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PANEL SESSION 24: Records, Knowledge and Memory (RK&M) for Nuclear Waste Geologic Repositories

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Tom Klein, *AECOM Technical Services, EPA Compliance Programs*

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Panelists

1. **Christine Gelles**, *Corporate Vice President and Chief Strategy Officer, Longenecker & Associates*
2. **Kathleen Economy**, *Physical Scientist, Radiation Protection Division Center for Waste Management and Regulations, US EPA*
3. **Jean-Noel Dumont**, *Special Advisor, Andra (France)*

Approximately 30 people attended this session which focused on the challenge of developing long term markers for nuclear waste geologic repositories, the form the markers should take, what the message should be, and some schools of thought behind communicating with future generations. The session began with a presentation given by each panelist including a question and answer period immediately following each presentation. The session ended with an extended question and answer period. The question and answer periods covered topics such as consideration of repository location in marker design, the potential impact of social media on RK&M, the importance of international collaboration, and the evolution of language.

Summary of Presentations

Christine Gelles began her remarks with how the current Practical Implications for the Safety Case Methodology also applies to longer term disposal solutions. The primary responsibility for safety must rest with the operators. A lot of what is being done today is undoing past disposal decisions. The engineered adequacy of our records and markers needs to be as important as our present operational engineering. Don't only consider long-term geologic disposal issues. Parts of the world face significant risks right now due to lack of controls. In thinking about warning future generations, we cannot lose sight of near and present dangers.

Kathleen Economy began with an overview of what EPA has done about Passive Institutional Controls (PICS). EPA wrote in the regulations that PICS have to be part of compliance licensing for a waste repository. EPA has put PICS aside for the moment in favor of other issues. She then transitioned to a discussion of markers. Human beings are procrastinators, opportunists, spiritual, and have a short memory. Historically, edifices that have been protected through millennia were spiritual in nature. This spirituality transcends government. How do we instill a sense of reverence into long term memory for nuclear waste? It is our ethical duty to erect markers, but in

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a mineral rich environment, will future generations heed them? The Fukushima builders ignored the tsunami stones. EPA is considering these things, but right now it is not a big priority.

Jean-Noel Dumont gave a talk accompanied by a PowerPoint presentation entitled “Markers: What for and How?” Some tsunami stones were trusted, and some were not. Why is that? Phoenician sarcophagi were intended to deter intrusion. They did not work. We still do not know the full meaning and intent of the Egyptian pyramids. Markers are intended to warn of danger. They may or may not be interpreted correctly. Languages evolve and die. For a Rosetta stone type situation, at least one of the languages must still be known. Pictograms could be understood by people with different languages, but are not always self-explanatory. France has held two contests for artists concerning long-term memory and many of the entries were markers. Markers could be used in conjunction with landscape archeology. They could aid in interpreting the modification of the landscape. A set of multiple different types of markers could be an effective solution. In France, markers are a part of a systematic approach to memory preservation, but are not required by regulation.

Question and Answer

A question was posed about a reactor being disassembled in Manitoba, Canada. The plan is to simply back fill the space around the reactor and walk away. It is on treaty land and located 100 meters from a river. What markers should go on the site and for how long? **Christine Gelles** addressed the question by suggesting that the current operator should ensure that they fully understand the characterization of the reactor shell and run models. They need to demonstrate they understand the dose probability over time and add some detection around the perimeter. Markers that persist for several hundred years should be adequate. The same attendee followed up by asking how do we keep communicating the information about the site and ensure future generations believe it. **Christine Gelles** responded that it should be modeled. Can you make a compelling case based on models? Build in uncertainty as generations go forward.

Kathleen Economy addressed a question about what the effect of social media will be on long term memory. Social media is an example of short-term memory. It is so temporal that it will not have an effect on long term memory. The message is going to have to be written in stone. The attendee followed up by asking if social media is detrimental to transmitting facts. **Kathleen Economy** replied that it absolutely was. Social media is excellent for transmitting mythology.

Kathleen Economy was asked if she would add curiosity to the list of human attributes. Wouldn't markers draw people to investigate? She replied that, that was one of the original arguments against using markers. Look at the Sphinx or the pyramids as examples, or the Palmyra site that was destroyed by ISIS. If you are going to use markers, make them beautiful.

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Christine Gelles added, what we think the reaction to barriers will be or could be completely wrong. The solution is engineered impediments with re-visitation of the adequacy of the solution. Keep improving upon the record and marker systems over time. Another attendee responded with a statement that 1000 years ago they carved and painted. They thought their message would be around forever. The # sign's meaning has changed in just the last decade. Media changes quickly. Ultimately, interpretation today is much different than years ago.

Jean-noel Dumont was asked how important International collaboration is to ensuring the same markers are used in different countries. He replied that common markers could help with interpretation. **Kathleen Economy** added that EPA asked the same question to DOE about WIPP. We are all human. We have that commonality. We essentially have the same needs across cultures. International collaboration is very important. We will be a more global community in 200 years. We are doing what we think we know is right, right now. **Tom Klein** noted that he recently read an article that coined the term "Homo-Globus." Man is moving toward a global community. If there was a common global theme for markers, then people doing research in different countries would automatically know what the markers mean. **Kathleen Economy** replied by saying that if you look back at what survives, it seems to be spiritual sites like cemeteries and burial grounds.

Kathleen Economy responded to a question about the languages that had been included on a disk that had been sent with a space probe. They used music, hieroglyphs, animal sounds, etc. **Russel Patterson** added that WIPP had specified seven languages for the markers. One of the biggest things RK&M is looking at is communicating across generations. RK&M is looking at three time frames: short, medium, and long. Each time we look at a longer time period it gets more difficult in terms of language. We need to be better prepared. We need to have answers to all these questions. We need to have a plan in place. **Tom Klein** added that we would love to have the younger generations engage in the discussion as well. We have proof that human language evolves in just a couple hundred years. We have been looking at the possibility of soft A.I. like SIRI to overcome that challenge. Maybe the markers could be some sort of kiosk information exchange.

A question was posed to the entire panel that a lot of thought had been given to warning people. Has anyone thought about inviting people in? One example would be the Manhattan Project National Park site. Make people care about the site instead of fearing it? **Tom Klein** replied that thought certainly had been given to that possibility. In fact, the majority of the Manhattan Project's materials are emplaced at the WIPP, so the WIPP should be part of the Manhattan Project National Park system. **Russel Patterson** noted that there have been discussions about developing something that the community sees as a benefit, like a tourist destination or a spiritual site. It is not always a message of warning. We have tried to move toward a message of simple facts; leaving moral judgements about the material out of it.

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Kathleen Economy added that if vandals destroy something beautiful, they are ostracized. What is beautiful or beneficial tends to be protected.