

**POLICY ISSUE**  
**(Information)**

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FOR: The Commissioners

FROM: Catherine Haney, Director  
Office of Nuclear Material Safety  
and Safeguards

SUBJECT: ANNUAL STATUS REPORT: ACTIVITIES RELATED TO EXTENDED  
STORAGE AND TRANSPORTATION REGULATORY PROGRAM  
REVIEW

PURPOSE:

This paper provides the Commission with a status report on the staff's activities related to the Extended Storage and Transportation (EST) Regulatory Program Review. The staff last updated the Commission on this matter in May 2014 (Reference 1 in Enclosure 1.). This paper responds to the Commission's direction in SRM-COMSECY-10-0007 to provide an annual status report (Reference 2) and does not address any new commitments.

SUMMARY:

The staff of the U.S. Nuclear Regulatory Commission (NRC) continues to make good progress towards the goal of identifying and resolving technical or regulatory issues that might indicate a need for changes to NRC regulations or guidance for EST of spent nuclear fuel (SNF). The technical information obtained in the EST efforts directly supports the overall aging management approach that staff is using to ensure continued safe storage and transportation.

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BACKGROUND:

In 2010, the staff was directed by the Commission to examine potential EST issues in conjunction with considerations for a possible update to its Waste Confidence Decision and Rule covering a longer time period (Reference 2). This latter aspect of the project was subsequently separated from EST and addressed by the Continued Storage Generic Environmental Impact Statement and revised Final Rule published in September 2014 (Reference 3). This annual report thus contains updates only for the EST efforts.

The NRC staff continues to identify and address potential issues associated with storage and transportation of SNF over extended periods of time. Although staff anticipates that the current regulatory framework for storage and transportation can be extended to accommodate future needs, licensing practices may evolve over time in response to improved understanding, operational experience, and future Commission policy direction regarding EST of SNF. The goal of the staff's efforts in this area is to identify significant technical or regulatory issues that might indicate a need for changes to NRC regulations or guidance for EST of SNF, to ensure that the regulatory framework for these activities is appropriate, and to achieve safety and security.

Most existing Independent Spent Fuel Storage Installation (ISFSI) licenses and storage system Certificates of Compliance (COC) were initially issued for 20 years, consistent with 10 CFR Part 72 requirements that were in place when these licenses and certificates were issued. 10 CFR 72.42 was subsequently modified in 2011 to allow both initial and renewed licenses for dry storage to be issued for periods up to 40 years each. Within the EST regulatory program, the staff views the aging of systems and components as occurring on a continuum that extends from initial licensing and renewal through longer periods of extended storage and deferred transportation. In this regard, in evaluating component and system aging, the staff analyzes a period of up to 300 years of dry storage, and this is reflected in the staff's approach for time-limited aging analysis. The Office of Nuclear Material Safety and Safeguards (NMSS) is the agency lead for these efforts, and is partnering with the Office of Nuclear Regulatory Research (RES) and other offices to bolster technical bases of the regulatory framework to support extended storage periods, and subsequent transportation of SNF.

DISCUSSION:

As discussed in the previous Annual Status Report in 2014 (Reference 1), the goal of the EST Program continues to be the identification of changes in the NRC's regulatory framework that might be needed to support EST of SNF. Achieving this goal requires assessment of both potential technical and regulatory issues. Over the past year, the staff has continued its focus on technical areas where additional information is needed to inform Program decisions. During this period, the staff has also begun developing the necessary means to translate this technical information into potential changes in the existing regulatory framework for the Commission's consideration. These efforts are discussed in the subsequent section on Regulatory Areas. As has been the case since last year's report, the staff anticipates that EST efforts are more likely to lead to changes in staff guidance and inspection procedures, rather than changes in regulations. Any policy issues will be brought to the Commission as they are identified and assessed. With the available resources, the staff projects that the assessment of technical and regulatory issues will be completed by 2021, in accord with the schedule set forth in the 2014 Annual Status Report (Reference 1). Enclosure 2 provides resource estimates for this projection. Work under the EST Program supports and is closely coordinated with other NRC efforts on SNF storage

and transportation that focus on current licensing and license renewal areas, including technical evaluations and license process improvement activities.

### Technical Areas

The staff continues to make progress in evaluating the technical issues identified in its report "Identification and Prioritization of the Technical Information Needs Affecting Potential Regulation of Extended Storage and Transportation of Spent Nuclear Fuel," hereinafter called the Technical Information Needs Report (Reference 4). Work on the highest priority areas in this report is either completed or ongoing, as well as work on most of the lower priority areas. Over the past year, staff has completed reports on an improved thermal model for horizontal canisterized systems and in-service functional monitoring, and has continued or begun efforts on gaining a better understanding of the extent and significance of cladding stress and concrete degradation during extended storage periods.

Developing improved, more realistic thermal models for dry cask systems is one of the high-priority cross-cutting areas identified in the Technical Information Needs Report. Staff, including support from the Center for Nuclear Waste Regulatory Analyses (CNWRA), completed an improved thermal model for a horizontal ventilated dry cask storage system in 2014, using a three dimensional computational fluid dynamic (CFD) approach. The storage system analyzed was subject to limited inspection in 2012, and the model results were compared with measured temperature data for the canister exterior. The model calculated temperature profiles for 300 years of storage, and staff performed an uncertainty analysis to evaluate the adequacy of the computer model. This modeling is important because it removes some conservatisms and predicts more realistic temperatures for fuel cladding and the canister surface as compared to previous models. These temperature predictions are useful in determining if the cladding may become less ductile during later transport, and when various regions of the canister exterior may be susceptible to chloride-induced stress corrosion cracking. Such information helps to ensure that canister inspections can be conducted at the right locations and begin in the appropriate time frame. A sensitivity analysis was also performed for turbulence models, boundary conditions, and porous media. These model results provide realistic transient temperature profiles in the dry cask system, to aid in studying potential long-term impacts of temperature-dependent mechanisms on the degradation of systems and components. This work is documented in NUREG/CR-7191, "Thermal Analysis of Horizontal Storage Casks for Extended Storage Applications" (Reference 5).

The same team of NRC and CNWRA staff is now developing a similar CFD thermal model for a non-ventilated vertical dry cask system. This work is necessary as the flow pattern and heat transfer phenomena are different between the non-ventilated vertical cask and the ventilated horizontal cask. The model analyzes the storage system and fuel loading planned to be used in the U.S. Department of Energy (DOE) High Burnup Dry Storage Cask Research and Development Project that will be performed in the coming years to confirm information on SNF performance in a full-scale cask. This project, sponsored by the DOE, in cooperation with industry, and sited at Dominion Power's North Anna dry storage facility, will provide measured temperature data from inside the cask to help validate thermal models. The EST thermal model work is coordinated with a staff-directed experimental program at Sandia National Laboratories (supported by funds for current dry storage licensing, not EST) to obtain complementary data on thermal and fluid flow parameters for use in validating this and related numerical models used to support licensing and EST work.

A second cross-cutting issue addressed in the past year was in-service monitoring methods. With contract assistance from CNWRA, the staff performed a broad literature review of monitoring techniques for important internal and external environmental conditions such as temperature, humidity, chloride concentration, and microbial activity. These conditions are important for many potential material degradation processes, particularly for potential degradation of welded canister materials, concrete overpacks, cask bolts, and cask internal components. The review showed that many of the existing monitoring methods for these conditions would need to be modified to be used on dry cask systems, to fit within space limitations, and to operate under the temperature and radiation conditions of the storage systems. Nearly all of the identified monitoring methods would therefore require further demonstration and validation before use. This work was published in a 2014 report titled, "Available Methods for Functional Monitoring of Dry Cask Storage Systems" (Reference 6). This 2014 report provides information on issues associated with particular monitoring techniques, therefore enabling NRC reviewers to submit appropriate Requests for Additional Information, submitted when license applications do not provide adequate information, in a more efficient manner.

The NRC staff continues to evaluate the stress on fuel cladding over an extended dry storage period. Current efforts use the FRAPCON-SFMOD, a fuel performance code developed to predict fuel performance in the reactor, and modified for application in dry storage. Fuel pellet swelling correlations were developed to determine how swelling may stress the cladding, in addition to the stress exerted by helium gas production and release into the fuel rod plenum during extended storage. The potential for delayed hydride cracking was also assessed by calculating the critical flaw size required to trigger this potential breach mechanism. Preliminary conclusions indicate that volumetric fuel swelling may not provide sufficient stress to drive delayed hydride cracking, although localized random stresses may be an issue. An article describing the work has been submitted to the *Journal of Nuclear Materials* to obtain an independent peer review of the results.

In March 2015, the NRC staff held a public expert panel workshop at NRC Headquarters on potential concrete degradation processes. The panel was composed of technical experts from industry and academia. Technical areas discussed during the workshop were potential concrete degradation, inspection and monitoring techniques, and functional assessment, specifically for concrete components of dry cask storage systems. Information and relevant knowledge from non-nuclear concrete structures was also discussed. This effort will also support the staff review of the technical basis of the aging management tables, which is discussed further in the Regulatory Areas section.

In the coming year, the staff will continue to evaluate additional issues identified in the Technical Information Needs Report. These include the potential degradation of neutron absorbers and other cask internal components, behavior of cask bolts and seals, and microbiologically influenced corrosion of the canister. The staff also continues to follow progress on the DOE-sponsored High Burnup Dry Storage Cask Research and Development Project. In addition to the thermal data previously noted, this Project is designed to provide confirmatory information on stored fuel behavior over extended periods of time, as well as near-term information on possible residual water remaining in a cask after vacuum drying.

The staff continues to maintain cognizance of other technical investigations on EST areas being performed by industry, DOE, academic researchers, and international counterparts. The staff continues to interact with the Electric Power Research Institute Extended Storage Collaboration Program, which includes strong international participation as well as research funded through DOE's Nuclear Energy University Program. In addition, the staff participates in related activities of the International Atomic Energy Agency (IAEA), including the IAEA Cooperative Research Program (CRP), now in its third year, to evaluate demonstration programs that can provide information on expected behavior of components and fuel in dry storage. The CRP was developed at the strong urging of NRC and DOE staff to IAEA.

### Regulatory Changes

At this time, the NRC staff expects that EST can be accommodated within the existing regulatory framework for SNF management, with relatively minor changes to the regulatory framework. Most likely, these changes will primarily involve enhancements of guidance for renewal of licenses and COCs. Currently, the NRC is revising the regulatory framework for renewals of ISFSI licenses and storage system COCs, which includes revising and enhancing the Standard Review Plan for renewals, NUREG-1927 (Reference 7). This initiative and the EST Program share the goal of providing guidance and technical support for the review of time-limited aging analyses and aging management programs to give reasonable assurance that storage structures, systems, and components important to safety will continue to perform their intended functions for both the first renewal and any potential subsequent ISFSI license renewals to support their extended operation. It is anticipated that EST Program results will drive further enhancements to current guidance such as NUREG-1927. As part of this collaborative effort, the NRC staff members are developing Aging Management Tables (AMTs), with CNWRA support, to enhance the technical basis of future regulatory guidance. Initial efforts are focusing on one storage system, a horizontal canister system, and work on a second system will begin this fiscal year. Additional systems will be assessed in coming years. The staff will use the AMTs to develop system-specific aging management programs which will provide the basis for future guidance for NRC reviewers and inspectors, as well as licensees and applicants.

Consideration of potential effects of extended storage on physical security requirements for ISFSIs, identified in the 2012 EST status paper (Reference 8), continues to be deferred pending completion of rulemaking for security requirements for SNF storage in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 73, "Physical Protection of Plants and Materials."

Potential policy issues being considered for 10 CFR Part 72 license renewal storage periods include storage and transportation compatibility and integration, SNF long-term cladding integrity, and financial qualification and assurance. At this stage, the staff has not identified additional potential policy issues besides those currently being considered. Any issues that involve policy questions will be brought to the Commission for resolution.

CONCLUSIONS:

The staff has identified and prioritized technical information needs that might affect regulations and guidance for EST of SNF. The staff has completed several technical projects in addressing those needs, and is monitoring activities from the industry, DOE, international counterparts, and other researchers in this area. The staff expects that useful confirmatory information will be gained from the DOE and industry activities related to the High Burnup Dry Storage Cask Research and Development Project. The staff continues to identify and address potential regulatory issues for EST, in conjunction with related initiatives within the NRC, such as the dry storage license renewal initiative. At this time, information obtained in the EST effort supports the regulatory basis for safe storage.

RESOURCES:

Resources proposed to continue and complete the EST Program are discussed in the nonpublic Enclosure 2. All resources for the EST work are, or will be, identified in the Spent Fuel Storage and Transportation Business Line. Funding considerations for future years will be addressed during the planning, budgeting, and performance-management process at the agency level.

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objection. The Office of the Chief Financial Officer has reviewed this paper for resource implications and has no objection.

**/RA/**

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Enclosures:

1. References
2. Projected Resource Needs,  
Extended Storage and Transportation  
Program