The Office of Nuclear Materials Disposition Fiscal Year 2011 Research and Development Activities - 11537

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Abstract

The Office of Nuclear Materials Disposition (EM-33) reports to the Office of Technology Innovation and Development (OTID) and supports the core mission and function to manage and dispose of surplus nuclear material. EM-33 coordinates surplus plutonium, spent (or used) nuclear fuel (SNF), and other surplus material disposition through interactions with other stakeholder organizations, identification of key issues and proposed resolutions. The Nuclear Materials Disposition (NMD) research and development (R&D) program area has identified several task areas to improve technical understanding.

This paper discusses the strategy and approach for developing technologies for handling nuclear materials requiring disposition and provides an overview of high priority tasks.

Introduction

EM-33 reports to the Director of the OTID and coordinates the preparation (characterization, treatment/stabilization, and packaging) and disposition of surplus nuclear materials, SNF and other surplus materials. The 2010 Environmental Management (EM) Roadmap to Excellence[1] lists SNF storage, receipt, and disposition and special nuclear material (SNM) consolidation, stabilization and disposition as two of seven EM program priorities. To accomplish these missions, EM-33 performs analyses, develops integrated program strategies and identifies program areas that would benefit from technology development. These activities require extensive interface with other Department of Energy (DOE) Program Offices, industry groups, and international partners to optimize technology development efforts and integrate planning, coordination and timely resolution of cross-cutting issues. EM-33 seeks to develop and deploy technologies to reduce identified project risks associated with the management of SNF, challenging materials and excess plutonium.

Although no technology development activities were funded in FY 2010, EM-33 identified R&D areas that support its program, offer the opportunity to collaborate with others and leverage funding to maximize results. These activities included:

- Aging management to support re-licensing of SNF facilities;
- Improved packaging of SNF for storage and transportation;
- Improved processing of nuclear materials and spent fuel in existing facilities;
- Identification and characterization of “challenging materials”; and
- Alternative processes for aluminum-clad fuels and techniques for degraded fuel

[1] http://www.em.doe.gov/pdfs/Roadmap.pdf

OTID completed a prioritization of proposed technology development efforts that had been identified by EM sites as being needed to improve the efficiency and effectiveness of clean-up activities. One priority is to initiate aging management studies to ensure safe, long-term storage of SNF and support the Nuclear Regulatory Commission (NRC) license renewal activities. The first step in the aging management program is to develop remote visual/electromagnetic acoustic transmission technology to improve corrosion monitoring. This work could also be used to collaborate with the Public Agency for Radioactive Waste Management of the Republic of Hungary. In addition, the Idaho National Laboratory's participation in the International Atomic Energy Agency commercial light water reactor extended storage initiative for SNF will leverage resources.

EM-33 has pursued opportunities to leverage technology development efforts with international partners. In September 2010, the office sponsored a joint workshop with the United Kingdom's Nuclear Decommissioning Authority. Four potential areas of collaboration have been identified: Drying and Dry Storage, Aging Management, Non Standard Fuels, and Plutonium Management. Task plans for each of these areas are being prepared by the United Kingdom/United States team leads.

Background

SNF Management

The DOE manages over 2,400 metric tons of SNF at three sites: Hanford, Idaho and Savannah River. Domestic research reactor and foreign research reactor (FRR) fuel is expected to add to that inventory over the next 25 years. The current inventory contains over 250 different fuel types that have different enrichment, fissile materials, cladding and geometry. The physical condition of these fuels varies from intact assemblies to sectioned fuel pieces and failed cladding. The fuel is currently stored in varying configurations, including wet storage, dry facilities, and storage casks. Some of the fuel has been placed in overpack containers.

At President Obama's direction, DOE established the Blue Ribbon Commission on America's Nuclear Future (BRC) to conduct a comprehensive review of the back end of the fuel cycle, evaluate alternative approaches for meeting SNF and HLW obligations and recommend long-term solutions to managing the Nation's SNF and HLW.

Additional technology development is needed to assure the safe storage of SNF over extended timeframes; EM is collaborating with others to identify needs and perform development activities that address the critical issue of aging management, which requires an understanding of how materials and containment structures degrade over time and how to assess conditions in a non-destructive manner. The NRC is conducting a gap analysis on developing a technical and regulatory basis for up to 300 years of storage. In addition, the Electric Power Research Institute, in collaboration with the NRC, the DOE, and industry, has initiated an effort to identify technology needs and to establish an experimental program to provide data needed to support the technical and regulatory basis for storing SNF for more than 120 years. DOE's Office of Nuclear Energy (NE) has also dedicated part of its fuel-cycle R&D program, the Used Fuel Disposition campaign, to identify and meet technology needs associated with extended storage of commercial used nuclear fuel. While there are significant differences in commercial and DOE fuels, there are many similarities in facility and storage system degradation mechanisms. Thus, EM elected to participate in these activities and collaborates with international partners to leverage expertise to safely manage SNF and Challenging Materials.

Challenging Materials Disposition

The NMD Program area for challenging materials involves characterization, safe interim storage and conditioning/stabilization treatments leading to disposition. Certain miscellaneous materials cannot be dispositioned in their current configuration. Prior to planning optimal technology development efforts, detailed categorization of the materials must be performed. This provides critical information to quantify technical risks, uncertainties and data gaps that are needed for any proposed disposition strategy.

The inventories of challenging materials are held by various offices including EM, the Office of Science, NE and the National Nuclear Security Administration (NNSA). Because these materials may present similar stabilization, packaging and disposition challenges, EM-33 will coordinate management of challenging materials with the other offices, identify technology development needs and develop effective management strategies.

Plutonium Materials Management and Disposition

Up to 13 metric tons (MTs) of surplus, non-pit plutonium is or will be safely stored at the K-Area Materials Storage facility at the Savannah River Site using DOE Standard 3013 (DOE-STD-3013)[2]. This Standard provides direction for stabilizing and packaging excess plutonium-bearing metals and oxides that contain at least 30 wt% actinides and maintaining container integrity for at least 50 years. Providing assurance against failure of the plutonium storage containers involves proving that age-related degradation processes cannot occur if certain conditions are established prior to storage and certain conditions are maintained throughout the storage period.

The EM 3013 storage surveillance program includes R&D and field validation activities to mitigate risks. Conducting applied R&D to resolve unique and complex challenges is an integral part of the surveillance program. EM's R&D efforts have produced data to support risk reduction and understand behavior.

DOE has decided to convert at least 6.5 MT of non-pit plutonium into mixed-oxide (MOX) fuel and to process a limited amount (600 kgs) of excess plutonium material in H-Area and immobilize this material in HLW glass. Disposition of approximately 6 MT of non-pit plutonium is subject to an on-going Supplement Environmental Impact Statement. Alternatives being analyzed are: fabricating into MOX fuel, processing through H-Area, disposing as transuranic waste at the Waste Isolation Pilot Plant and immobilizing. Due to the diverse nature of the material matrices in this surplus plutonium inventory, R&D efforts would likely be needed to support the disposition approaches selected.

Discussion of R&D Needs

The NMD technology development program will develop transformational technologies to support the EM cleanup mission to safely store and disposition nuclear materials. The program is sensitive to the work product from the BRC and does not intend to presuppose policy;

[2] U. S. Department of Energy. *Stabilization, Packaging, and Storage of Plutonium-Bearing Materials*. DOE-STD-3013-2004. April 2004. (Superseding DOE-STD-3013-2000, September 2000.)

therefore, a decision has been made to identify prudent investments in tools to manage risk-reduction during extended storage and to be prepared to fund the priority activities to align with the content of the BRC Report.

SNF Management

Proposed SNF R&D activities support extended, interim safe storage and readiness for disposition. The activities include aging management studies to assure fuel and storage system integrity in wet or dry storage systems. The age and condition of many storage facilities present unique challenges relative to maintaining safe and effective storage for extended periods. Maintaining fuel and storage system integrity is a principal safety function relied on in safety basis documents. Developing and implementing tools to assure system integrity are key to this intiative. Proposed aging management R&D activities include:

- Develop remote corrosion characterization and inspection techniques for fuel storage containers, their contents and safety-related components;
- Develop new technologies to extend the life of existing storage systems and demonstate methodology for repairing aging concrete; and
- Evaluate water chemistries and their effects on concrete material properties and on fuel corrosion and identify conditions that inhibit deterioration.

The development and implementation of portable assay verification equipment for FRR and other materials prior to receipt at DOE storage facilities has also been proposed.

Finally, improved technologies for SNF disposal preparation are needed to assure robust and efficient packaging of spent fuel over a broad range of future scenarios, including:

- Develop and demonstrate remote weld, inspection and repair of SNF and HLW hot isostatic pressing product canisters;
- Develop advanced neutron absorber materialss for use in canister baskets/internals for long-term sealed storage; and
- Improve drying technologies.

Challenging Materials Disposition

The Challenging Materials R&D initially focuses on inventory and characterization of miscellaneous nuclear materials that cannot be dispositioned “as is.” Examples of these materials include mixed waste streams that require remote/special handling, classified components, activated metals, sealed sources and other unique materials. Prior to planning technology development efforts to manage and disposition these materials, a detailed catalog and categorization of the materials is needed. This effort would determine technical risks, uncertainties and data gaps for proposed disposition strategies.

While none of the individual material streams that constitute the challenging materials inventory is large, taken together they represent a significant quantity of materials requiring specialized action to enable disposition. Many of these materials could be disposed following appropriate conditioning, processing, and/or repackaging.

Plutonium Materials Management and Disposition

Plutonium Materials Management R&D supports the continued safe storage of excess plutonium materials at the SRS, processing and stabilization of plutonium-bearing materials, characterization of excess plutonium materials for potential use as feed to the MOX Fuel Fabrication Facility, and evaluation of disposition options. R&D program activities include:

- Examination of age-related degradation mechanisms, including stress corrosion cracking;
- Non-intrusive characterization techniques for condition assessment and surveillance; and
- Life management and life prediction models for containment systems.

Prioritization

After identifying R&D needs and recognizing that budgets would not support all requests, EM formulated a prioritization effort that would return the highest near-term payback yet still address strategic goals. The prioritization was completed with input from facility managers, DOE field representatives, and HQ programmatic and budget staff. The result was a transparent process that identified early R&D needs yet maintaining the flexibility to redirect funds given uncertainties regarding the Blue Ribbon Commission report and unforeseen issues,

Conclusion

DOE's goal to accelerate completion of the EM cleanup mission requires modest investments in new technologies. EM has systematically identified R&D needs, obtained field proposals, and prioritized work activities in support of this goal. EM-33 determined that many of the field-proposed R&D activities had merit. However the current FY 2011 budget does not include funding to initiate these activities. After the report is issued by the Blue Ribbon Commission, DOE will update its strategic plans for management of nuclear materials and reevaluate R&D needs and priorities.