

WHEN THE ROCKET'S UP

20 YEARS OF INTERNATIONAL LEARNING ON RETRIEVABILITY – REVERSIBILITY (R&R) FOR HLW AND SPENT FUEL DISPOSAL

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BACKGROUND TO PRESENTATION

- Thanks !
- Two major international projects on retrievability and reversibility. The second ran between 2008 and 2011. 16 countries plus EC and IAEA.
- Post-2011 work on monitoring, memory preservation, and radiological standards
 - New thinking / progress. Especially, ICRP-122
 - Memory Project at NEA, ongoing
- Title of – and Messages in – this presentation reflect all that

PLAN OF PRESENTATION

- **Part – I : Post 2011 findings / thinking**
- **Part – II : 2008-2011 NEA's project**
- **Part – III : Conclusions**

SONG LATE 60'S (T. LEHRER)

*“WHEN THE ROCKET’S UP,
WHO CARES WHERE IT COMES DOWN ?
IT IS NOT MY DEPARTMENT
SAYS WERNHER VON BRAUN”*

- **Who is willing to say a similar thing for a waste repository?**

NOBODY

Today nobody is willing to say

- ... **“WE WALK AWAY”**

OR

- ... **“THE NUCLEAR MATERIALS IN THIS REPOSITORY ARE BELOW REGULATORY CONCERN”**

**ALL RAISE HOPE / POSSIBILITY FOR CARE
TAKING AND, THEREFORE, POSSIBLE
INTERVENTION (AND RETRIEVAL) AFTER
CLOSURE**

**SUGGESTIONS RANGE
FROM SUBLIMINAL
TO TOTALLY ASSUMED**

EVERYBODY HINTS AT R&R AFTER CLOSURE – I USA

- **Subliminal**

- 10,000 years Land Withdrawal
- Markers are required. They're called "passive institutional controls"

- **Assumed**

- "Stewardship" in environmental remediation of nuclear sites (USDOE-LM and -EM)
- Retrievability is a requirement for WIPP. (USDOE had to prove technology for retrievability in order to obtain certification)

EVERYBODY HINTS R&R AFTER CLOSURE - II

JOINT CONVENTION (1997) (SUBLIMINAL)

Article 17 “INSTITUTIONAL MEASURES AFTER CLOSURE” engages the over 100 signatory governments

”to take the appropriate steps to ensure that after closure of a disposal facility:

- (i) records of the location, design and inventory of that facility required by the regulatory body are preserved;**
- (ii) active or passive institutional controls such as monitoring or access restrictions are carried out, if required; and**
- (iii) if, during any period of active institutional control, an unplanned release of radioactive materials into the environment is detected, intervention measures are implemented, if necessary.”**

EVERYBODY HINTS AT R&R AFTER CLOSURE – III

IAEA GUIDANCE (VERY SUBLIMINAL)

- IAEA regulatory guidance for waste disposal is replete with the word “control” for both the pre- and post-closure phase of the repository.
- **“Control, in the IAEA sense, is always carried out by people and implies knowledge.”** (see <https://www.oecd-nea.org/rwm/docs/2014/rwm-rf2014-2.pdf>)

EVERYBODY HINTS AT R&R AFTER CLOSURE – IV

ICRP (SORT OF ASSUMED)

International Commission on Radiological Protection recommendations in the field of geological disposal [ICRP, 2013].

- **A closed repository should be seen as a functioning nuclear facility and, although the repository should be designed and built to be safe without the intervention of Man, there ought to be *no intention to relinquish oversight* after closure.**
 - Oversight includes memory provisions and the involvement of society.
- **Surveillance of the closed facility should continue for as long as practicable.**

EVERYBODY HINTS AT R&R AFTER CLOSURE – V

OECD/NEA (SORT OF ASSUMED)

- **“The NEA Radioactive Waste Management Committee accepts and adopts the ICRP-122 position on the relevance of maintaining oversight over the geological disposal of radioactive waste for as long as practicable.”** (<https://www.oecd-neo.org/rwm/rkm/documents/flyer-A4-rkm-collective-statement-en-2014.pdf>)

EVERYBODY HINTS R&R AFTER CLOSURE – VI

KBS-3 CONCEPT (SORT OF ASSUMED: “NOT-IRRETRIEVABLE, BUT NOT MY DEPARTMENT”)

- In the 1980’s: “It must be assumed that future generations will bear the responsibility for their own conscious actions. *What is of importance in this context is to provide them with the best possible information as a basis for their decisions, i.e. to make sure that information on the location, design and function of the final repository is carefully recorded and preserved. If, at some time in the future, people wish to retrieve and recover the copper or the spent fuel present in the final repository, they will then be aware of and able to cope with the radiological risks.*” [SKBF, 1983]
- In the years 2000s SKB demonstrated that the technology for retrieval can be developed and deployed.
- The industry’s position (SKB) is “**this is not irretrievable**”. Maintaining information and capabilities for retrieval is not their concern, however. Same position for Finland, NOW

EVERYBODY HINTS AT R&R AFTER CLOSURE – VII

OTHERS (ASSUMED, THEREFORE SUBJECT TO LICENSING)

- **SWITZERLAND** : Long-term Monitored Retrievable Deposition/Disposal
- **GERMANY** : Containers suitable for retrieval 500 years

OVERALL

- **HOST COMMUNITIES DO NOT WANT THE REPOSITORY TO BE LEFT UNATTENDED OR FORGOTTEN ...**
- **.... NOR DO THE TECHNICAL FOLKS. HISTORICALLY, HOWEVER, IT HAS BEEN AND IT IS DIFFICULT FOR THEM TO BE EXPLICIT ABOUT NOT FORGETTING AND WHAT IT MEANS FOR RETRIEVABILITY**
- **MEMORY KEEPING IS SOMETHING THAT CERTAINLY EVERYBODY WANTS... BUT NO ROBUST STRATEGY IS IDENTIFIED YET ... THE RECENT VERDICT BY THE SWEDISH ENV'L COURT ON SKB'S LICENSE APPLICATION (2017) UNDERSCORES THIS POINT**

THE OFTEN OVERLOOKED RADIOLOGICAL REASON FOR REQUIRING CONTINUED OVERSIGHT

- **The 0.3 mSv/yr standard for repository performance applies to situations where radiological exposure is managed (“planned exposure situations” in ICRP jargon)**
- **When exposures are not managed, the standards are different:**
 - **Free release / below regulatory concern (\ll 0.3 mSv/yr)**
 - **Accidental and intervention conditions ($>$ or \gg 0.3 mSv/yr)**

R&R PROJECTS OF THE NEA

- IN THE EARLY 2000s THE SWISS HAD AN ARTICULATED NEW POSITION ABOUT R&R; THE SWEDISH INDUSTRY WAS ALSO PRETTY CLEAR: *“IT IS NOT OUR DEPARTMENT, BUT WE ARE DOING SOMETHING ABOUT IT ”*; THE FRENCH WERE DEBATING REVERSIBLE OR NON-REVERSIBLE DISPOSAL ; THE FINNS SUDDENLY HAD A LEGALLY-IMPOSED REVERSIBILITY REQUIREMENT AND WERE SCRATCHING THEIR HEADS ; THE MORE ADVANCED PROGRAMMES WERE UNDER PRESSURE - SOME FROM THE LOCAL COMMUNITIES - TO CLARIFY THINGS. HENCE THE 1ST NEA PROJECT AROUND 2000.
- **THE SECOND PROJECT (2008-2011) WAS SPURRED BY ANDRA WHO WISHED THAT AN INTERNATIONAL RETRIEVABILITY SCALE COULD BE ESTABLISHED**
 - **WE WENT FARTHER AS WELL**
 - **ICRP-122 IS INFORMED BY THIS NEA PROJECT FINDINGS.**

2008-2011 R&R PROJECT OF THE NEA

- **VERY WELL DOCUMENTED AT <http://www.oecd-nea.org/rwm/rr/>**
- **BIBLIOGRAPHIC DATA BASE ON R&R AS OF 2010**
- **REPORT ON HISTORY AND STATUS OF R&R IN NEA MEMBER COUNTRIES AS OF 2010**
- **INTERNATIONAL CONFERENCE, REIMS, DEC 2010.**
- **FINAL REPORT, 2011 (75 pages)**
- **FINAL BROCHURE, 2011 (24 pages)**
- **INTERNATIONAL RETRIEVABILITY SCALE, 2011 (4 pages)**

R&R BIBLIOGRAPHY - INTRO REVIEWS HISTORY TO 2009

- Reversibility and retrievability are not new concepts.
- In 1969, the United States National Academy of Sciences, observed: “*Other things being equal, those technological projects or developments should be favored that leave maximum room for maneuver in the future. The reversibility of an action should thus be counted as a major benefit; its irreversibility, a major cost.*” [Report to Congress on “Technology: Processes of Assessment and Choice”]
- In the document NUREG-0300, dated 1978, one of the Proposed Goals for Radioactive Waste Management was: “*If wastes are disposed on earth, their retrievability - assuming a technology as advanced as present - should not be precluded.*”

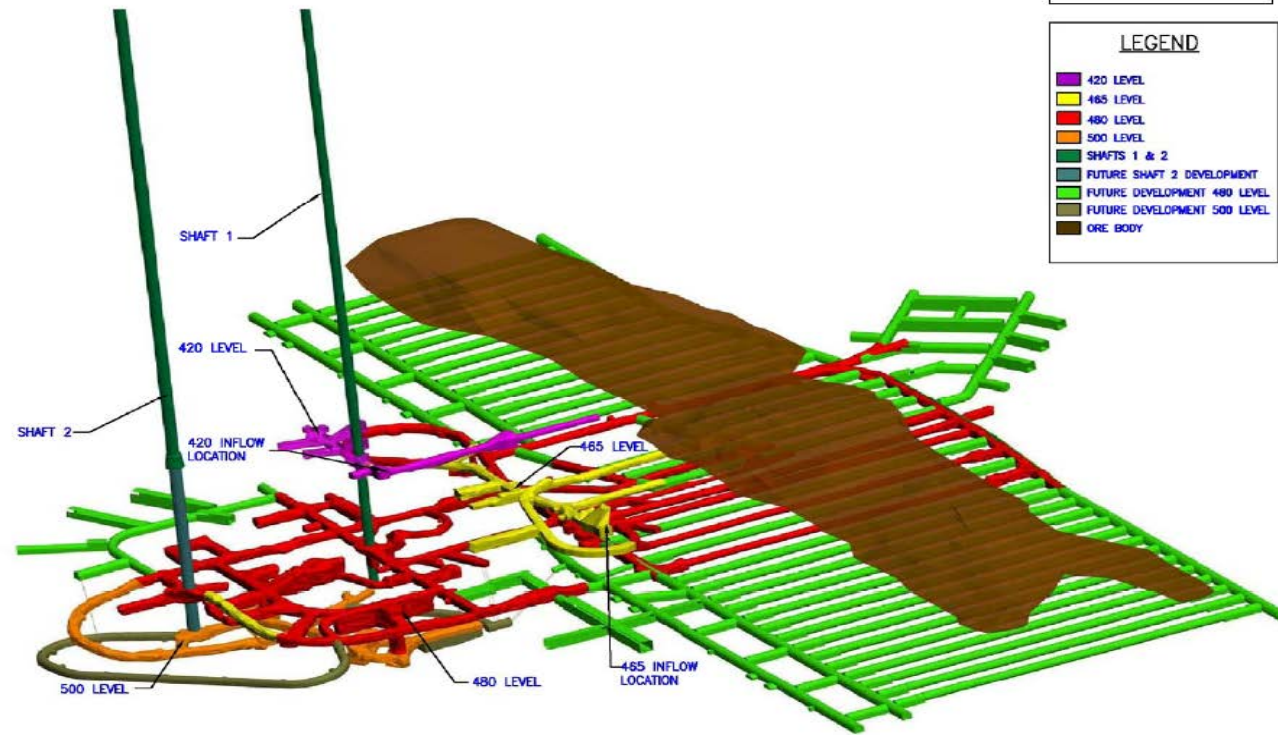
REPORT ON STATUS AND ISSUES IN R&RAS OF END 2010. FACTUAL COLLECTION OF RESPONSES FROM 14 COUNTRIES – GOOD DOCUMENT FOR ASSESSING PROGRESS

- **1. DEFINITIONS AND SCOPE OF APPLICATION**
- **2. HISTORICAL DEVELOPMENT**
- **3. CURRENT POLICY**
 - **General**
 - **Communication with stakeholders**
 - **Stepwise decision making**
- **4. PRACTICAL IMPLEMENTATION ISSUES**
 - **Regulatory issues**
 - **Monitoring, demonstration, performance measures**
 - **Decision-making process**
 - **Financial aspects**
 - **Technical aspects**

IF THERE IS THE WILL, THERE IS THE MEANS.

A REPOSITORY IS MINED-BACK: CIGAR LAKE

Figure 18-3: Three Dimensional General Mine Layout – looking northwest



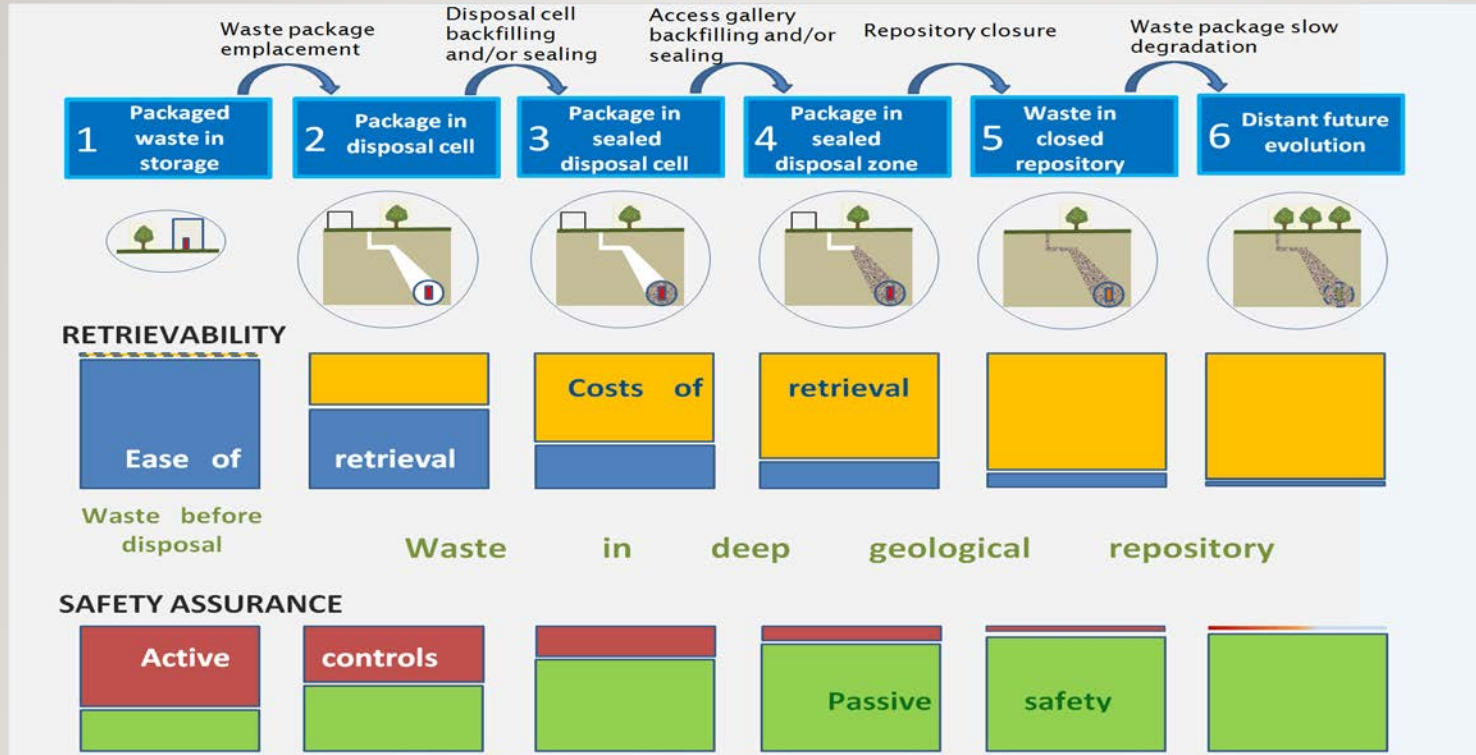
IF POSSIBLE ONCE, LIKELY ALWAYS POSSIBLE

- “Instead of refuting or ignoring these requests **Nirex did the research and found that it could deliver the retrievability that was being asked for:**
 - in terms of **technical feasibility**; and
 - **without compromising safety.**”

Nirex Report no. N/122 (2005)

EASE OF RETRIEVAL CHANGES WITH TIME

(INTERNATIONAL SCALE)



TECHNICAL MEASURES THAT BOOST REVERSIBILITY - I

- **Providing easier access to the waste packages.**
 - enhancing the stability of openings, for example by incorporating concrete or steel liners and by proper alignment of galleries to the rock stress;
 - delaying backfilling;
 - more easily removable buffer materials
 - delaying the final sealing of the access shafts to the underground facility
- **Providing improved capability to handle the waste packages.**
 - longer-lasting containers,
 - more durable waste forms.

NON-TECHNICAL MEASURES THAT BOOST REVERSIBILITY – II

- **A decision-making system that is inclusive and that proceeds in stages**
 - Before ending each stage the question is asked: Is there a need to go back and modify what was done?
- **Institutional and non-institutional provisions to preserve records and memory**
 - Maintaining records is required anyway for obtaining all authorizations and for meeting international safeguards agreements and requirements, including post-closure.
 - Keeping records up-to-date and usable over time is a challenge in and by itself

COSTS FOR SUPPORTING REVERSIBILITY AND RETRIEVABILITY

- They can range :
 - From **no** significant extra cost, if the option is “built-in” and part of the disposal concept (Sweden, Finland, France, ...)
 - To the **full cost** of the national program if, at one point, a much stronger commitment to R&R was wanted.

OTHER SELECT MESSAGES FROM THE NEA PROJECT – ON RETRIEVABILITY

- Disposal is carried out without the intention to retrieve. However, it is a good idea **NOT** to reduce retrievability unnecessarily and to apply reversibility
- ❑ **The type or degrees of “retrievability” must be socially negotiated for each national situation and, likely, over time.**
 - ❑ The ease of retrieval that may be built-in must be balanced against other considerations: limiting risk across generations; abiding to the expectations of society; cost and availability of the technologies. Technology will also depend on the physical location of the repository and the type of waste.
 - ❑ Prevailing attitudes to retrievability may change in time, e.g., whether to make it as difficult or as easy as possible to retrieve. There will exist opposing views at all times.
 - ❑ **It easier to scale-down than scale-up !!**

OTHER SELECT MESSAGES FROM THE NEA PROJECT – ON REVERSIBILITY

- **Reversibility is a characteristic (1) of the process of repository management and (2) of national decision making.**
 - ❑ **Aspect 1: Reversibility is “best available technique” in terms of a management approach that values flexibility.**
 - ❑ During development of the design and its realization, the *implementer* asks itself the question: could we undo this *action/decision*, if we wanted to? Are we placing unneeded obstacles to potentially reversing this action ?
 - ❑ **Aspect 2 : Reversibility is a feature of staged decision making.**
 - ❑ Each time a major decision to go forward is to be made, the *decision maker(s)* would address the question: are there, at this time, any reasons to change course or go back?
 - ❑ The final decision to close the facility will take advantage of the previous decisions where not needing to go back was explicitly addressed.

CONCLUSIONS

- **WALKING OFF A HLW REPOSITORY SITE IS NOT IN THE SPIRIT OF OUR TIME**
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- **RELEVANT QUESTIONS ARE : HOW TO WE KEEP AND EYE ON THE REPOSITORY FOR AS LONG AS PRACTICABLE? WHAT DOES IT ENTAIL? WHO WOULD DO WHAT ? And WHAT CONNECTION TO RETRIEVABILITY?**
 - **FOR ADVANCING DISPOSAL PROGRAMMES FORMS OF RETRIEVABILITY ARE NEEDED POST-CLOSURE. (Pre-closure retrievability seems obvious)**
 - **3 APPROACHES HAVE EMERGED:**
 - **FACILITATED ACCESS FOR REPAIR OR RETRIEVAL ;**
 - **NON-FACILITATED ACCESS BUT NOT-IRRETRIEVABLE DISPOSAL (RETRIEVAL TECHNOLOGY DEMONSTRATED) ;**
 - **NON-FACILITATED ACCESS BUT WHOLE CONTAINERS MUST BE SUFFICIENTLY INTACT FOR POTENTIAL RETRIEVAL OVER A MANDATED PERIOD OF TIME**
 - **APPLYING REVERSIBILITY IN REPOSITORY DEV'T IS A CHALLENGE BUT IT PAYS**
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