Nuclear Fuels Storage and Transportation Planning Project Strategic Crosscutting Activities – 15180

William Nutt*, John Wagner**, Matt Feldman**, Joe Carter***, Robert Howard**, Joshua Jarrell **
* Argonne National Laboratory
** Oak Ridge National Laboratory
*** Savannah River National Laboratory

ABSTRACT
The United States Department of Energy's Office of Nuclear Energy (DOE-NE) is conducting planning activities within the Nuclear Fuels Storage and Transportation Planning Project (NFST) to lay the groundwork for implementing interim storage, including associated transportation, per the Administration's *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste (Strategy)*, and to develop a foundation for a new nuclear waste management organization. The NFST is organized into the following four major elements: 1) Consent-Based Siting, 2) Storage, 3) Transportation, and 4) Strategic Crosscuts. This paper discusses those activities underway in the NFST Strategic Crosscuts element.

INTRODUCTION
The United States Department of Energy's Office of Nuclear Energy (DOE-NE) is conducting planning activities within the Nuclear Fuels Storage and Transportation Planning Project (NFST) to lay the groundwork for implementing interim storage, including associated transportation, per the Administration's *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste (Strategy)* [Ref. 1], within existing legislative and budgetary authorizations, while the Administration and Congress work together on legislative changes to the nuclear waste management program. The objective of the NFST is to identify and begin implementation of activities to 1) support deployment of interim storage; 2) improve the overall integration of storage as a planned part of the waste management system; 3) prepare for the large-scale transportation of spent nuclear fuel (SNF) and high-level radioactive waste (HLW), with an initial focus on removing SNF from the shutdown reactor sites; and 4) develop foundational information, resources, and capabilities needed to support the aforementioned objectives and future implementation decisions and actions. An over-arching goal is to develop options for decision-makers on the design of an integrated waste management system.

The NFST is organized into the following four major elements: 1) Consent-Based Siting, 2) Storage, 3) Transportation, and 4) Strategic Crosscuts [Ref. 2].

Consent-Based Siting: The objective of the NFST consent-based siting element is to support the establishment of a publicly accepted consent-based siting process to identify one or more viable sites. The primary focus is currently on developing information that would support a consent-based siting process.

Storage: The objective of the NFST storage element is to lay the groundwork for implementation of consolidated interim storage as a planned part of the waste management system, with an initial focus on a pilot interim storage facility (ISF) for accepting SNF from shutdown reactor sites. The primary focus is currently on developing and evaluating design options for interim storage.

Transportation: The objective of the NFST transportation element is to prepare for the large-scale transportation of SNF and HLW to facilitate the acceptance of SNF at a pilot ISF, with an initial focus on

accepting SNF from shutdown reactor sites. The primary focus is currently on making progress on long lead-time, destination-independent aspects of the transportation infrastructure.

NFST STRATEGIC CROSSCUT ACTIVITIES

The objective of the NFST strategic crosscut element is to perform required functions and activities to support the Storage, Transportation, and Consent-Based Siting objectives discussed above. In addition to project management and integration activities, there are seven strategic crosscut sub-elements discussed below.

Waste Management Systems Analysis

Waste Management Systems Analysis identifies and evaluates options for the future phased and adaptive deployment of a comprehensive nuclear waste management system. System analysis and system engineering principles are applied to evaluate an integrated approach to transportation, storage, and disposal in the waste management system with an emphasis on providing flexibility to respond to evolving national policy/direction.

These analyses support the establishment of functional and operational requirements for the SNF management system, provide the framework for future planning activities (e.g., transportation hardware procurements), and can be used to support environmental impact analyses and any future decisions regarding strategies for accepting SNF from shutdown and operating reactors.

Decision Support Framework: The NFST is developing a Decision Support Framework (DSF) for identifying and evaluating alternatives for the management (transporting, storing, and disposing) of SNF and HLW under the Standard Contract[1] from shutdown and operating reactors, and DOE-managed SNF and HLW. The NFST DSF will utilize accepted decision analysis techniques to identify the information needed to be obtained during planning efforts to support future decisions and to evaluate information currently being developed and collected by other NFST activities (such as those discussed below).

Initial prototype value models that consider a range of perspectives, based on historical experience and information, are under development. These tools will serve as benchmarks, or starting points, for iterative improvement and focus as details of objectives, value preferences, alternative scenarios and other elements emerge. It is important to build knowledge and trust in the decision support methods and procedures early in the decision process. In this regard, the prototype value models will also serve to provide a framework for socialization and confidence building.

System Architecture Analysis: Integrated waste management system architecture analyses are being conducted to support the future deployment of a comprehensive system for managing SNF and HLW under the Standard Contract from shutdown and operating reactors, and DOE-managed SNF and HLW. Integrated approaches for transportation, storage, and disposal in the waste management system are being evaluated, with an emphasis on providing flexibility to respond to evolving waste management policy and direction.

[1]The Standard Contract for the Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste (10 CFR Part 961) that DOE has in place with nuclear utilities orders acceptance and transportation priority based on oldest fuel first, i.e., based on date of discharge from the reactor. However, the Secretary of Energy has discretion under the Standard Contract to decide whether to give priority acceptance to used nuclear fuel at shutdown sites (10 CFR 961.11, Article VI.B.1.(b)).

Analyses are under way to evaluate the system and disposal implications of continuing the current practice of storing SNF in large dry storage systems at reactor sites. Alternative strategies and approaches for managing the SNF are being identified and evaluated to determine potential benefits, including those pertaining to cost and flexibility. Preliminary analyses of strategies for accepting SNF, first from the shutdown reactors and then from other contract holders, have been completed [Ref. 3] and additional analyses are underway.

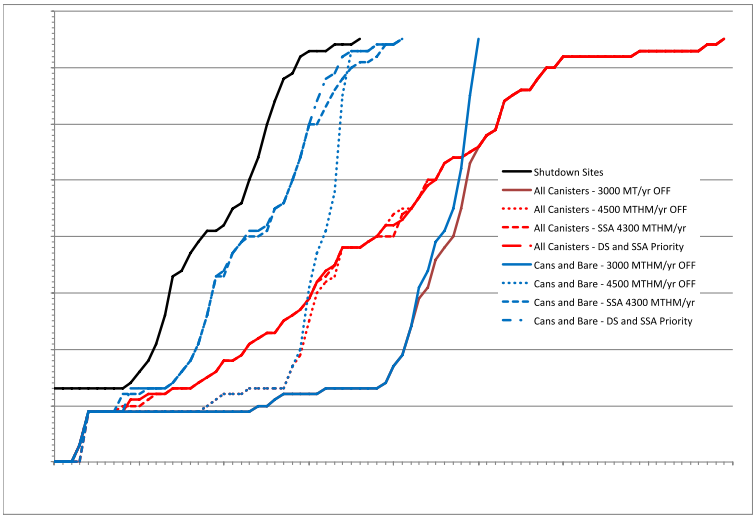

Fig. 1. Example Result from Waste Management System Architecture Analyses [Ref. 3]

Next Generation System Analysis Model (NGSAM): In addition to maintaining and enhancing, where necessary, legacy system analysis tools, the NFST is developing NGSAM [Ref. 4] that (1) is more readily sustainable and maintainable in the future, (2) is flexible for use by a broader set of users, (3) takes advantage of advanced simulation techniques, such as agent-based simulation, (4) leverages existing logistics and transportation simulation models developed for other applications, and (5) links with the UNF-ST&DARDS system currently under development (discussed below).

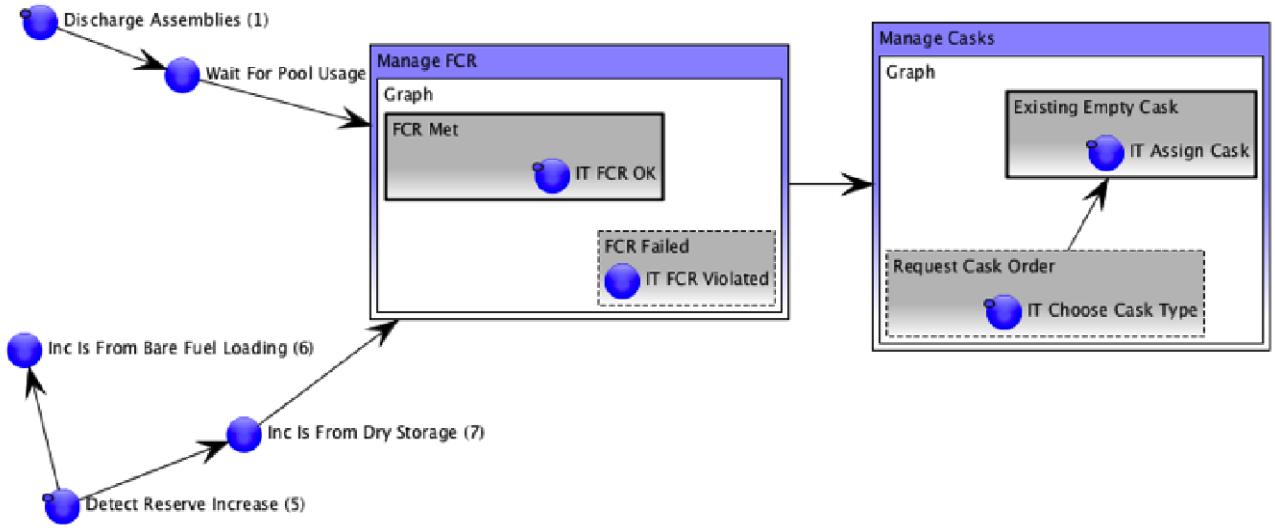

Fig 2. Example of NGSAM Agent-Based Linkages [Ref. 4]

Execution Strategy Analysis (ESA): The NFST is also developing a dynamic simulation modeling capability for use in the analysis of alternative implementation strategies and plans. This effort provides an approach and tool for ongoing performance assessment of the evolving project plan/strategy that takes into account significant assumptions, risks, and uncertainties throughout the project life cycle. This effort will provide fully capable risk assessment and management tools and analyses.

The ESA capability provides a comprehensive, fully integrated systems planning process and tool that ties together the implementation options at a high level to identify and examine alternative strategies for achieving project objectives. This tool is helping to develop sound, risk-informed business practices and communicate/defend future program execution decisions to multiple stakeholders by doing the following:

- Capturing linkages between different waste management program/project elements (e.g., transportation, manufacturing, construction and licensing)
- Capturing consequences of changing funding structure and priorities
- Capturing technical and non-technical risks, including those due to linkages between waste management program elements
- Identifying and tracking key metrics (i.e., cost, schedule, etc.)
- Evaluating alternatives for prioritizing activities and evaluating alternative approaches
- Helping to foresee the potential consequences of proposed decisions
- Helping to identify opportunities for optimization
- Helping to improve the ability to reduce programmatic risks.

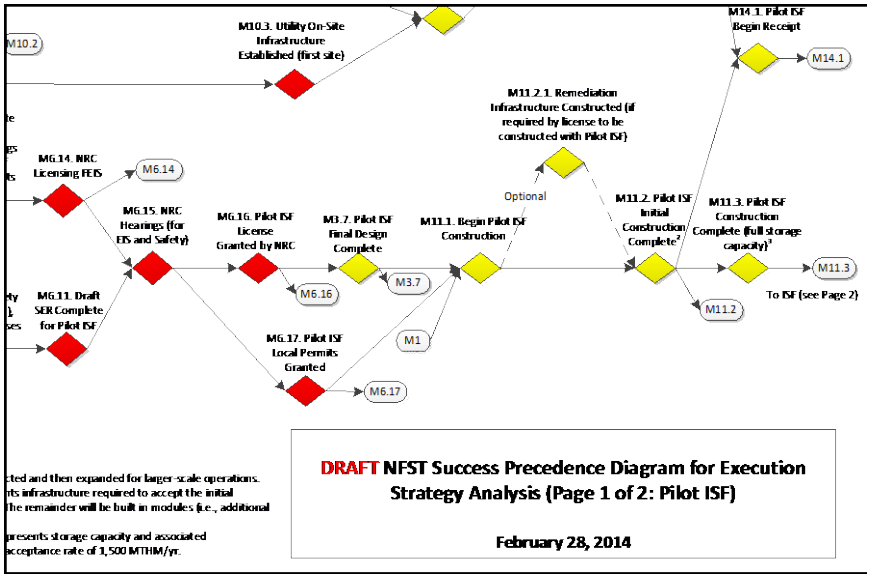

Fig. 3. Example of a Success Precedence Diagram Used to Develop the NFST ESA Model

Functional and Operational Requirements: The capabilities and analyses discussed above support the establishment of system-level functional and operational requirements for the entire SNF management system, provide information for future planning activities (i.e., evaluating approaches to standardization and transportation hardware procurements), provide information for future environmental impact analyses, and support future decisions regarding strategies for accepting SNF and HLW under the Standard Contracts from shutdown and operating reactors, and DOE-managed SNF HLW.

Data and Document Access

Data and Document Access is composed of the activities necessary to establish, populate, and maintain a collaborative document and data system to provide ready access to data, reports, and other work products to support the NFST activities and objectives. The DOE, the NRC, and others have generated a vast amount of information and data pertaining to the storage and transportation of SNF over the past several decades. This data and information are currently stored and maintained in a variety of locations (e.g., the DOE Office of Civilian Radioactive Waste Management's Record Information System currently maintained by DOE-Legacy Management). Much of this information is relevant to the NFST mission and must be collected and maintained for ready access by the NFST contributors and stakeholders (as necessary).

The Data and Document Access area involves development and maintenance of a collaborative SNF document and data access system, the Centralized Used Fuel Resource for Information Exchange (CURIE; curie.ornl.gov) [Ref.4]. CURIE provides ready access and use of SNF data, reports, and tools to support the NFST activities. It also maintains reactor- and site-specific information, displayed on a map, related to dry and wet storage in the United States. In addition to supporting the NFST, CURIE is a national resource accessible to industry, vendor, federal, and laboratory partners, as well as other stakeholders. To date, over 2200 documents have been loaded onto CURIE, the majority of which are accessible to the public. Along with documents, CURIE also maintains a calendar, data, image galleries, and the Siting Experience Database (SED), as recommended by the Blue Ribbon Commission on America's Nuclear Future (BRC) as a near-term action.

The NFST will continue to develop and maintain CURIE with an emphasis on improving functionality, as needed, expanding the content, improving the usability of the SED, and expanding the map-based functionality and content.

Fig. 4. CURIE Homepage

Standardization and Integration

Standardization and Integration is composed of the activities for evaluating standardization options within the nuclear waste management system. This includes standardized transportation, aging, and disposal (STAD) canister systems and standardization of storage and transportation overpacks for the variety of dry storage canisters currently in use.

Opportunities for standardization and integration include, but are not limited to, standardized storage systems, standardized transportation overpacks, standardized cask-handling equipment, and reusable bare fuel casks [Ref. 6]. The NFST has sought nuclear industry input relative to the feasibility, issues, and benefits of standardization. In collaboration with the DOE-NE Used Fuel Disposition Research and Development campaign and consultation with industry, the current focus is on conducting a quantitative assessment and comparison of relevant options to establish the basis for future policy decision-making relative to the potential benefits and impacts associated with deviating from the current industry practice of loading large dual-purpose canisters (DPCs).

To support systems analyses and the standardization assessment, near-term activities under way include the following:

- Developing generic design concepts for small (4 PWR/9 BWR) STAD canister systems that can be stored in the following storage configurations: (1) multi-canister storage overpacks in horizontal or vertical mode; and (2) vaults. These concepts can also be transported in a horizontal mode in a multi-canister transportation overpack.
- Evaluating the operational impacts at the utility sites of using smaller capacity standardized canister designs to load the required number of SNF assemblies in a designated time frame (i.e., the "required SNF throughput") to gain a better understanding of these impacts with the ultimate goal of identifying innovative design and/or operational solutions to alleviate the impacts of using smaller-capacity canisters.
- Developing a performance specification for selected system components of small (4 PWR/9 BWR) and medium STAD (12 PWR/32 BWR) canister-based systems.

Characterization and Assessment

Characterization and Assessment is composed of those activities for establishing a unified, comprehensive SNF database and integrated analysis system, referred to as UNF-ST&DARDS [Ref. 7], to characterize the input to the waste management system; provide a credible, controlled data source for key information; assess issues and uncertainties related to the extended storage and transportability of loaded canisters; support safety confidence and R&D prioritization; and provide a foundational data and analysis capability resource for the future.

UNF-ST&DARDS currently includes five main types of data: 1) fuel assembly discharge information; 2) fuel assembly design data; 3) reactor-specific operation data; 4) cask design and loading data; and 5) infrastructure and logistics-related data to support systems analyses. The integrated analysis capabilities include assembly depletion and decay and cask criticality and dose via the SCALE code system [Ref. 8] and cask thermal analysis via the COBRA-SFS code [Ref. 9].

Activities under way include the following.

- Identifying data sets and sources for inclusion to support NFST activities, including SNF characterization activities, waste management systems analysis, routing analyses, and shutdown site de-inventorying evaluations.

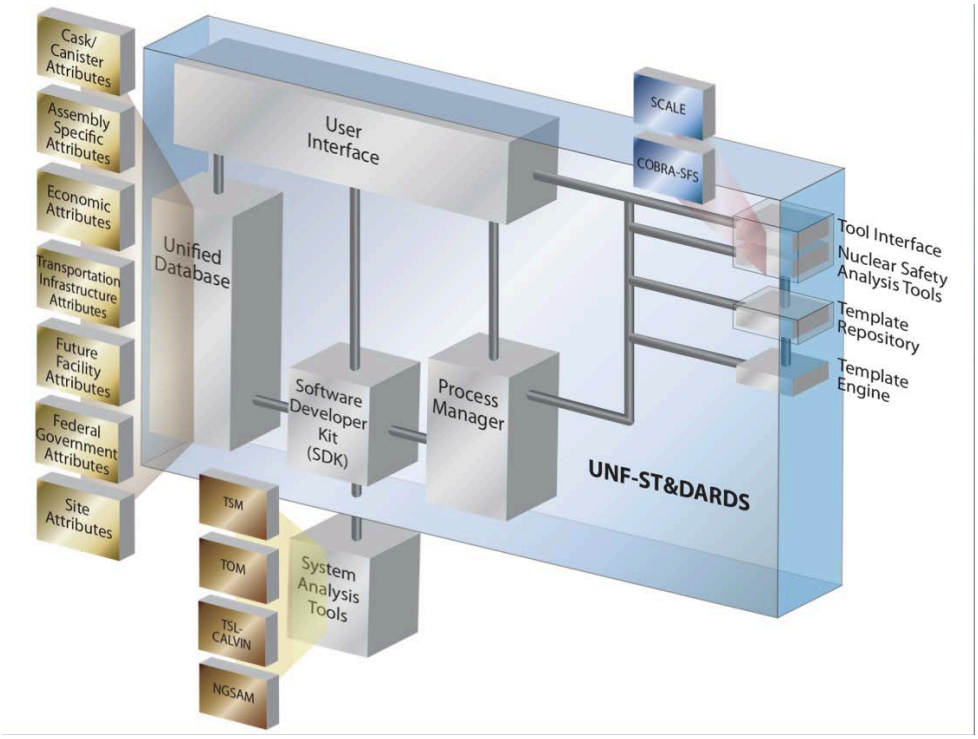

Fig. 5. Information Flow in UNF-ST&DARDS

- Maintaining, developing, and enhancing the Unified Database to meet the needs of a variety of data users.
- Integrating schema to facilitate data interface with waste management system architecture analysis tools.
- Developing and incorporating SNF inventory projections.
- Updating and supplementing important SNF information previously documented in the Characteristics Data Base (CDB) [Ref. 10]. This information has not been compiled in more than 20 years, with the last release of the CDB, and hence the available information is out of date and inadequate to support the NFST mission and objectives. This effort involves engaging with the nuclear industry to collect and process the information.
- Collecting and integrating SNF discharge data as it becomes available, including preparation for and integration of the General Council 859 (GC-859) database being prepared by the Energy Information Administration, as well as supplemental information being collected outside the GC-859 process.
- Integrating the Unified Database with analysis capabilities to support NFST objectives, such as evaluating the characteristics of loaded DPCs to assess potential issues related to transportation and subsequent storage at an ISF, with focus on the shutdown reactor sites.
- Developing and applying SNF safety assessment capabilities including
  - determining realistic safety margins and assessing the capability to demonstrate safety and regulatory compliance for transportation of SNF from shutdown sites,
  - expanding the number and variety of SNF casks represented in the analysis system, and
  - enhancing the SCALE and COBRA-SFS system to support NFST safety assessment capabilities as needed
- Enhancing the user interface by enabling access to some portions of UNF-ST&DARDS via

CURIE.

National Environmental Policy Act (NEPA)
The NFST is identifying and evaluating various strategies for meeting NEPA requirements.

Communication Products
A well-planned strategy for outreach and communication between the implementing organization and the stakeholders is crucial to achieving a successful consent-based siting process. An NFST activity has been initiated to develop a communications plan to guide efforts to prepare information materials on storage and transportation of SNF that could be used to support any future stakeholder and public interactions.

Regulatory
Title 10 of the *U.S. Code of Federal Regulations,* "Energy," Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste and Reactor-Related Greater than Class C Waste," (10 CFR 72*)* addresses the licensing of Independent Spent Fuel Storage Installations (ISFSIs). Title 10 of the *U.S. Code of Federal Regulations,* "Energy," Part 71,"Packaging and Transportation of Radioactive Material," (10 CFR 71) addresses the certification of transportation casks and overpacks.

The NFST is identifying current regulatory requirements and potential issues for future U.S. Nuclear Regulatory Commission (NRC) licensing activities including the following:

- Being cognizant of NRC activities to understand current and potential future changes to regulatory requirements and guidance, identifying and understanding emerging regulatory issues, and improving understanding relative to regulatory interpretations and implications for interim storage and transportation licensing.
- Reviewing existing transportation cask Certificates of Compliance (CoCs) to identify items for confirmation and/or resolution prior to transportation, with priority on the systems that may be used to remove SNF from the shutdown reactor sites.
- Reviewing operational safety bases for other nuclear waste management facilities and NRC Technical/Safety Evaluation Reports for applicable lessons learned.
- Reviewing existing storage cask licenses to summarize their range of relevant licensing conditions and parameters and identify potential issues associated with their use at an ISF, with priority on the systems currently used at the shutdown reactor sites.
- Developing a Topical Safety Analysis Report (TSAR) for a generic (not site-specific) pilot ISF to resolve regulatory issues and uncertainties prior to submittal of a future site-specific license application for a pilot ISF.

CONCLUSION

NFST strategic crosscut activities support the Storage, Transportation, and Consent-Based Siting objectives of the NFST and the over-arching goal of developing options for decision-makers on the design of an integrated waste management system.

REFERENCES

1. U.S. DEPARTMENT OF ENERGY, "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," January 2013.
2. J. WAGNER, J. CARTER, M. FELDMAN, R. HOWARD, W. NUTT, J. WILLIAMS, "Overview of

the DOE Nuclear Fuels and Storage Transportation Planning Project," Proceedings of the WM2015 Conference, March 2015, Phoenix, AZ.
3. W. NUTT, E. MORRIS, F. PUIG, R. HOWARD, J. JARRELL, R. JOSEPH, T. COTTON, "Waste Management System Architecture Evaluations," Proceedings of the WM2014 Conference, March 2014, Phoenix, AZ.
4. W. NUTT, B. CRAIG, K.L. SIMUNICH, E. VANDER ZEE, M. KEHRER, J. ST. AUBIN, "Next-Generation System Analysis Model for Studying Alternative Courses of Action for Nuclear Fuel Logistics and Disposal," Proceedings of the WM2015 Conference, March 2015, Phoenix, AZ.
5. J. JARRELL, D. WHITE, "Centralized Used Fuel Resource for Information Exchange," Proceedings of the WM2014 Conference, March 2014, Phoenix, AZ.
6. J.JARRELL, "Integrating Standardization into the Nuclear Waste Management System," Nuclear Waste Technical Review Board 2013 Winter Meeting, Washington DC, November 20, 2013.
7. J.M. SCAGLIONE, J.L. PETERSON, K. BANERJEE, K.R. ROBB, R.A. LEFEBVRE, "Integrated Data And Analysis System For Commercial Used Nuclear Fuel Safety Assessments," Proceedings of the WM2014 Conference, March 2014, Phoenix AZ
8. OAK RIDGE NATIONAL LABORATORY, "SCALE: A Comprehensive Modeling and Simulation Suite for Nuclear Safety Analysis and Design," ORNL/TM-2005/39, Version 6.1, Radiation Safety Information Computational Center at Oak Ridge National Laboratory, 2011.
9. PACIFIC NORTHWEST NATIONAL LABORATORY, "COBRA-SFS: A Thermal-Hydraulic Code for Spent Fuel Storage and Transportation Casks," PNL-10782, 1995.
10. U.S. DEPARTMENT OF ENERGY, "Characteristics of Potential Repository Wastes," DOE/RW-0184-R1, Vol. 1, Office of Civilian Radioactive Waste Management, Washington, DC, 1992.

ACKNOWLEDGEMENTS

This work is supported by the U.S. Department of Energy, Office of Nuclear Energy, Office of Fuel Cycle Technologies under contract # DE-AC02-06CH11357.