-ACTOR NETWORK

- Develop common understanding on uncertainty management and how it relates to risk & safety among WMOs, TSOs, REs and Civil Society
  - If a common understanding is beyond reach → achieve mutual understanding on why the views are different
- Share knowledge/know-how and discuss common methodological/strategical challenging issues
- Identify contribution of past & ongoing R&D projects to the overall management of uncertainties
- Identify future joint activities and initiatives



METHODOLOGY

UNCERTAINTY IDENTIFICATION:

UMAN Expert Groups

- (Preliminary) lists of uncertainties

→

ANALYSIS:

UMAN questionnaires

- Overall picture of actors & their roles, types of uncertainties, generic management strategies
- Significance for safety, characterisation, evolution

→

PREFERENCES:

UMAN workshops

- Preferred management strategies & options
- Future programme activities
- Actors: WMOs, TSOs, REs
- Input: possible manage-ment strategies & options

→

PLURALISTIC DISCUSSION:

UMAN seminars

- CS views and opinions
- Actors: WMOs, TSOs, REs, CS, Regulators, other uncertainty-specific invited actors

site & geosphere › **human aspects** › spent nuclear fuel › waste inventory › near-field

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IDENTIFIED UNCERTAINTIES ON HUMAN ASPECTS POTENTIALLY RELEVANT FOR SAFETY

- Process for the identification of a workable set of repository requirements
- Continuity of the waste management policy along political changes
- Robustness of the presently considered safety requirements with regard to the long term

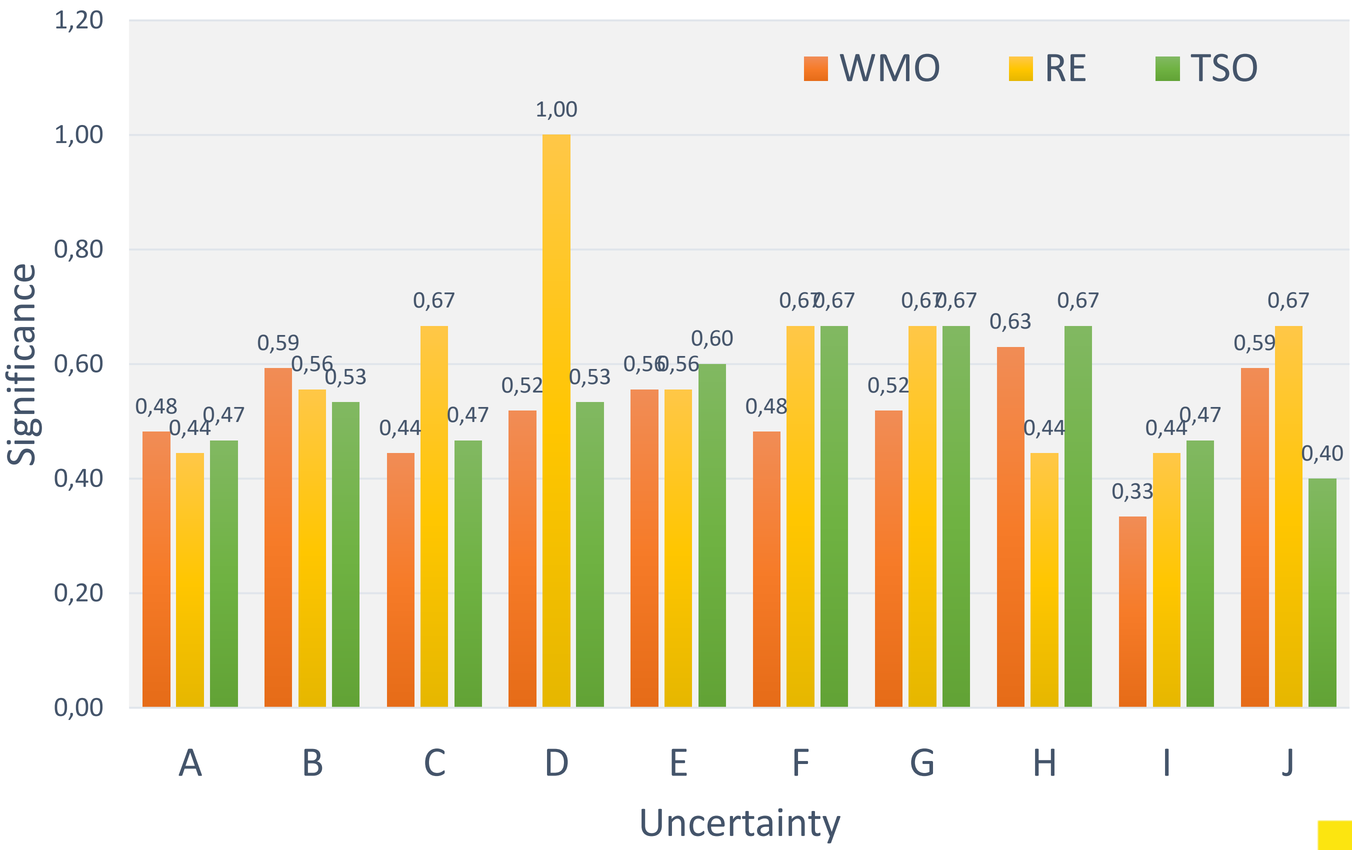
- Public acceptance of the repository at potentially suitable or projected locations
- Schedule to be considered for implementing the different phases of the disposal programme

- Robustness of the safety case vis-à-vis sociotechnical factors
- Reliability of monitoring results and safety analysis
- Adequacy of safety-related activities (in siting, design, construction, operation and closure) for the implementation of safety provisions
- Robustness of safety performance vis-à-vis possible cyber-attacks or programming errors
- Availability of well-educated human resources and relevant experts in RWM along the repository lifetime until closure

ASSESSMENT OF UNCERTAINTIES SIGNIFICANCE FOR SAFETY

Uncertainties on:

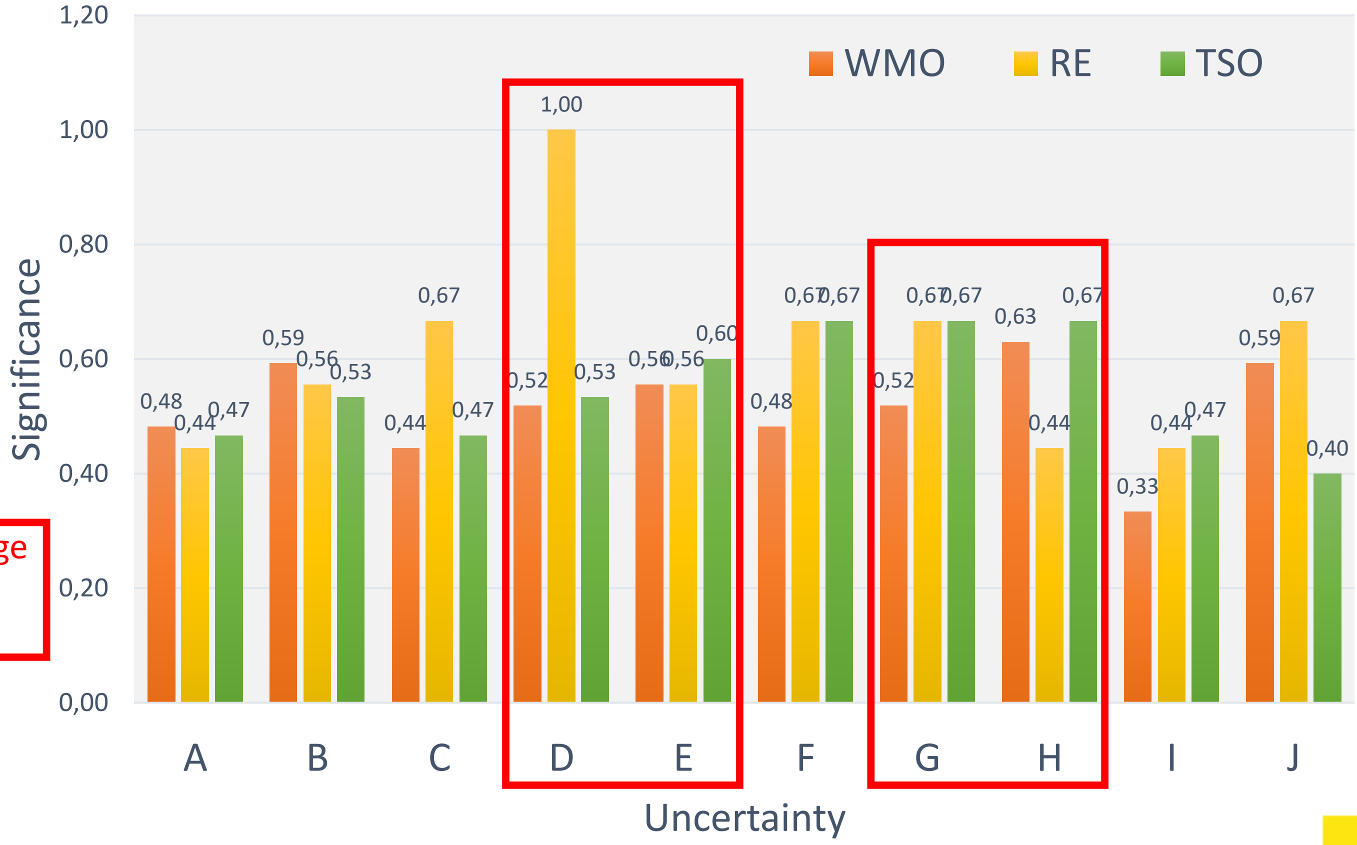
A. Processes for identification of a workable set of repository requirements
B. Continuity of waste management policy along political changes
C. Robustness of presently considered safety requirements with regard to the long term
D. Public acceptance of the repository at potentially suitable or projected 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. Reliability of monitoring results and safety analysis
H. Adequacy of safety-related activities for safety provisions implementation
I. Robustness of safety performance vis-à-vis possible cyber-attacks or programming errors
J. Availability of well-educated human resources and relevant experts along the repository lifetime until closure



ASSESSMENT OF UNCERTAINTIES SIGNIFICANCE FOR SAFETY

Uncertainties on:

A. Processes for identification of a workable set of repository requirements
B. Continuity of waste management policy along political changes
C. Robustness of 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. ~~Reliability of monitoring results and safety analysis~~ „New" knowledge
H. Adequacy of safety-related activities during construction for safety provisions implementation
I. Robustness of safety performance vis-à-vis possible cyber-attacks or programming errors
J. Availability of well-educated human resources and relevant experts along the repository lifetime until closure

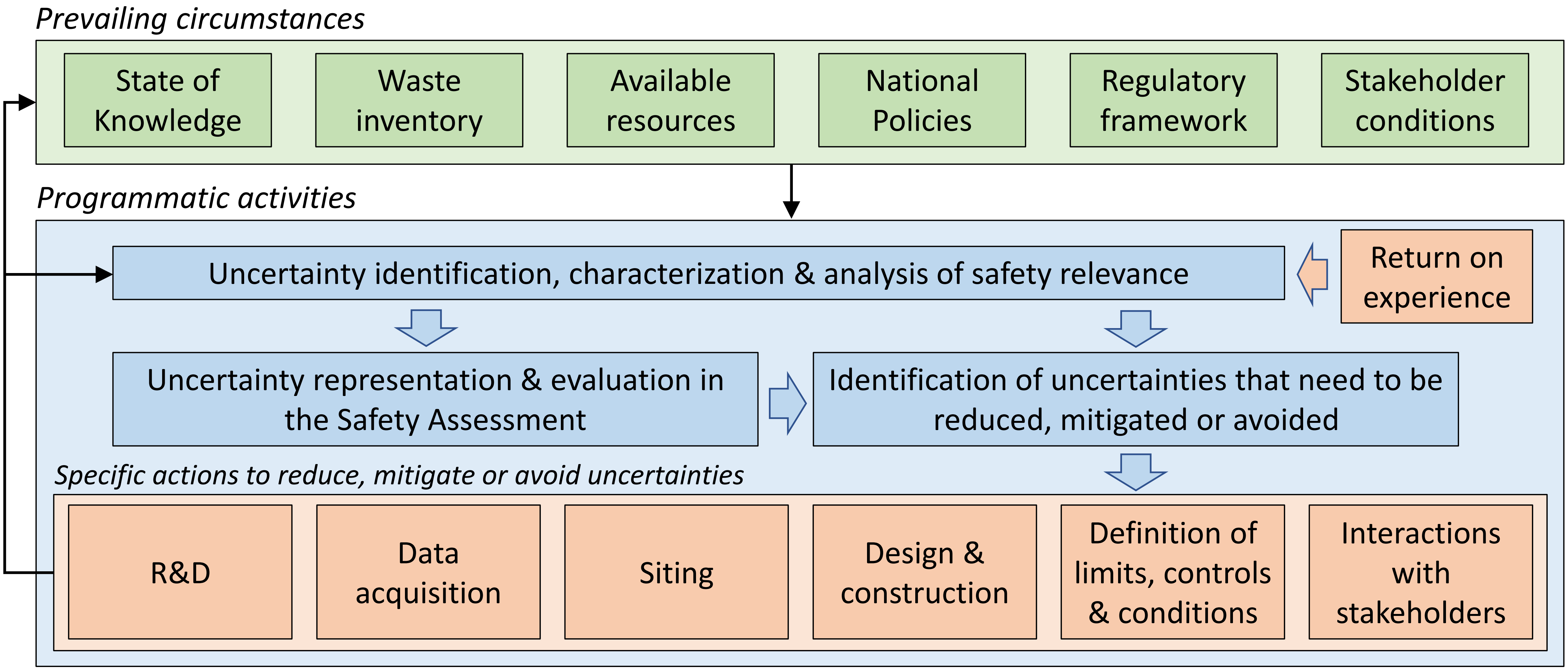


UNCERTAINTIES CLASSIFICATION

Uncertainties associated with completeness of FEPs considered in the safety case (applies to: Unknown/Ignored Knowns, Unknown Unknowns)

	Topical uncertainties	Known Unknowns	Unknown/Ignored Knowns	Unknown Unknowns
Programme uncertainties	Schedule	e.g. duration of licensing process	e.g. ignored lack of financial resources	e.g. unconceived political instabilities
	Public acceptance	e.g. conditions set by a community for accepting the project on ist territory		e.g. unconceived negative decision of a community
Uncertainties associated with initial characteristics & its environment	Implementation of safety provisions in construction → characteristics of built components	e.g. uncertainties in as-built repository components (due to construction errors)		
Uncertainties in the evolution of the disposal system & its environment	„New" knowledge		e.g. ignored possible magnitudes of disturbing events (e.g. Fukushima)	e.g. really new knowledge, unexpected, with possible impact on the safety case
Uncertainties associated with data, tools & methods used in the safety case	Implementation of safety provisions in construction → tools & methods		e.g. ignored mistakes in methods for implementing safety-related activities (e.g. 2nd WIPP incient)	

ELEMENTS OF AN UNCERTAINTY MANAGEMENT STRATEGY



„NEW“ KNOWLEDGE: CONTEXT AND ASPECTS OF SAFETY RELEVANCE

WMOs

- New technologies/developments → well-proven vs new technologies
- Consolidates the existing knowledge and contributes to reduction of uncertainties
- Possible adaptations, modifications and optimisations (e.g. safety case/SA, facility design, regulatory framework)
- Basis for reversibility of decision-making process
- BUT: when to stop?

TSOs

- Unknown/ignored knowns vs unknown unknowns
- Appropriate uncertainty management strategy required → at the end of the decision-making process, no remaining uncertainty can potentially jeopardize disposal safety

REs

- New scientific findings
- Continuously generated → its management & systematic incorporation into safety case/SA necessary
- Knowledge relevant vs irrelevant to disposal safety

„NEW“ KNOWLEDGE: EVOLUTION OVER PROGRAMME PHASES

- **Phase 0** – Policy, Framework and Programme Establishment
- **Phase 1** – Site Evaluation and Selection
- **Phase 2** – Site Characterisation
- **Phase 3** – Repository Facility Construction
- **Phase 4** – Repository Facility Operation and Closure
- **Phase 5** – Post Closure

WMOs ! reversibility, waste retrievability, waste recoverability !

TSOs: unknown/ignored knowns (for “unknown unknowns” difficult to be assessed)

REs: safety significance cannot be known *a priori*

All actors: uncertainty reduction

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„NEW“ KNOWLEDGE: MANAGEMENT PREFERENCES

Elements of uncertainty management	WMOs	TSOs	REs
Overall strategy	• Disposal should be promoted as new technologies/challenges	• Stepwise, flexible decision-making process	• Knowledge management
Representation in SA	• What-if scenarios • Robustness • Good analysis principle	• What-if scenarios • Systematic FEPs management	• Safety margins
Specific actions to reduce/mitigate/avoid	• R&D programme (including trans-disciplinary research) • Robust disposal system • Periodic safety reviews • Experience feedback programme • Investigation of new components/materials • Strong regulator	• R&D programme (including trans-disciplinary research) • Robust disposal system • Periodic safety reviews • Experience feedback programme • Defence in depth principle • Reversibility	• R&D programme (including trans-disciplinary research) • Exchange with advanced programmes

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„NEW“ KNOWLEDGE: RESULTS OF UMAN SEMINAR

Pluralistic view:

- “New” knowledge is inherent to a safety analysis of a long-term process
- It is important to ensure resources for production of “new” knowledge and to develop of a structure (linked to Rolling Stewardship) for generation of “new” knowledge and assessment of its relevance for DGR
- Transparency of monitoring results necessary
- Emergence of “new” knowledge may also cause a major trust issue regarding the whole assessment process.
- Consequences depend on the stage of the programme. If “new” knowledge emerges early in the programme, the consequences may be limited as there is a lot of time to adapt the design of the repository.

Management options:

- Margins in the safety case address known unknowns, thus cover partially the possibility of “new” knowledge. If “new” knowledge creates a safety issue, a dedicated research project should be launched to gather the information and address the consequences. The results should be communicated within the safety community.
- Involving CS early in the programme reduces the risk of large impact of “new” knowledge, as it may bring the focus on less investigated aspects. 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.

PUBLIC ACCEPTANCE: CONTEXT AND ASPECTS OF SAFETY RELEVANCE

WMOs

- Volatile upon some factors: political, next generations
- Relevant for interim storage, operational (e.g. waste retrievability) and long-term safety (e.g. post-closure monitoring, waste recoverability)
- Can delay or abrupt national programme

TSOs

- With reversibility, site acceptance is never definitively achieved
- Questioning competencies of actors involved in decision-making
- Can delay decision-making → impact on interim storage, transportation and disposal safety. Also: potential loss of resources resulting in poor execution of future activities, early closing or abandonment of facility
- Additional requirements with positive/negative implications for safety

REs

- Consent-based process with some power attributed to key actors
- Public consent evolves and is influenced by many factors: cultural, societal, political factors, changes of individual/community preferences, world views and concerns for future generations, information, communication and unexpected nuclear events
- Can delay or abrupt national programme → impact on interim storage safety, waste properties
- Additional requirements with positive/negative implications for safety

PUBLIC ACCEPTANCE: EVOLUTION OVER PROGRAMME PHASES

Phase 0	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Policy, Framework and Programme Establishment	Site Evaluation and Selection	Site Characterisation	Repository Facility Construction	Repository Facility Operation and Closure	Post Closure

WMOs: in general high in all programme phases with some minor differences ! !

TSOs: evolution difficult to predict; uncertainty re-appears at each decision point in the programme

! ! !

REs: public consent and the meaning of safety evolve as well

Uncertainty reduction (WMOs: through RD&D; TSOs: through participative and transparent decision-making process)

PUBLIC ACCEPTANCE: MANAGEMENT PREFERENCES

Elements of uncertainty management	WMOs	TSOs	REs
Overall strategy	• Transparent, participative, science-based, safety-oriented and self-questioning site selection process • Continuous/intense dialogue with CS (suitable communication strategy, science and solid knowledge based) • Lessons learned!	• Transparent and participative decision-making process • Continuous actions to build trust and participation willingness • Flexibility (in terms of RWM options and schedule) • No decisions/preferences made in advance	• Continuous, transparent and rule-based process of stakeholder engagement • Building and maintaining trust
Representation in SA		• Scenario of postponing/abruption of facility construction	• Assessment of risk associated with this uncertainty
Specific actions to reduce/mitigate/avoid	• What we try to avoid is the lack of public acceptance • Reduction by R&D (transdisciplinary research, ethical and societal studies, citizen science) • No real mitigation possible (unless unacceptance is only partial) • Popularisation of science/educational measures (focus on new generations; change of paradigm *geology decides, not emotions*) • Public acceptance assessment through dedicated surveys • Development of local partnerships when regions are preselected • Door-to-door discussions	• Uncertainty cannot be avoided • Transparency, accessibility and understandability of research results	• Uncertainty cannot be avoided • Public acceptance cannot be increased by more R&D and more communication on safety

PUBLIC ACCEPTANCE: RESULTS OF UMAN SEMINAR

Pluralistic view:

- Should it be viewed as uncertainty or as uncertainty management strategy?
- Acceptance or non-acceptance: two ultimate manifestations of public views (not only motivated by safety), changing over time. Conditions for public acceptance: effective access to all relevant information, to participation in the RWM decision-making process, to justice and to sufficient resources (Aarhus Convention).
- Public acceptance vs acceptability → close notions but are not equivalent; acceptability cannot replace but complement acceptance. The project must be acceptable before being accepted, both are necessary.
- No legal definition available; different interpretation by different stakeholders
- Public acceptance has impact on the success of the siting and on the schedule of the project.

Management options:

- Necessity of a stepwise development. This requires fair communication and a transparent decision-making process.
- Continuous dialogue with CS (from the beginning) is necessary to maintain trust. Independent reviews contribute to building trust.
- 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.

CONCLUSIONS

- Differences are relatively limited and are due to the different roles and responsibilities of the actors, due to national specificities (including regulations), current programme phase and lessons learned
- Stepwise (flexible) programme and a public involvement seen as key management elements. But differences of views exist on how this could/should be done:
  - from regular stakeholder dialog to active involvement and taking some ownership
  - cannot be solved through more R&D/communication but through building trust
- Different actors may focus on different context of “new” knowledge
- “New” knowledge is not necessarily negative for safety
- Uncertainty related to public acceptance can be large and often considered as unavoidable
- When to stop, when is it enough (w.r.t. uncertainties reduction, optimization)? Who defines the state-of-the-art?
- How to measure public acceptance? What is the sufficient public acceptance level?

THANK YOU FOR YOUR ATTENTION !

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