PACIFIC RIM SPENT FUEL MANAGEMENT PARTNERSHIP WORKSHOP

Organized by the Nuclear Threat Initiative (NTI) and the Korea Radioactive Waste Agency (KORAD)

5-7 September 2018
Kyowon Training Center · Gyeongju, Republic of Korea

MEETING SUMMARY

Introduction and Objectives

The co-chairs emphasized the importance and benefits of tackling spent fuel management challenges cooperatively. Approaches include sharing of best practices, exchanging information and collaborative R&D to address security, safety and proliferation concerns. The main objective of the workshop was to operationalize the research agenda by creating several working groups that will work to address specific topics that are beneficial to all participants. These working groups will be tasked with identifying gaps in current research and developing cooperative work streams. The groups will define the purpose, structure and schedule of their work in early 2019 then meet throughout the rest of the year and 2020 to complete their tasks.

Session 1: Above-Ground Long-Term Monitored Storage

The main safety functions of storage systems are maintaining subcriticality, confinement and radiation shielding. Thermal management also must be considered as several components have temperature limits. Components that are important to safety include, but are not limited to, bolted lid systems, lid seals, metal canister welds and fuel cladding.

Discussion focused on the effects of aging on long-term dry storage of spent fuel. Higher volume storage options are spent fuel pools and storage vaults. Lower volume dry storage options are of two major types: a bolted lid metal system and welded steel canisters inside a storage overpack. Regulators and national laboratories have concerns about long-term degradation of storage systems – container integrity (seal failures, cracks) and fuel integrity. Some inspection experiments – muon, acoustic, thermal – are being developed for potential applicability to detecting failures and/or identifying incremental degradation. It was also noted that some pools are approaching capacity in Korea or have reached saturation in Taiwan and the development of centralized storage facilities have been delayed by lack of social acceptance in Korea and political/environmental issues in Taiwan.

Discussion then moved to Germany's experience with above-ground monitored storage. Dual-purpose casks for transport and interim storage were developed in the 1970s and licensed in the 1980s. There are two centralized storage facilities – Gorleben and Ahaus. In the 2000s, there was a political decision to quit reprocessing by banning transport of spent fuel except for final disposal. As a result, 12 independent spent fuel storage installations (ISFSIs) were required – one at each nuclear power plant site. The ISFSIs were built and have operated without any public resistance for more than a decade. The concept of interim storage is widely accepted as long as the ISFSI is on-site and the spent fuel is from the co-located plant only. Local stakeholders participate from the earliest stage of the siting process.

Ideas for Working Group R+D

- Develop a better understanding of seal failures
- Investigate canister cracks and mitigation/repair options, including inspections
- Investigate cask-to-cask transfers and transfer of spent fuel without a spent fuel pool
- Study deformation of seals over time under pressure
- Examine transportation issues (especially for high burn-up fuel) and licensing
- Remote monitoring
- Consideration for the interim storage of used/spent enhanced accident tolerant fuel

Session 2: Deep Borehole Disposal

Benefits of the DBD concept include robust isolation from biosphere (several kilometers deep), long residence time of deep groundwater in the crystalline basement – including isolation from shallow groundwater – and the highly saline environment enhances the absorption and limits the solubility of many radionuclides.

Several countries have done, are doing, or are interested in researching DBD for disposing of certain types of radioactive waste. Deep drillings have been carried out in several parts of the world using technology borrowed from the oil and gas industry, and the technology has advanced greatly. However, drawbacks to this disposal technique include the difficulty of retrieving the waste package (as some national legislation requires) and waste package contents. KAERI has done predominantly conceptual work on what type of waste should be emplaced if deep boreholes are considered. In Korea, DBD is considered a disposal alternative and international cooperation is sought on this topic. Given seismic activity in Japan and Taiwan, how feasible is this disposal concept for the region?

The United States has been deeply involved in DBD research and development, although it is not envisioned for disposal of spent nuclear fuel. The US deep borehole disposal concept involves a 2km disposal zone with a 1km basement seal, with the boreholes reaching a depth of 5km. There are concerns related to the characterization of the boreholes and drill head drift, which has to be kept to a minimum, or retrieval of the waste packages becomes impossible. There is currently no active US government DBD program.

Deep borehole disposal could be investigated as a complementary disposal pathway to a repository. While DBD feasibility has not yet been demonstrated, advancements in drilling technology encourage further work on this topic. A field test would be particularly useful. As demonstrated recently in the US, siting is a challenge.

Session 3: Underground Research Laboratories (URL)

Discussion focused on R&D activities at Japan Atomic Energy Agency's Horonobe and Mizunami Underground Research Laboratories. Both URLs were established based on a recommendation by the Japan Atomic Energy Commission in 1994. The URLs help to confirm the applicability of geological disposal techniques, advance understanding the deep geological environment, providing a training area for staff from Japan and international disposal programs, and promote public understanding of deep geological disposal.

Activities Horonobe include: development of techniques for investigating and long-term monitoring of the geological environment; developing design and construction technologies; performing studies on long-term stability of the geologic environment; and enhancing the safety assessment methodologies. In the current phase, a full-scale EBS test was conducted to observe near-field coupled THMC phenomena in-situ, increase the confidence in models and demonstrate various technologies related to disposal pit excavation, EBS emplacement and tunnel sealing. No radioactive materials are allowed in either URL – experiments using radionuclides are conducted at the Tokai Laboratory.

There was clear interest in international collaboration at the Japanese URLs, particularly THMC modelling, R&D on corrosion and related aspects, and up-scaling. Participants expressed hopes for flexibility in experiment conditions as different countries may have different THMC situations. A longer term R&D perspective (beyond 2020) is also needed to ensure continued support for and operation of the URLs. After identifying common interests, technical agreements should be put in place but in order to initiate substantive collaborative projects, top-down support from senior political leadership will be necessary.

Ideas for Working Group R+D

- Standards to ensure disposal media characterization is proper and verifiable when applied to repository development
- Extended benchmarks based on the EBS experiment:
    - monitor the THMC behavior after heating;
    - safety assessment at full saturation;
    - simulation of transient THMC processes until full saturation in the EBS
- Dismantling of the EBS experiment
- Tracer experiments:
    - develop up-scale methods for performance assessments as only small-scale data are now available;
    - validation of system performance by in-situ experiments;
    - training and education of tracer experiment technique;
    - standardization of tracer experiment method to deal with regulation requirements

Session 4: Public and Stakeholder Engagement

Wolseong LILW Disposal Center

Korea currently has 24 operating reactors with 5 more units under construction that are expected to be operational by 2029. Spent fuel is temporarily stored at each reactor site: pools for PWRs; pools and dry storage for CANDU. A repository for low and intermediate level waste – the Wolseong LILW Disposal Center – in Gyeongju has been in operation since 2015. All waste transport to the facility is by sea. Total capacity is 800,000 drums of waste:

- In the first phase, 100,000 drums of waste will be disposed in six underground silos reaching a depth of 130 meters below sea level
- In the second phase, now under construction, 125,000 drums of waste will be disposed in a engineered vault near-surface facility

For two decades, the Korean government tried to site a repository for all categories of nuclear waste. Due to lack of success, responsibility for the LILW and SNF streams was separated in 2004 and transparency/stakeholder participation was emphasized. In late 2005, the provincial city of Gyeongju voted (89.5% approval) in a referendum to host the LILW disposal facility. Also of note: the benefits package offered to the host community was increased significantly in March 2005. In 2013, a Public Engagement Commission (PECOS) was established to make recommendations on spent fuel management based on stakeholder input. As a result, a 'national plan on high level waste management' was approved in 2016. A second public engagement is planned that will revisit the plan to address social acceptance amongst other topics.

Participants discussed the utility of making this topic a formal information exchange on lessons learned while acknowledging that each situation is unique and best practices will need to be tailored to the needs of the specific country/host community. The group agreed that a two-track approach would be most useful: track 1 focused on public/stakeholder engagement and track 2 focused on technical issues.

Session 5: Training, Education and Information

Discussion focused on the technical feasibility assessment report on spent nuclear fuel final disposal (SNFD) in Taiwan. The SNFD 2017 report includes the spent fuel management strategy and the geological disposal program, the geological disposal system and the safety concept, the geological environment, the repository design and engineering technology, the safety assessment, the technical basis for site selection and development of safety standards, and future R&D requirements. Over the past 20 years of geological repository R&D work, three potential host rock types (granite, mudstone and Mesozoic basement rock) were identified – granite is preferred. No candidate site has been identified yet. A reference case has been established based on surface geological survey, geophysical survey and borehole investigations. No implementing agency has been created yet.

There was group interest in sharing technical materials and best practices in order to facilitate better public communication. It was noted that an important part of making this work is providing a language translation service. A proposal was made to couple this topic with public and stakeholder engagement to create a more comprehensive siting working group. This idea will be revisited in 2019.

Session 6: Cooperative Approaches to Disposal

The OECD NEA Radioactive Waste Repository Metadata Management (RepMet) Initiative was the focus of discussion. The objective of the initiative is to investigate the role of metadata in data, information and knowledge management within the national programs for radioactive waste repositories. RepMet has created three Libraries: a Site Characterization Library (geological and geophysical characterization of the repository site), a Waste Package Library (packaged waste and spent fuel ready for final disposal) and a Repository Library (repository requirements and structures at closure). One proposed topic for further discussion was investigating security aspects of a multinational facility.

Next Steps

Participants agreed to help facilitate the establishment of three working groups in the first phase of work. These are:

1. Underground research facility R&D;
2. Long-term monitored dry cask storage;
3. Siting
    a. Public/stakeholder engagement
    b. Technical aspects

Participants committed to selecting which working group they will join and agreed to identify experts in their own country who should be invited to join specific working groups.