Case Study: United States of America

Communication and stakeholder involvement in the radioactive waste disposal programme

1. Overview of RWM (especially disposal) programme

The U.S. Department of Energy's (DOE) Used Fuel Disposition Research and Development (UFD) Campaign identifies alternatives and conducts scientific research and technology development to enable storage, transportation, and disposal of used nuclear fuel (UNF) and wastes generated by existing and future nuclear fuel cycles. An overarching objective of the campaign is to support the Administration's 2013 *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste* (http://energy.gov/downloads/strategy-management-and-disposal-used-nuclear-fuel-and-high-level-radioactive-waste, henceforth referred to as the "*DOE Strategy*"). The *DOE Strategy* identifies key goals and target dates associated with used nuclear fuel management. The challenge for the UFD Campaign is to provide a sound technical basis for supporting the DOE strategy for managing the back end of the nuclear fuel cycle, including the identification and evaluation of safe and secure options for storage, transportation, and permanent disposal of radioactive wastes resulting from existing and future fuel cycles.

Storage and Transportation Research and Development R&D examines three topics: Storage, Transportation, and Security. Storage R&D focuses on closing technical gaps related to extended storage of UNF, including uncertainties with high-burnup nuclear fuel cladding performance and long-term canister integrity. Transportation R&D focuses on ensuring transportability of UNF following extended storage, addressing data gaps regarding nuclear fuel integrity, retrievability, and understanding stresses and strains during normal conditions of transport. Security R&D focuses on questions related to material attractiveness and self-protection due to surface dose rate, which decreases as UNF ages. The UFD campaign participates in the international Extended Storage Collaboration Project, led by the Electric Power Research Institute (EPRI) with input from the DOE, the U.S. Nuclear Regulatory Commission, and programs in multiple other nations.

A major current focus is the start of the Confirmatory Data Project. This project, led by EPRI under contract to DOE, will conduct a multiyear test to collect data from a UNF dry storage system (located at the North Anna Nuclear Power Plant in Virginia, USA) containing high burnup fuel. The primary goals of the test are to provide confirmatory data for validation of, and potential improvement in, models of the long-term performance of high burnup fuel under typical dry storage conditions. These models will provide key input to future dry storage cask design, support license renewals and new licenses for Independent Spent Fuel Storage Installations, and support transportation licensing for high burnup used fuel.

Disposal R&D focuses on identifying multiple viable geologic disposal options, addressing technical challenges for generic disposal concepts in various host media (e.g., mined repositories in salt, clay/shale, and granitic rocks, and deep borehole disposal in crystalline rock). R&D goals at this stage are to reduce generic sources of uncertainty that may impact the viability of disposal concepts, to increase confidence in the robustness of generic disposal concepts, and to develop the science and engineering tools needed to select, characterize, and ultimately license a repository. International collaborations are a significant component of the disposal R&D portfolio, and include: DECOVALEX (Development of Coupled Models and their Validation against Experiments, with participation from multiple nations in Europe and Asia); the Mont Terri underground research laboratory (Switzerland); Colloid Formation Migration (Switzerland); SKB Task Force (Sweden), Salt R&D (Germany); and crystalline disposal R&D with Korean Atomic Energy Research Institute (KAERI) Underground Research Tunnel.

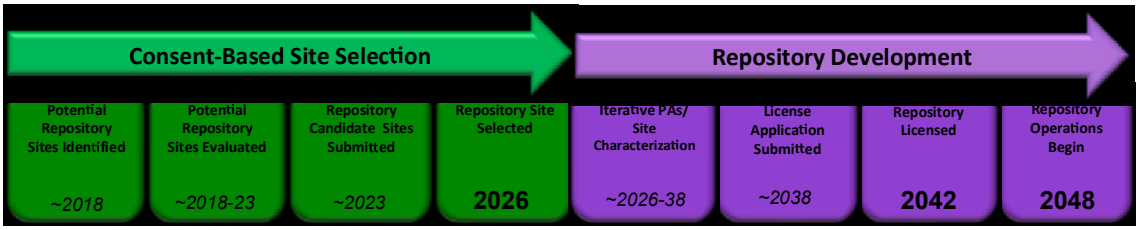

Figure 1. Summary Timeline for Disposal R&D activities.
Note: Approximate target dates (in *italics*) needed to meet deadlines (in **bold**) set out in the *2013 DOE Strategy.*

Disposal R&D is being performed in multiple areas, including analysis of generic mined repository concepts in salt, crystalline rock, and clay/shale rock, as well as deep borehole disposal. Related R&D had examined the performance of engineered barriers, including the waste form, in various geologic environments, and the feasibility of direct geologic disposal of existing dual-purpose (storage and transportation) canisters currently used for dry storage of used nuclear fuel. Selected work is highlighted here.

Evaluation of Disposal Options for the Existing and Projected Inventory of HLW and SNF involves a multidisciplinary team including members from eight national laboratories, universities, DOE, the US Navy, and private firms concluded that multiple disposal options are available for all existing and currently projected waste forms, with the exception of untreated sodium-bonded fuels, for which additional information is needed. Host media considered included salt, crystalline hard rock and clay/shale rock. Disposal concepts include backfilling upon emplacement (salt) and emplacement of a sorptive backfill either at emplacement or after a ventilation period for mined repositories, and disposal of small waste packages in deep boreholes in crystalline rock.

Direct Disposal of Dual Purpose Canisters (DPC) investigates the feasibility of direct disposal of DPCs supports the conclusion that direct disposal of DPCs is technically feasible, at least for some DPCs, and for some of the disposal concepts depending on the system thermal response, potential for postclosure nuclear criticality, and long-term opening stability. Specific to criticality controls, a key finding is that chloride-rich brines (as might be found in a salt repository) could function as an effective neutron absorber and virtually eliminate the potential for post-closure criticality events.

Deep Borehole Disposal current activities included completion of a Project Plan for a deep borehole field test designed to evaluate the feasibility of the deep borehole disposal concept without the use of radioactive waste. As planned, the five-year test will site and drill two boreholes (one small diameter and one large diameter) at the same location to conduct downhole scientific analyses assessing hydrogeochemical conditions and engineering analyses assessing the viability and safety of deep borehole canister emplacement.

Generic Mined Repository R&D current activities include:

- Establishment of reference cases for mined repositories in crystalline, clay/shale, and salt host rocks. Reference cases provide a common basis for analysis of representative concepts, and specify the emplacement concept, waste inventory, waste form, engineered barriers including packaging, host rock properties, failure scenarios, and biosphere properties.
- Improved data and models for reactive transport (and actinide sorption/retardation) in fractured rock, building on data from the Grimsel test site in crystalline rock in Switzerland.
- Experimental investigations of the impact of elevated temperatures on material properties of clay, relevant to the performance of both host rock and engineered bentonite backfill.
- Development of generic disposal system modeling capability that employs (1) the high-performance-computing (HPC) capable PFLOTRAN multi-physics code to support the evaluation of repository and subsystem performance in the presence of coupled thermal-hydrologic-chemical (THC) processes, and (2) the HPC-capable uncertainty sampling and propagation code DAKOTA for sensitivity analysis and multi-realization performance assessment. The PFLOTRAN-based modeling capabilities provide multi-physics representations of various coupled processes, including waste degradation, radionuclide

mobilization, fluid flow, and radionuclide transport (advection, dispersion, diffusion, sorption, and radionuclide decay and ingrowth) through the engineered barriers and natural barriers to a well location in an overlying aquifer.

Generic Disposal System Modelling has been demonstrated with deterministic and probabilistic simulations of a reference-case repository in bedded salt, as shown in Figure X. The generic salt repository model included a complex, integrated THC source term (spatially-varying waste degradation across 160 individual waste heat-generating packages, decay heat and thermal effects, and radionuclide solubility and mobility), fluid movement and radionuclide transport through the engineered backfill, disturbed rock zone, host rock (halite and anhydrite interbeds), and overlying aquifer and sediments. In addition to deterministic baseline simulations, sensitivity analyses were performed from 100 realizations with 10 varying parameters.

International Collaborations in Disposal Research included collaborative work investigating field tests from underground research facilities in Switzerland (Mont Terri and Grimsel), Sweden (Äspo), Japan (Horonobe), the Czech Republic (Bedrichov Tunnel), and the Republic of Korea's KAERI Underground Research Tunnel (KURT). Work included completion of nine reports documenting advanced modeling of field tests in the areas of 1) near-field perturbations and engineered barrier system integrity, and 2) fluid flow and radionuclide transport. The UFD campaign also participates in the planning of two major field tests in underground research facilities and has performed related laboratory experiments.

2. Legal and institutional framework of stakeholder involvement in RWM

Please describe conventions, directives, laws, regulations, etc. which specify the obligations and prescribed procedures.

3. Roles and responsibilities of each player in stakeholder involvement in RWM

Please explain the roles and responsibilities of national government, local government, nuclear power operator, RW implementer, the public, local community, scientific community, etc.

If it's possible and applicable, please try to highlight the role and responsibility of regulatory bodies (i.e., nuclear regulator, environmental regulator).

4. Major challenges and key strategies to address the challenges

Please give a few challenges in implementing stakeholder involvement in RWM especially disposal, which you want to emphasize. (e.g., no clear process, no financing mechanism, no volunteer community, strong opposition, unwelcomed NGOs, opposition of surrounding communities, opposition from neighbouring countries etc.)

Also, please explain the most relevant strategies to address such challenging issues. (e.g., local partnership, community benefits, mediators, local committees, consultation with small group, veto right, etc.)

5. Some concluding remarks

References

- USDOE, January 2013, Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Waste." http://energy.gov/downloads/strategy-management-and-disposal-used-nuclear-fuel-and-high-level-radioactive-waste

- Bragg-Sitton S, Birkholzer J, MacKinnon R, McMahon K, Saltzstein S, Sorenson K, Swift P, "Update of the Used Fuel Disposition Campaign Implementation Plan." FCRD-UFD-2014-000047, Idaho Falls, ID: US Department of Energy Fuel Cycle Technology Program; 2014

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