HOW TO KEEP THE MEMORY OF NUCLEAR WASTE ALIVE

In Switzerland, there are three regions under discussion for the construction of deep geological repositories for radioactive waste: Jura Ost (AG), Nördlich Lägern (AG, ZH) and Zurich Nordost (TG, ZH). The places where the repositories will be built in the end should, according to current opinion, remain recognizable over a very long period of time and knowledge about the deep geological repositories should be passed on over thousands of generations. A group of experts from the Organization for Economic Cooperation and Development (OECD) now outlines how this can be achieved in a report to be published in autumn. Experts and representatives of the regions discussed the proposals and their consequences for Switzerland at a conference at the Kunsthaus Zurich in early September 2019.

A threateningly designed ‹spike field› - according to an idea from the late 20th century - could keep people away from nuclear waste disposal sites. Illustration: Documentation RK&M-Symposium

A technical report about the results of the symposium «Mark, point or forget?» on 4 September 2019 in Zurich, which was organized by the Swiss Federal Office of Energy. The report has been published in several regional media.

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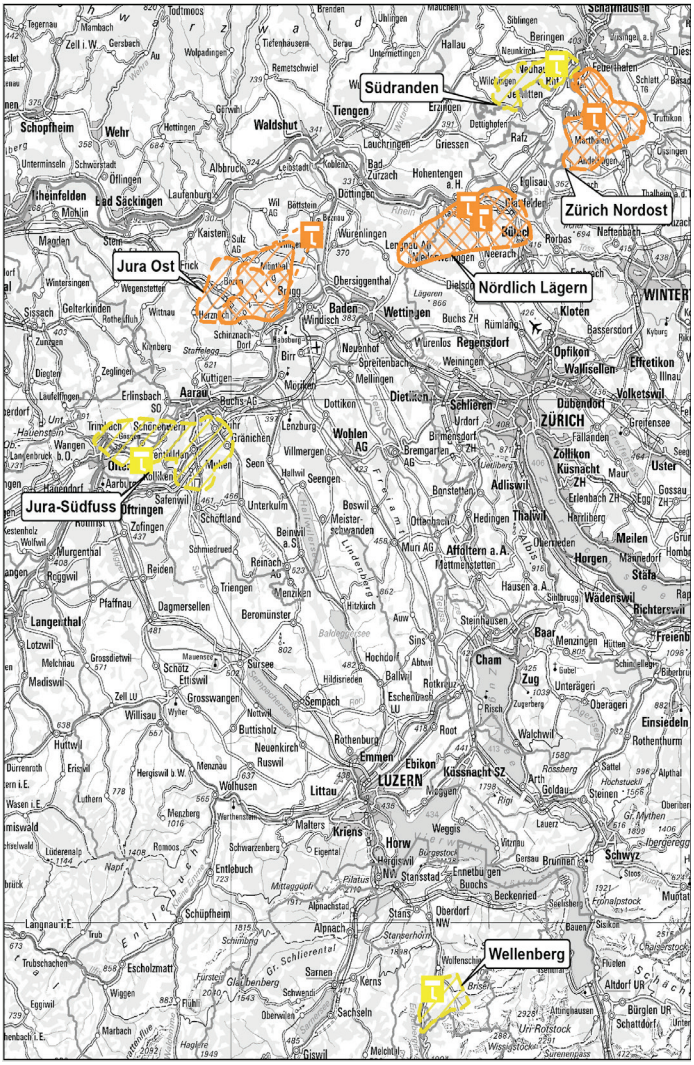
Deep geological repositories store radioactive waste that endangers people for hundreds of thousands of years if they come into contact with it. Therefore, the waste must be safely sealed and it must be ensured that no human inadvertently enters a storage facility. This was a striking idea developed in the 1980s and 1990s: It was proposed that large steel spikes, boulders or earth walls be erected at the site of the repositories to warn people not to enter the site. Another idea was to breed cats that would react to radioactive radiation with a color change in their fur. They would warn people of any radiation that might be emitted.



Following a decision by the Swiss Federal Council in November 2018, the following three regions are under discussion as sites for deep geological repositories for radioactive waste: Jura Ost (AG), Nördlich Lägern (AG, ZH) and Zürich Nordost (TG, ZH). The regions are shown in orange in the diagram. The three areas in yellow are reserve options. Graphic: SFOE

The discussion of how the location and content of nuclear depositories can be kept in the consciousness of the population for very long periods of time continues today. "Whereas in the past it was mainly a question of preventing inadvertent entry into the deposits with obstacles, today it is primarily a question of maintaining knowledge of the deposits for as long as possible in order to enable future generations to make informed decisions about the disposal of radioactive waste," says Simone Brander, who works at the SFOE as an expert for the disposal of radioactive waste.

Results of the RK&M-Initiative

A conference organized by the Swiss Federal Office for Energy in Zurich at the beginning of September 2019 discussed how the knowledge and memory of nuclear deposits can be preserved for thousands or even hundreds of thousands of years. "Mark, point or forget?" was the title. However, the third option - forgetting - was not seriously considered by any of the speakers. "Prescribed forgetting does not work," said Dr. Stephan Hotzel of the Association for Facility and Reactor Security GRS in Cologne. Hotzel is chairman of the initiative RK&M (for: Preservation of Records, Knowledge and Memory). Since 2011, experts from 14 countries have been discussing how knowledge and information on deep geological repositories can be preserved over the long term under the umbrella of the Organization for Economic Cooperation and Development (OECD).

Hotzel presented the results in Zurich, which will be published in the final report of the RK&M initiative. The result was not a patent solution for all nuclear repositories worldwide, but a «toolbox» of 35 instruments, as Hotzel put it. The spectrum ranges from documentation and marking through the establishment of archives and museums to the activities of supervisory authorities and legislators (see table p.3). According to Hotzel, the measures must be selected in such a way that important information remains available even in the event of partial losses (redundancy), and the affected population must be involved (participation).

Generally Understandable Key Information

France has already gained practical experience in this field, namely at the Manche low and intermediate level waste disposal plant at La Hague (Normandy), which was closed in 1994 and is intended to be a long-term storage site. Those responsible at Andra, the French equivalent of Nagra in Switzerland, prepared a Key Information File (KIF) for the plant.

Approaches	Mechanisms	
Dedicated record sets and summary files	• Key Information File (KIF) • Set of Essential Records (SER)	
Memory institutions	• Archives • Libraries • Museums	
Markers	• Surface markers • Monuments • Sub-surface markers	• Deep geological markers • Surface traces
Time capsules	• Large visible time capsules • Large invisible time capsules • Small time capsules	
Culture, education and art	• Industrial heritage • Alternative reuse of the disposal site/infrastructure • Heritage inventories and catalogues • Public information dissemination activities	• Local history societies • Intangible cultural heritage • Education, research and training • Art
Knowledge management	• Knowledge retention tools • Knowledge risk analysis • Knowledge sharing philosophy	
Oversight provisions	• Monitoring • Land use control • Clear and planned responsibilities	
International mechanisms	• International regulations and agreements • International standards and guidelines • International inventories and catalogues • International education and training programmes	• International cooperation • International archiving initiatives
Regulatory framework	• National regulatory framework • Safeguards	

The table lists nine approaches with a total of 35 tools (mechanisms) devised by the RK& M initiative with which knowledge about the storage of radioactive waste can be preserved for the future. Table: RK&M Initiative

The 35-page document summarizes the most important information about the plant. The guide is written for the general public and is intended to ensure that no one is endangered at the plant and that all the information necessary to ensure proper handling of the storage facility will continue to be available in the future.

"This is the first time we have made available a summary commemorative document as required by French legislation since 2016," said Andra disposal expert Jean-Noël Dumont in Zurich. The document was sent to the French supervisory authority in spring 2019. It will be updated every ten years. The KIF is one of the many instruments from the "toolbox" of the RK&M initiative. The idea is to complement the KIF with a more comprehensive Set of Essential Records (SER) addressed to technical experts. Dr. Ulrich Noseck (Association of Facilities- und Reactor Security GRS/Braunschweig) called the creation of a SER challenging, as it is supposed to contain many documents and very different types of documents. To ensure that the information remains available for a long time, Noseck advocated that the information be stored electronically for the time being. He would recommend age-resistant paper for long-term storage, he said.

Permanent Marking Planned

Switzerland still has time to decide in what form the memory of its nuclear heritage should be kept alive in future generations: According to current planning, the two Swiss repositories - one for low and intermediate level waste, the other for high-level radioactive waste - will not be filled with radioactive waste until 2065/74 and will be closed definitively by 2118/24. The 2003 Nuclear Energy Act provides for "permanent marking" of deep geological repositories. Only the building permit application can one day prove what this will actually look like. Deep geological repositories must be built in such a way that they safely store radiation waste. Site markings are not mandatory for the safety of a deep geological repository, "but only serve to increase the chance that the deep geological repository will remain undisturbed," said Dr. Felix Altorfer, Head of the Disposal Supervision Division at the Swiss Federal Nuclear Safety Inspectorate (ENSI). As long as the state and the Federal Archives are there, the preservation of knowledge about the repositories is not a problem, Altorfer said. But in the long term this prerequisite may no longer be met, and consequently alternatives must also be considered.

In Switzerland and many other countries, there are now regulations for the storage of records on nuclear waste, but hardly any binding requirements for the preservation of knowledge and "memory". In Zurich, Dr. Anne Claudel (Nagra) advocated an approach based on the RK&M initiative to develop an

appropriate strategy to ensure the long-term preservation of knowledge about future Swiss deep geological repositories. Claudel sees the legislator, the supervisory authority (ENSI) and the waste management organization (Nagra) as having a duty to do so. "This does not shift responsibility onto future generations, but gives them the opportunity to assume responsibility if they want to," Claudel said.

Impulses from the Humanities

The Zurich conference complemented the debate on the long-term preservation of knowledge with a humanities perspective on art, literature and cultural studies. The Belgian philosopher Jantine Schröder calls deep storage a "socio-technical long-term experiment," the success of which will only be certain at the very end of the storage period. "Art can make an important contribution here to coping with the uncontrollability of the experiment," said Anna Volkmar, who is writing a doctoral thesis on the relationship between art and nuclear energy at the University of Leiden (Netherlands). She presented various works of art dealing with radioactivity and reported how students at the Free University of Amsterdam ritually buried a demon made with 3D printing in May 2018. Volkmar said that the performance created a "feeling of complicity" with regard to the final storage issue. Art could "create a sense of consternation - as a basis for further engagement with the problem," Volkmar said.

Art and nuclear waste can sometimes come very close: In the Dutch interim storage facility COVRA, museums now store some of their works of art between the barrels of nuclear waste. This fact was referred to in his presentation by the cultural scientist Dr. Cornelius Holtorf (Linné University Kalmar/Sweden). He sees nuclear waste as "a special kind of cultural heritage." If there is a dispute about this heritage today and also in the future, this conflict ultimately serves the preservation of knowledge, because it is precisely polarization that ensures that people deal with a topic, Holtorf said.

Despite all the Uncertainties

With all the different approaches discussed at the Zurich Symposium on the preservation of knowledge on the long-term storage of radioactive waste, it became clear time and again that, in view of the long time periods of one hundred thousand, even one million years, society faces a task that ultimately cannot be overlooked. Stephan Hotzel from the RK&M initiative did not want to be discouraged by this and said that the efforts to preserve knowledge would be worthwhile despite all the uncertainties. "You despair when you think of a million years," Hotzel admitted, but also pointed out that "radioactive waste will be somewhat less dangerous in 10,000 years" than it is today.

↗ **Presentations** from the symposium "Mark, point or forget?" on 4 September 2019 at the Kunsthaus Zurich are available at: https://bit.ly/2kULu14

↗ The **final report** of the RK&M-Initiative will be available shortly at: www.oecd-nea.org/rwm/rkm/

Installation by the Belgian artist Cécile Massart: The three spots of colour are only provisionally protected, so that the visitors spread the colour throughout the room over time. The artwork encourages the viewer to think about the effectiveness of warning and protection strategies, says art historian Anna Volkmar. Illustration: Documentation RK&M Symposium

- Information on the **symposium** topic can be obtained from Simone Brander (simone.brander[at]bfe.admin.ch), Head of the Service for Waste Disposal at the SFOE.

- Further **information** about nuclear waste can be found at: https://bit.ly/2m4eK5w.

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Version: November 2019