LONG-TERM PRESERVATION OF INFORMATION AND MEMORY

Summary of a topical session held at the 43rd meeting of the RWMC, 25 March 2010

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INTRODUCTION

Preservation of information and memory across generations is a cross-cutting theme of increasing importance for radioactive waste management both for institutional and non-institutional actors. National programmes would benefit from a shared, broad-based and documented understanding, at the international level, of the range of methods and concepts for the long-term preservation of information and memory. Such understanding – technical, institutional, societal and culture-specific – could be used as a reference for those national programmes that are involved in siting and licensing repositories, or that are involved in other long-term projects (whether or not those imply strong interactions with local communities, for whom preservation of information and memory is a particular concern). Such understanding would also foster the development of more robust strategies and regulations for national radioactive waste management programmes whatever their stage of implementation.

The interdisciplinary forum provided by RWMC offers an appropriate venue for exploring and helping to develop guidance on regulatory, policy and technical aspects of long-term preservation of information and memory that are germane to the implementation of waste management programmes. In 2009 the RWMC started its programme of work in the area of long-term preservation of information and memory\(^1\). In March 2010 a topical session was held on this subject during the plenary meeting of the RWMC with a view to identify common issues and, in due course, to start the RWMC first international project around the topic of an “action plan for long-term information and memory preservation in the field of geological disposal” as described in the document NEA/RWM(2009)7, p.5. A specific “vision document” was provided by the RWMC Bureau [NEA/RWM(2010)5].

The speakers were invited to address the following questions:

- What specific priority areas for long-term memory development have been identified in your agencies/countries? Which are the time scales of largest interest?
- Do these priority proceed from good practice or/and from specific laws, regulations, policies exist in your country that set out requirements for long-term memory in long-term waste management?
- How far advanced are you regarding establishing an action plan for long-term information and memory preservation in the field of geological disposal? Are you addressing the following RWMC questions:
  - What information should be preserved?
  - Why?
  - Where?
  - How should it be preserved?
  - Which target groups?
  - Which time horizons?

\(^1\) See document NEA/RWM(2009)7
What suggestions do you have for possible areas of focus for RWMC? (e.g., an international project that may assist members?) What are the untapped areas that deserve more attention?

Would you have studies, research, reports, policies that you might share with RWMC members?

RWMC members, plus IAEA, were also invited to provide input on this topic in advance of the meeting. The topical session was chaired by Kathryn Shaver (NWMO, Canada). The speakers were:

**ANDRA, France** Patrick Charton

**SKB, Sweden** Erik Setzman

**BfE, Switzerland** Michael Aebersold

**EPA, United States of America** Dan Schultheisz

**NEA, Claudio Pescatore**

The present report documents the topical session that was held by the RWMC in March 2010. The main text provides summaries of the presentations and of the discussions that took place within the Committee. The Appendix provides the actual slides that were shown during each presentation. A companion report [NEA/RWM(2010)7] tabulates the answers that were received from the RWMC members. Eventually the Committee decided to proceed with an international project on the subject of preservation of information and memory.
ITEM 21. TOPICAL SESSION ON LONG-TERM MEMORY

Chair: Kathryn Shaver

Ms. Shaver introduced the topical session. At the 2009 meeting, RWMC members were very positive on starting an initiative on long-term memory. This topical session was intended to develop the action plan for long-term information and memory preservation in the field of geological disposal as proposed in NEA/RWM(2009)7.

To initiate discussion, speakers were invited to address the following questions:

- What specific priority areas for long-term memory development have been identified in your agencies/countries? Which are the time scales of greatest interest?
- Do these priority areas proceed from good practice or/and from specific laws, regulations, policies existing in your country that set out requirements for long-term memory in long-term waste management?
- How far advanced are you regarding establishing an action plan for long-term information and memory preservation in the field of geological disposal? Are you addressing the following RWMC questions:
  - What information should be preserved?
  - Why?
  - Where?
  - How should it be preserved?
  - Which target groups?
  - Which time horizons?
- What suggestions do you have for possible areas of focus for RWMC? (e.g. an international project that may assist Members?) What are the untapped areas that deserve more attention?
- Would you have studies, research, reports, policies that you might share with RWMC members?

RWMC members, plus the IAEA, were also invited to provide input on this topic in advance of the meeting.

a. ANDRA

Patrick Charton

Mr. Charton presented the French regulatory guidance and Andra’s research on memory preservation. The regulatory guidance prescribes a retention period of at least 300 years for near-surface LILW facilities, and at least 500 years for geological disposal. The measures adopted by Andra for existing LILW facilities include a synthesis memory (a relatively short book) and detailed memory (about 500,000 pages), both printed on permanent paper, as well as records in the land registers to control future use. In addition, there are regular discussions with the public and with local information committees. There is a proposal to subject these measures to an international review every 10 years.

Within its sustainable development programme, Andra is also considering a number of initiative that would contribute to society keeping a relationship to the waste. Research is also being carried out on a number of topics related to very long-term memory preservation. Andra is proposing international cooperation on this subject.
b. SKB

Erik Setzman

Mr. Setzman gave a presentation on Swedish viewpoints and experience on long-term memory preservation. A draft action plan for long-term preservation of information about the repository is requested by the regulator. SKB is carrying out studies in a number of areas. They have considered a variety of potential incidents that could lead to loss of memory and are devising strategies to cope with these scenarios. A two-pronged approach is proposed, one involving records to be passed down from generation to generation, and the other involving permanent monuments and markers. The presentation also described a Danish documentary thriller about the difficulty of maintaining information about a repository for spent nuclear fuel video, called “Into Eternity”. Sweden is very interested to participate in international cooperation, and proposes several topics to be pursued.

c. BfE

Michael Aebersold

Mr. Aebersold described Swiss legal requirements and studies related to memory preservation. The law requires documents to be created for safeguarding by governmental agencies, and also permanent markers. To date there is little experience and many open questions remain. Desk studies are in progress looking at the scientific and technical state of the art, aims and limitations of markers, and knowledge management for long time scales. Switzerland proposes a comprehensive synthesis of the international state of the art, and supports the proposed RWMC project.

d. EPA

Dan Schultheisz

Mr. Schultheisz gave a presentation on geologic disposal and long-term memory preservation in the United States, including experience at WIPP. EPA’s general requirements include “the most permanent markers, records, and other passive institutional controls practicable to indicate the dangers of the wastes and their locations”. At WIPP, the DOE proposes to address these requirements via several measures, including a hierarchy of permanent markers, national and international archives and continued ownership of the site. He concluded by saying that RWMC attention on international consistency of messages, media, language, and type of records facilities would be useful.

e. Review of RWMC members’ input and available studies/reports from international agencies.

NEA Secretariat

Mr. Pescatore presented a review of inputs the Secretariat had received from members following the discussion at RWMC-42. Reasons cited for preserving information and memory included legal requirements to limit the likelihood of intrusion, and facilitation of decision making by future generations, both with regard to monitoring and surveillance and with regard to the need for future decisions on projects whose duration extends over several decades. The FSC has noted that local communities regard information preservation and memory as control measures that contribute to safety. Time scales of interest that were mentioned range from decades, for project decision making, to centuries or millennia over which continued memory would be desirable, e.g. for preventing inadvertent intrusion. Information to be preserved includes information about the nature of the hazard, detailed records of site construction and wastes emplaced, and metadata about the basis for past decisions to be used in support of future decision making.
Existing material that was mentioned included experience from the LLW field, study reports by the NDA in the UK as well as guidance from the regulator (HSE), an EC study on the collection, recording and storage of waste data up to disposal, IAEA TECDOC-1222 on waste inventory record keeping systems, a 1993 study in the Nordic countries, and Hungarian and Japanese studies.

There is general interest in a survey to provide guidance or confirm approaches in national programmes for identifying and managing information and meta-data. The IAEA and EC had both expressed interest in participating, and the EC had noted that consideration would be given to an EC research project if one was proposed.

f. Discussion

Ms. Kathryn Shaver opened the discussion. The following main points were made:

• Spent fuel will never be regarded as waste by the safeguards community. Therefore records must be kept. Both Euratom and IAEA will have to keep the info in their archives.
• Information and memory keeping is an issue that is closely related to retrievability. There should be a session on this topic in Reims.
• Not all information has the same value, and not all data deserve the same preservation efforts. It is not easy how to tell, however, which is which and how to reduce the info to be kept to the required level without being overwhelming.
• At WIPP, one of the messages that the scientists gave is that a message will not be understood the same way as society evolves. Maintaining meaning is one challenge in maintaining information.
• The IAEA is interested in co-operation. Several documents are available. For instance, one was released in 2006; another one, not from this area (decommissioning), dates from 2008.
• If we take a few steps back: where are the most important dangers in today’s society? In disposal? What is the situation in other fields? What memory systems are applied, for instance, to uranium mill tailings (UMTRA programme in the USA)?
• Any marker may attract people to the facility in other ways than just for keeping memory.
• One thing is clear from history: memory is lost and recovered intermittently. One must expect loss of knowledge and plan for making recovery possible.
• A plan that would work, on its own, for thousands of years is not credible; we must plan to pass on the task from generation to generation.

g. Way forward

Ms. Shaver referred to the vision document and the Bureau’s proposal that a project be scoped against discrete activities year. The project could begin in 2010 with a Study Report drawing from a survey of the literature and RWMC experience. The management structure of the R&R project would be implemented. Namely, an advisory group would propose direction of work; the work would be coordinated by the Secretariat and steered by the RWMC Bureau; a consultant would be hired; findings would be reported and discussed at March 2011. A budget would be needed for the project. The project should be run in such a way as to keeping travel to a minimum.

Ms. Haney asked whether this would be seen as a budget increase. H. Riotte explained that the voluntary contributions do not lead to an increase in the NEA budget. Interest in starting the project was expressed by:

• Sweden: both SKB and SSM.
• Switzerland: Nagra and BfE. Nagra nominated A. Claudel as contact.
• France: Andra.
• Finland: both Posiva and STUK
• UK: the NDA
• Spain: Enresa
• Czech republic: RAWRA
• IAEA

Reviewing the movie “Into Eternity” was mentioned as being beneficial at the start of the project. S. Webster observed that if this topic is under the scope of one of the EC technology platforms, it could also be subsumed in there, at least in part (for instance, a coordinated project with the regulators). The Secretariat observed that the amount of the needed financial contribution would depend on the number of participants. It would be at the level of 5,000€ per paying organisation.

A draft Terms of Reference will be developed by the Secretariat. It will be distributed along with the responses to questionnaire.

**Decision:** There is important interest in the subject of information and memory preservation. A number of initiatives in this area have been started. International cooperation is one part of the solution in many ways. It was agreed to start a survey study drawing from the available literature and RWMC experience. Terms of reference based on the current vision document will be distributed along with the summary of responses to the questionnaire. Confirmation in writing of the interest in participating will be requested with nomination of experts by end of May with a view to have a meeting or a teleconference in late June. The advisory group will make proposals to the RWMC Bureau for deliverables in 2011 and beyond. A conference on long-term information and knowledge preservation – to be held in 2013 – will be considered. The management model for the R&R project will be implemented for this project.
APPENDIX: PRESENTATIONS MADE DURING THE TOPICAL SESSION

Nuclear Energy Agency
Radioactive Waste Management Committee
43rd session – 24-25 March 2010

Initiative on long-term preservation of information
and memory under the AEGIS of the RWMC

25 March 2010

Patrick CHARTON
Sustainable Development

2nd topical session on long-term memory

1. French guidelines and applications
2. Andra’s solutions for surface disposal facilities
3. Andra’s research on the very-long-term memory
4. Proposals for international memory cooperation
1. French guidelines and applications

All the guidelines are issued by Nuclear Safety Authority:

- no long-term memory for the “very-low-level disposal facility”: only a normal archiving system (30 operating years followed by 30 years of monitoring)

- for the low- and intermediate-level short-lived disposal facilities (Aube and Manche), a long-term memory period is prescribed for 3 centuries after the beginning of the monitoring phase

- for the geological disposal facilities, the regulatory guideline recommends 5 centuries after the total closure of the facilities

1. French guidelines and applications

Two areas are concerned by long-term memory at Andra:

- Manche disposal facility (CSM, opened in 1969, closed in 1994)
  institutional monitoring phase since 2003 (technical monitoring since 1996)
  The long-term memory was implemented between 1995 and 1998, and complemented every 5 years

- Aube disposal facility (CSA, opened in 1994, in activity)
  Monitoring phase should start in the middle of the century
  The long-term memory is built day after day

Duration of the long-term memory for these facilities:

Prescription: 300 years after the beginning of the monitoring phase
Andra hopes more than 500 years
Implemented solutions can last between 600 and 1,000 years
2. Andra’s solutions for surface disposal facilities

The French approach for long-term memory for surface disposal facilities takes into account five solutions (1/2):

Three solutions for “passive memories”:
- A “synthesis memory” in a relatively short book
  → for global knowledge of the site
  → for the public and decision-makers (mayor, member of parliament, lawyer, association, media...)
- A “detailed memory” to answer several future scenarios
  → to understand precisely what can be seen on the site and the near environment
  → to modify the site locally or globally
  → for an operator or a manager of the site
- Easements (servitudes) recorded in the local cadastre (land register) to forbid constructions, other uses, ground water for domestic use...

For example, for our “Manche disposal facility”:
- a first version of “synthesis memory” in 160 pages
  → updated every ten years after each safety report
- a “detailed memory” to answer several future scenarios
  → around 500,000 pages of information, completed with new data every 5 years
- Easements recorded in the local cadastre: not done yet

2. Andra’s solutions for surface disposal facilities

The French approach for long-term memory for surface disposal facilities takes into account five solutions (2/2):

Two solutions for “active memories”:
- direct discussions with the public
  → site visits, conferences, open-days, special publications...
- discussions with the local information commission (CLT)
  → meetings, debates with associations and representatives, contradictory examination of results...

How we selected information:

Several scenarios (environment, physical, social and historical) in line with the safety analysis. A review of the scenarios and the selection had been made by an internal committee.

In the next two years, a French review and later an international review.

Then, every ten years, an international review to confirm the adequacy between the long-term memory and the needs of future generations.
2. Andra’s solutions for surface disposal facilities

How we store information:

For the current decades, knowledge, facility configuration and documentation are managed digitally.
They are stored on databases (for CSM, all the past is being digitized and will be entered in the databases by the end of 2010).

- If this phase isn’t performed correctly,
  it’s very difficult to work about long-term memory

For the future centuries, selected information for the future generations is printed on “permanent paper” (ISO 9706 and ISO 11118) every 5 years: 1 copy for National Archives and 1 copy for the disposal facility.

Digital technologies and databases are not a good solution for the long term: technological changes every ten or twenty years.

3. Andra’s research on the very long-term memory

Future geological facilities
The same thing will apply as for our surface facilities
(5 centuries required after closure)

Should the memory of the facility be preserved beyond societal requirements?

Solutions exist. For example:
- 5,000 years: micro-engraving [Japan]
- 25,000 years: surface markers [USA]
- 2,000,000 years: platinum/sapphire [France]

Is it sensible to keep memory over long timescales?
- What “industrial memory” have we kept of the past?
- What heritage have we found in and kept from the past?

Since 50,000 years we retrieved drawings, structures, objects...
Before, we only retrieved bones and fossils.
3. Andra's research on the very long-term memory

However still many questions remain to memorize for millennia and more:
- Which evolutions will there be for humans? Their organization? Their environment? Etc.
- Which will be the needs in this future? What information to preserve? Etc.
- Which languages? Which drawings, symbols or markings? Etc.
- How to avoid vandalism? Where to find the data? Etc.
- What meaning will future generations associate with those traces? Etc.
- How to transmit from generation to generation during all this time? Etc.

Andra studies in 2008/2009
- Durability of the solution “toner / permanent paper” according to several standards
- Scientific studies about the most important criteria of this solution

Andra projects for this year
- Manufacturing of a sapphire disk with platinum incrustation (Arnano from CEA/LETI)
- Manufacturing of micro-etching plates (Laser glyph – Japan)
  ➔ as demonstrators of very long term solutions

Andra project for the next ten years : long-term memory centers (CAM)
- Preservation center for animal and plant biodiversity (decided)
- Preservation center for geological samples
- Center for the international records of radioactive waste sea dumping
- Center for archives and memories of facilities and research about support and language
- Center for modern art contributions to the long-term memory
- Research center for sociology, history, long time scales...
- Museum for technologies used in the disposal of radioactive waste
4. Proposals for international memory cooperation

Proposals for international memory cooperation:

- Ten-year periodic review of our long-term memories of surface repositories (ICSM in 2012, then every 10 years) for the adequacy of future generations needs.
  ➡️ What about a “laboratory” to test process improvement from feedback?
- Creating a common Internet site for sharing information on the memory (database on the existing, and exchange of ideas and works for the future).
- Creating a study group on the different needs for very-long-term memory (millennium and more) to investigate different approaches for solutions.
- Sharing of thoughts for all or part of the CAM project as seen before.
  ➡️ What about transforming a national memory center into an international center.

All these actions require a prior assumption:

For present and future facilities, document and record management, configuration management and knowledge management must be operational and at a good level. Otherwise it is not possible to build long-term memory.

➡️ What about creating a group to exchange good practice in these fields?

Andra proposes to establish a steering group on the long-term memory whose aims would be:

- To propose topics of study at RWMC.
- To organize periodic exchanges (audio or video conferences, meetings…) to explore these topics.
- To report progress periodically (every 2 years?) and suggest new topics to RWMC.

Thank you for your attention.
Swedish Nuclear Fuel and Waste Management Company

Svensk Kärnbränslehantering AB

Long-term memory
Erik Setzman

Application – review – decision

Application KTL Final repository
Application MB Final repository, encapsulation plant and cell

Site selection

2009 2007 2008 2009 2010
Licensing review

Government decision

Conditions

KTL – Nuclear Activities Act
(Swedish Radiation Safety Authority)
MB – Environmental Code
(Envionmental Court)
Background Sweden

- SKB has been assigned the task of managing and disposing the spent nuclear fuel (timescale – 100,000 years)
- A draft action plan for long-term preservation of information about the repository is requested by the regulator
- The draft action plan should contain
  - Proposals on procedures for how the plan can be kept up to date
  - Suggestions for how the implementation of information preservation can be done
- After the closure of disposal facilities – the action plan and responsibility for the repository is expected to be passed to the State

Aim with information preservation

In the long term:
- Avoid damage by accident
- Allow for our generation and future generations to make decisions based on knowledge (use of the site, withdrawal of spent fuel …)

In the short term:
- Statutory filing, eg. for technology maintenance, safety reports and safeguards
- Facilitate continued technology development and research
- Facilitate historical research of societal concern
Laws and regulations in Sweden

- Regulations on filing at nuclear plants (Swedish Radiation Safety Authority)
- Regulations for filing in general (Swedish National Archives)
- Conservation and Retrieval of Information (NKS 1993.596, SKB TR 96-18)
- Maintenance of Records for Radioactive Waste Disposal (IAEA-TECDOC-1097)
- ISO standards for filing and document management

Recent work at SKB

Information preservation

- A summary of previous and ongoing work in Sweden and in other selected countries (2007)
- A proposal for an action plan to preserve and transfer information, in the short and long term (2008)
- Initiated a network with other stakeholders:
  - Swedish Environmental Protection Agency
  - Swedish Radiation Safety Authority
  - Swedish National Archives
  - Swedish National Heritage Board
  - SAKAB (hazardous waste management)
Examples of target groups

Conclusions

- Planners and developers of new facilities (e.g., mines)
- Politicians, decision-makers
- Waste management companies, energy companies
- Scientists
- Members of the public, nearby residents

What information is of interest to preserve?

Conclusions

Facts and know-how...

- Vital to safety, environmental protection and licensing
- Facilitating possible further development
- Of great scientific or social interest

- Location and site information
- Design, structure and properties of the repository
- Properties and content of radioactive waste and other substances
- Results from and data used in safety analysis
Time horizon
Conclusions

- Today and near future
- At the time of decommissioning and closing of facilities
- Very far future

*Focus on potential incidents, not on time!*

Potential incidents
Conclusions

<table>
<thead>
<tr>
<th>Incident</th>
<th>Consequence</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>War salvo (Political)</td>
<td>File or markers are destroyed or degraded</td>
<td>Geographic redundancy of archives, markers</td>
</tr>
<tr>
<td>Society continuity breaks (Political)</td>
<td>Loss of authority facts</td>
<td>Geographic redundancy of archives, Markers</td>
</tr>
<tr>
<td>Information preservation poorly performed (Social)</td>
<td>Information is destroyed entirely or partly</td>
<td>Long-term mandate with clear responsibilities, markers</td>
</tr>
<tr>
<td>Change of language and importance of markers (Social)</td>
<td>Misinterpretation can lead to wrong behaviour</td>
<td>Regular update and revision of archives and markers</td>
</tr>
<tr>
<td>Environmental changes (Environment)</td>
<td>File or markers damaged or lost</td>
<td>Geographic redundancy of archives, Markers</td>
</tr>
<tr>
<td>Degradation of the medium (Technical)</td>
<td>Misinterpretations</td>
<td>Update medium, several mediums, markers and archives</td>
</tr>
</tbody>
</table>
Strategies for preservation

Two alternative tracks:
- From generation to generation
- Directly into a distant future

From generation to generation
Media

- Paper, 200 – 1,000 years
- Microfilm, 200 – 300 years
- Video, CD, DVD, approx 10 years
- Magnetic media, approx 10 years
Directly into a distant future
“Charged landscapes”

Measurement and formation of technological sublime locations

- Project in the framework of SKB’s social science research
  Gunilla Bandolin, College of Art and Sverker Sörlin, KTH, School of Architecture
- Conservation issues – protection, memories and monuments of locations with an element of risk and danger
- Case studies in Australia and USA (2005)

The communicative task is difficult and one should seek fundamental and simple solutions

Here detonated the first atomic bomb. Source: Jon Forber, University of California

Directly into a distant future
“Watch out!”

Symbol!!
- Competition on SKB’s website for youths (2007)
- 250 suggestions were received
Examples of preserved information

- Cave paintings and pyramids
- Potsherds from Mesopotamia (possible to interpret)
- Runestones and petroglyphs
- Vatican archives
- Parish registers and population registers (Sweden)

"INTO ETERNITY"

- A Danish documentary thriller about the difficulty of maintaining information about a repository for spent nuclear fuel
- Dialogue with SKB, Posiva and authorities in Finland and Sweden
Swedish Radiation Safety Authority
National report 2009, under the Convention on Nuclear Safety

Presents an overview of were different categories of radioactive waste arise and how it is handled and disposed

How to preserve information about near surface landfills and disposal of long lived radioactive waste in order to maintain control in the long term?

• State records, including restrictions on the short and long term use of the current land areas

Use existing real estate register – managed by the National Land Survey

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Next step
International cooperation – Long-term memory

SKB is anxious to participate in international cooperation!

• Identified that international cooperation is a part of the solution
• SKB are about to submit the applications
• Action plan for information preservation requested by the regulator
• Positive experiences from CAN 1-3 “Conservation and retrieval of nuclear information”. A project in IAEA 1992–1993
Key aspects to handle 1(2)
Long-term memory

What should be preserved? (information with focus on the content of the canisters and location of the repository)

Where should it be preserved? (in established archives, in connection to the repository, as markers in the landscape, in the collective memory)

How should it be preserved? (format, language and medium)

Key aspects to handle 2(2)
Long-term memory

• Clear responsibility for collection, updating and revision of information
• The most serious consequences:
  • Information disappears physically (physical loss)
  • The information is available physically, but can not be understood or interpreted (epistemic loss)
• Main measures
  • Geographical redundancy of information (archives)
  • Markers
Thank you for your attention!
Topical session on long-term memory

43rd Session of the Radioactive Waste Management Committee

Nuclear Energy Legislation (1)

Nuclear Energy Act
Art. 40 Protection of a deep geological repository
The protection zone is the underground area in which intervention could interfere with the safety of the repository. The Federal Council shall specify the criteria for the protection zone.

Anyone intending to carry out deep drilling, construct shafts, carry out explosions or other activities that affect a designated protection zone is required to apply to an authority designated by the Federal Council for a licence.
Nuclear Energy Legislation (2)

The Federal Council is responsible for ensuring that all records concerning the repository, the waste stored therein and the designated protection zone are duly preserved and that associated findings are retained in a suitable manner. It may pass on corresponding data to other countries or international organisations.

The Federal Council stipulates that the repository be permanently marked.

Nuclear Energy Legislation (3)

Nuclear Energy Ordinance
Art. 71 Documentation

1 The owner of a deep geological repository must compile documentation that is suitable for securing information about the repository over the long term.

2 This documentation must contain the following:
   a. the location and extent of underground structures;
   b. an inventory of disposed radioactive waste by type, quantity and disposal area;
   c. the design of safety barriers, including sealing of accesses;
   d. the basis for and findings of the definitive analysis of long-term safety.
Nuclear Energy Legislation (4)

The owner must hand over all documentation to the Department [of Environment, Traffic, Energy and Transportation] after closure or on expiry of the additional monitoring period.

Where we stand today

Where we stand in Switzerland
⇒ Legal requests
⇒ No/few experience
⇒ No state-of-the-art
⇒ Many open questions

Desk study (in progress)
⇒ Scientific and technical state of the art
⇒ Aims and limits of markings
⇒ Knowledge-management for long time scales
Desk study (1)

General questions
⇒ What are the reasons - why?
⇒ What information (content)?
⇒ Potential of misunderstanding, manipulation?

Human and Society
⇒ Sender and receiver of the messages?
⇒ Learning from the past?
⇒ Time frames?

Desk study (2)

Environment and geology
⇒ Changes of the environment (surface) and the repository (underground)?
⇒ Is it possible to (voluntarily) forget about the repository (hiding potential)?

Markings
⇒ State-of-the-art of the technology?
⇒ Active and passive measures?

Communication
⇒ Reparation and correction measures?
⇒ Coding and decoding mechanisms?
Desk study (3)

Provisional findings
⇒ Vast information is available in the literature
⇒ Ongoing research
⇒ No clear answer to the question “what should be marked”
⇒ No comprehensive synthesis of the actual knowledge

“What ever we think and do today, we can not anticipate or take decisions for future generations”
“What can be used, will be used by future generations”
“Information over long-time frames will change meaning or be misunderstood”

Conclusions (1)

Learning from the past
e.g. Topical session on Interpreting radiological protections principles & criteria for geological disposal

“Consensus nationally and internationally is hampered by the lack of common definitions of concepts and terms”
“Regulations have to be explained to and understood by different stakeholders,…”
“International guidance plays an important role, serving as a basis for national regulation development and as an element for stakeholder confidence.”

Dr. Carmen Ruiz Lopez, RWMC Paris, March 25th 2010
Conclusions (2)

- Comprehensive synthesis of the international state-of-the-art
- Identification of the main questions and developing a common understanding
- Definition of a common policy

Support the suggested way forward: NEA/RWM(2010)5

1. Human and society
2. Environment (Biosphere, Atmosphere, Hydrosphere)
3. Hostrock and geology (Lithosphere)
4. Disposal facility with radioactive waste
5. Barrier and remote systems (in the disposal facility and in the environment)
Geologic Disposal and Long-Term Memory Preservation
Experience in the United States

25 March 2010
Presented by:
Dan Schuster
U.S. Environmental Protection Agency
Office of Radiation and Indoor Air
Radiation Protection Division

Presented to:
Nuclear Energy Agency
Radioactive Waste Management
Committee (RWM/C)
43rd Meeting – Session 21
Paris, France

Overview of Presentation

Memory Preservation
• in Statute
• in Regulation
• at the Waste Isolation Pilot Plant*
  • Implementation
  • Site markers/passive institutional controls
  • Application to the safety case
  • Examples
• Summary

*While this presentation focuses on WIPP, geologic disposal for spent fuel and high-level waste would consider similar issues, with the possible exception of the time frame applicable to these institutional control measures
Memory Preservation in Statute

Nuclear Waste Policy Act of 1982 provided one basic justification for preserving knowledge of a spent fuel repository:

“[A]ny repository...shall...permit the retrieval of any spent nuclear fuel...during an appropriate period of operation of the facility, for any reason pertaining to the public health and safety, or the environment, or for the purpose of permitting the recovery of the economically valuable contents of such spent fuel.”

United States Code, Title 42, Section 10142

Memory Preservation in Regulation

EPA’s generally applicable standards for spent fuel, high-level waste, and transuranic waste extended requirements for memory preservation (40 CFR 191):

- “Disposal sites shall be designated by the most permanent markers, records, and other passive institutional controls practicable to indicate the dangers of the wastes and their locations” (191.14(c))
  - “Can be effective in deterring systematic or persistent exploration of disposal sites” for mineral resources
  - “Can reduce the likelihood of inadvertent, intermittent human intrusion to a degree determined by implementing agency’
- “[R]emoval of most of the wastes is not precluded for a reasonable period of time after disposal” (191.14(f))
  - “Disposal” defined as “permanent isolation” (i.e., after closure)
Memory Preservation at WIPP

EPA’s compliance criteria for the Waste Isolation Pilot Plant contain specific requirements (40 CFR 194):
- “Compliance application shall include detailed descriptions of the measures that will be employed to preserve knowledge about the location, design, and contents of the disposal system” (194.43(a))
  - Markers of controlled area “as permanent as practicable”
  - Records in “archives and land record systems of local, State, and Federal governments, and international archives” including
    - Location of controlled area and disposal system
    - Design of disposal system
    - Nature and hazard of waste
    - Site data pertinent to containment of waste (or its location)
    - Results of tests on containment of waste (or its location)

Implementation at WIPP

Department of Energy (DOE) proposed to address these requirements through the use of
- Markers to convey a hierarchy of messages, including
  - Large earthen berm outlining waste emplacement area
  - Dozens of granite monuments, large and small
  - Information rooms above and below ground
  - Thousands of small buried markers
- National and international archives
- Site ownership
- Message in multiple languages communicating
  - Facility location and design
  - Content and hazard
Potential Analogs for Site Markers

- DOE contractor surveyed Native American petroglyphs within 250 km of WIPP
- Direction and inclination of surface has no observed effect on longevity
- Local granite subject to exfoliation - sandstone, basalt, andesite, rhyolite/rhyolitic tuff weathers more evenly if not jointed or fractured
- Study concludes that inscriptions on unfractured rocks should last thousands of years

Additional Studies on Markers/Controls

**DOE continues to evaluate passive controls**

- Re-evaluation of the surface berm indicates use of salt is not optimal, even in arid climate where salt is protected
- Long-term durability of granite is suspect due to exfoliation; local basalt may be a good substitute
- May need to re-design large surface markers because of potential difficulty in construction
- Use of alternate materials should be reviewed in conjunction with modified long-term control designs, such as cylindrical information room made of concrete
- Final design due at time of closure
Application to the Safety Case

DOE proposed to take credit for passive institutional controls in limiting human intrusion
- DOE must justify proposed time period on the basis that controls will endure and be understood (194.43(c))
- EPA may allow credit for “several hundred years”
- DOE proposed to limit drilling intrusion rate by 99 percent over 700 years (primary release mechanism)
- EPA agreed that controls likely to endure, but not “virtually certain” to be understood
- EPA questioned quantitative estimates and did not accept proposed drilling rate reduction – no credit

Example – Small Warning Marker

Small markers such as this would be placed throughout the controlled area

DANGER
POISONOUS RADIOACTIVE WASTE HERE
DO NOT DIG OR DRILL

Disk diameter 23 cm (9 in)
Not to scale
Example – Surface Berm

A surface berm would extend around the perimeter of the underground disposal rooms.

Example – Proposed Surface Berm Profile

Berm Cross Section (Profile not to scale)

- Salt
- Caliche
- Riprap
- Soil/Riprap

13 m
4 m
30 m

NGF (SW)

NGF (NW)
Example – Information Rooms

Information rooms would be constructed above and below ground
Summary

U.S. law and regulation addresses long-term memory
- Retrievability of waste
- Limitation of future human intrusion (intentional or not)

Information should be preserved describing the nature of the site and hazard for general public
- Preserved in multiple locations w/various media/devices
- Time frame for WIPP ~10,000 years (TRU/ILW)
  - Much greater challenge for spent fuel/HLW (~ 1 million years)
- Significant progress on plans for WIPP (still evolving)

RWMC attention on consistency of messages, media, language, type of records facilities, would be useful
TOPICAL SESSION ON LONG-TERM MEMORY

REVIEW OF RWMC MEMBERS INPUT AND AVAILABLE STUDIES/REPORTS FROM INTERNATIONAL AGENCIES

RWMC-43  Item 21e

Claudio Pescatore, PhD

Presentation

• FIVE QUESTIONS

• RESPONSES FROM EIGHT COUNTRIES (plus the ones in the Topical session) + IAEA and EC

• FEEDBACK RECEIVED
WHY preserving information and memory - 1 ?

• Requirements for records, markers, and other LT memory measures have been associated, historically, with the need to limit the potential for human intrusion.

• In the US there is a high-level requirement to maintain the capability to retrieve waste for some times after disposal. This was applied to WIPP.

• There is now an affirmed intention to favour decision making by future generations. In particular,
  • an emerging issue of “continued” monitoring and safeguards
  • realization that any development project will take decades until end of operations: which data to save, how to contextualize it so that it is useable by future generations for their management decisions and also for re-use, e.g., in a safety case?

WHY preserving information and memory - 2 ?

• The NDA reports on the interest of communities in discussing the strategy for information and memory preservation.

• From FSC:
  • Local communities/partnerships do look at information preservation and memory as “control” measures that increase safety.
  • Some also have an interest in helping in monitoring and in managing information and memory.
Time scales

- Several decades of transferring information to succeeding generations for managing decisions
- One-to-two centuries of actual operations and continuous data checking and re-certification of data and licenses
- A few centuries of active information and memory keeping, with perhaps reviews of license
- Millennia of repository evolution where information and memory-keeping would be desirable.

*Some mention all those scales, others only one or two*

Planning for information preservation (and memory)

- Is a legal obligation and also descends from regulatory or policy guidelines
- Has been (is being) implemented in the field of LLW (e.g., Spain, Korea)
  - Possibly important lessons to be learnt there
Planning for the future is to take place now

- In any event a license would not be given without proposed provisions for long-term info and memory keeping; much work done at the WIPP for their licence

- Communities want to discuss strategies for long-term information and knowledge management

- “In order to achieve the long-term objective we must focus on the timescale for transferring the information and knowledge to the next generation in a way that it does not foreclose their options for managing it in turn, which we characterise as a timescale of the order of 30 years”

What to “save”

- Information and knowledge about the nature of the hazard
  - Land use controls, permanent markers, preservation of records at multiple locations

- Actual records
  - Waste characterization and inventory
  - Location and lay-out of repository, boreholes, shafts and ramps, boundaries of the site
  - Site data, the rock volumes that provide containment, those that contribute to retention, the results of monitoring...
  - The nature and hazard of the waste, the location of the WP...

- Metadata to support decisions of future generations
  - How data was used; basis for decision-making

- Both summary and detail information should be preserved
What useful material is already available

- WIPP CCA of 1996 has numerous references
- Experience from the LLW field
- Study Reports of the NDA.
- Recent guidance (2010) from the UK regulator (HSE)
- EC study on the collection, recording and storage of waste data up to disposal
- IAEA-TECDOC-1222 on Waste inventory record keeping systems (WIRKS) for the management and disposal of radioactive waste of 2001
- Nordic Countries’ study of 1993....
- Documents in the Hungarian programme
- Studies from the Japanese programme (also in English)

Where efforts would be needed

- The NDA and the HAEA observe that the real challenge for the future lies on the “long-term of enabling or contextual information and the importance of metadata”. Think short-to medium-term in order to prepare for the long-term
- The USA points out the importance to arrive at uniform archival of records and uniform type of markers, in a long-term optics
- STUK suggests revisiting the Nordic Countries’s study of 1993. Archiving is an important issue.
- Japan speaks of the interest of an overall study
- Interest in survey to provide guidance or confirm approaches in national programmes for identifying and managing information and meta-data
Overall

- The topic is of high interest both to regulators and implementers.

- There is acceptance that the issue needs addressing
  - although, at this stage, colleagues tend to see different areas/timescales of priority.

- EC and IAEA are ready to co-operate. EC-Research observes that consideration would be given to a EC project if proposed by April 2011.
LONG-TERM PRESERVATION OF INFORMATION AND MEMORY

RWMC-43 Item 21

Kathryn Shaver

Possible Next Steps

• Project management through “R&R” model:
  • Members establish Steering Group to direct project (by June)
  • NEA Secretariat is project coordinator
  • Assisted by consultant to NEA
  • Cost-sharing

• 2010
  • Distribute to RWMC responses to survey questions, reference document
  • Initiate project: Study Report (survey of literature, RWMC experience)
    • Steering Group provides direction on structure
    • Report findings at March 2011 RWMC

• 2011-2012
  • RWMC, with Steering Group, identifies specific project focus each year
  • EC-Research—possibility to pursue research topic through EC program if alignment of topics

• 2013
  • Potentially a conference to highlight findings