

## Long-term preservation and the concept of oversight

*(The start of this period is very speculative.  
It may begin at perhaps 1 000 years from closure)*

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According to the definition of the Records Knowledge and Memory (RK&M) initiative, “long-term” refers to “the period of time with no repository oversight. This period extends over the time of concern in the safety regulations, typically over hundreds of thousands of years in the case of high-level waste” (NEA, 2014a). “Oversight”, in turn, “is a general term for ‘watchful care’ and refers to society ‘keeping an eye’ on the technical system and the actual implementation of plans and decisions” (NEA, 2014a). Oversight is always exercised by people and includes regulatory supervision (such as control and inspection), institutional control (e.g. monitoring), preservation of societal records (such as archiving) and societal memory keeping of the presence of the facility (ICRP, 2013). After closure, and as more time goes by, oversight and preserving RK&M should become a societal endeavour.

The lack of oversight, as defined above, is therefore equivalent to the lack of memory keeping and awareness of the facility. This implies that, in order to allow any transmission of information, RK&M preservation mechanisms still in place at the time of loss of oversight must have the potential to generate awareness of the facility, thus initiating a new period of oversight. Although the facility is designed to be safe by itself, this “regeneration of awareness” is desirable, because oversight will reduce the probability of inadvertent intrusion and favour taking informed decisions about the facility.

In the course of Phase I of the RK&M initiative, it was recognised that there was no single best means of RK&M preservation over all time scales: a combination of mediated and non-mediated transmission methods should be preferred (“dual-track strategy”) within a systemic approach in which the various elements complement and reference to one another. This would provide redundancy and therefore maximise the survivability of a recognisable and comprehensible message.

Phase I of the RK&M initiative has led to the conclusion that markers or other marking strategies, taken individually and in isolation, may not be fully effective. They could, however, play an important role in a systemic approach to RK&M preservation.

### Markers and marking strategies

Throughout Phase I of the initiative, a number of RK&M preservation methods frequently mentioned in the literature were discussed during meetings and workshops to gain input from members and other specialists, whereby considerable attention was given to the

general topic of “marking a site”. This concept was first established in the United States and has, for many years, been a recurring topic in the discussions surrounding geological disposal. It has been presented as the main non-mediated method for preserving memory and deterring human intrusion.

As other important concepts, the term has been included in the RK&M Glossary, whereby a “marker” is defined as “a long-lasting object that indicates an area of influence, power or danger. It is placed strategically at or near the site for immediate recognition or for discovery at a later time. Any marker is conceived to be immobile (i.e. in permanent association with a site), robust, in order to maximise survivability on its own, and [able] to provide messages that are likely to be understandable across generations” (NEA, 2014a).

Furthermore, the topic was looked into specifically when compiling the RK&M Regulatory Catalogue. At present, no country other than the United States and Switzerland legally requires the use of markers. However, discussions have shown that issues such as whether markers should be used at all, when to start preparing for them, and when to construct them will require further evaluation and development of the corresponding regulatory guidance. This was found to be potentially beneficial, both for the repository planning process and the dialogue with local communities.

Finally, two dedicated studies – a literature review and reflections on the role of traditional tsunami warning stones in Japan – were sponsored by the initiative and are briefly presented below.

### **A survey of existing marking concepts**

The original *Literature Survey on Markers and Memory Preservation for Deep Geological Repositories* (NEA, 2013), commissioned by the Swiss Federal Office of Energy in 2008, was translated and edited by the RK&M group. It reviews some 150 publications, with a large number of titles published between in the 1990s and 2000s. The study aimed at compiling existing information and conveying both the complexity of the topic and the variety of interdisciplinary issues that remain to be addressed. The remarks below reflect some findings of the literature survey as well as discussions held in the framework of the RK&M initiative.

A wealth of ideas, technologies and materials has been proposed for marking a repository, both on surface and sub-surface (e.g. berms, magnets, radar reflectors, small ceramic tokens, tracers, acoustic signals, marking of disposal shafts and waste containers, or biological marking). With regard to materials, adaptation to the natural environment and/or the use of non-recyclable and non-reusable materials has been suggested. In line with historical markers in other fields, such as archaeological artefacts, large surface markers in the form of monuments have received a lot of attention. In addition to deliberately placed markers, residual surface features such as retaining walls built to preserve visual amenity, altered water courses or access routes for road and rail were noted to leave marks or “scars” in the landscape, thus hinting at previous activity. It has been suggested that geological disposal sites mark themselves by means of their content and/or artificial barrier materials, implying the possibility of a message based on radioactivity or on other physical properties of the disposal components, e.g. gravitational magnetism. The concept of cultural marking, for instance through choosing a meaningful name for the site, has also been mentioned. Finally, additional methods, not yet discussed in this particular context, have been found to be worthy of further investigation. This is the case for “time capsules”, ranging from a simple box to a full room holding a range of artefacts and due to be opened or accessed at a future date. These three-dimensional “information repositories” have the potential to preserve meaningful content with some degree of complexity over long periods of time.

However, in spite of the variety of proposals discussed, no straightforward, conclusive answers – and therefore no clear recommendations – have emerged as to the objectives,

the messages and the methods to be used. Arguments against the implementation of markers are just as numerous, and plausible, as arguments in favour of them, for instance: even if individual markers remain intact and traceable over time, they can be moved or destroyed. Cultural and aesthetic interpretations or even deliberate falsification can alter the meaning of the messages they bear. They may also attract intruders rather than deter them.

A case study on an existing marking method was considered necessary in order to assess the role and effectiveness of markers in more detail.

### **Tsunami stones: A model for repository markers?**

Hundreds of so-called “tsunami stones” can be found on the north-eastern shore of Japan. Emplaced at different times in history to commemorate past tsunamis, they carry different messages, e.g. a warning against building houses close to the sea. The case study *Markers – Reflections on Intergenerational Warnings in the Form of Japanese Tsunami Stones* (NEA, 2014) was aimed at assessing how effective stone markers could be in preserving information in order to warn populations and urge them to take appropriate actions to protect themselves.

The potential longevity of this type of marker has clearly been demonstrated, as tsunami stones have been shown to last up to 1 000 years with, in some cases, old stones being regularly replaced by new ones. It has also been shown that their historical and cultural significance may accrue over time, although the evolution of language may make it more difficult to understand the messages of commemoration and warning they convey.

However, the effectiveness of the tsunami stones as warning devices can be questioned: in many cases, the messages they bear were not heeded. Reasons for this include a lack of awareness or understanding, but also, more importantly, reliance on other, more modern warning systems, deferring responsibility to the authorities, and pursuit of short-term economic interests. Memory may be kept alive – the actual warning function, however, seems more likely to survive in relatively small rural communities that have closer links to their past, an oral history tradition and more limited access to, or confidence in, the latest technologies.

### **Markers and beyond**

As for other means of RK&M preservation, the effectiveness of markers on the long term, i.e. in the absence of oversight, depends on the care exercised during periods of oversight. Even if stone markers are conceived for non-mediated information preservation and transmission, society undoubtedly has an important role to play in the longevity of comprehensible messages. Indeed, in earlier periods, markers may be part of a strategy fostering the existence of cultural links between the waste repository and the siting communities. They can be included in mediated, memory-regenerative processes, restricted land use functions, rituals, and/or conceived as mediated objects themselves.

If the goal is to ensure that awareness and knowledge of the repository are periodically regained, the marking strategy must be geared towards purposefully leaving traces – possibly with some traces being designed to be immediately visible, while others would only be rediscovered in the future. This could be achieved by a network of redundant markers – a marking system – placed strategically and designed to arouse curiosity and the desire to learn more. To design individual markers, the methods compiled during Phase I (briefly outlined above) should be further evaluated.

Regarding the content and level of detail of the message conveyed by the marking system, the case study on tsunami stones has shown that factual information is transferred more easily than warnings and memory more easily than knowledge.

However, the sole awareness of past events and impacts is not enough to ensure the kind of oversight that supports safety. It is knowledge that saves lives: the marking strategy should therefore be aimed at reinitiating awareness and oversight at a level that would foster learning and understanding. This could be done by stimulating the willingness to understand the sense and purpose of the markers, but also by pointing to other sources of information that may be available elsewhere. With this in mind, the potential use of “time capsules” within a marking system should be further assessed.

## Conclusions

An important conclusion reached during the course of Phase I of the RK&M initiative is that there is no single best means of RK&M preservation over all time scales: a combination of mediated and non-mediated transmission methods should be preferred (dual-track strategy) within a systemic approach in which the various elements complement and reference to one another. This would provide redundancy and therefore maximise the survivability of a recognisable and comprehensible message.

Visible markers placed near or above a waste disposal site have been the most studied form of marking so far. Taking into account the results presented before, the effectiveness of markers taken by themselves and in isolation may be questioned. However, markers could play an important role in a systemic approach to RK&M preservation. At this stage, their specific function – in relation with the defined time scales – remains to be outlined in more detail, as do potential interactions with other RK&M preservation and transmission methods. Whether some degree of international standardisation would be beneficial when designing markers also needs to be evaluated.

## References

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