UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

September 11, 2012

The Honorable Allison M. Macfarlane
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: TECHNICAL INFORMATION NEEDS AFFECTING POTENTIAL REGULATION OF EXTENDED STORAGE AND TRANSPORTATION OF SPENT NUCLEAR FUEL

Dear Chairman Macfarlane:

During the 596th meeting of the Advisory Committee on Reactor Safeguards, July 11-13, 2012, we reviewed the technical information needs affecting potential regulation of extended storage and transportation (EST) of spent nuclear fuel (SNF). Our Radiation Protection and Nuclear Materials Subcommittee also reviewed this matter during meetings on September 22, 2011 and June 5, 2012. During these meetings, we met with representatives of the NRC staff, Electric Power Research Institute (EPRI), Nuclear Energy Institute (NEI), and Department of Energy (DOE). We also had the benefit of the documents referenced.

CONCLUSION AND RECOMMENDATIONS

1. The staff has comprehensively reviewed and systematically assessed the need for further study and evaluation of materials degradation phenomena that might challenge one or more of the six functions (criticality control, confinement, shielding, thermal performance, structural integrity, and fuel retrievability) important to safety in dry cask storage systems (DCSSs) over a projected life in excess of 120 years.

2. Aging management programs for DCSSs should address the potential for stress corrosion cracking (SCC) in stainless steel canisters exposed to marine environments.[1]

3. The report, "Identification and Prioritization of the Technical Information Needs Affecting Potential Regulation of Extended Storage and Transportation of Spent Nuclear Fuel," should be finalized after public comments have been considered.

[1] A marine environment is a location where environmental conditions are likely to result in the deposition of salts (chlorides) on exposed surfaces over time.

BACKGROUND

The Commission directed the staff to evaluate the technical needs and potential regulatory changes that may be required to assure safe dry cask storage and transportation of SNF for periods in excess of 120 years. The purpose of the EST Program as described in NUREG/CR-7116, "Materials Aging Issues and Aging Management for Extended Storage and Transportation of Spent Nuclear Fuel," is to evaluate DCSS designs and materials to determine whether SNF assembly or canister materials could be expected to degrade during long-term storage, and whether these degradation processes could significantly challenge functions important to safety.

The EST Program focuses on identifying and addressing the technical and regulatory needs for ensuring effective regulation of SNF storage and transportation. In particular, the EST Program focuses on (1) potential changes to regulations and related guidance in order to accommodate extended storage and transportation of SNF and (2) technical information to inform regulatory changes and support future licensing reviews.

DISCUSSION

Degradation of SNF and DCSS components over long periods is a concern. A compilation of the data and technical needs has been prepared by the staff in a report entitled, "Identification and Prioritization of the Technical Information Needs Affecting Potential Regulation of Extended Storage and Transportation of Spent Nuclear Fuel." The information in this report focuses on establishing a technical basis for the safety of DCSSs for periods longer than 120 years. The report identifies a number of high priority areas for further investigation and the potential impact on the DCSSs' ability to perform their safety functions and satisfy NRC's regulatory requirements. The report also contains an evaluation of the manner by which time-dependent degradation mechanisms may affect the ability of DCSSs to fulfill specific safety functions. Priority areas for further investigation include: the potential for SCC of stainless steel canisters in specific environments, the impact of fuel swelling or pressurization on cladding stress, the effect of degradation of cask bolts, the effects of residual moisture after drying, the need to improve thermal calculations, and methods for monitoring and inspecting DCSSs components in-service.

Other areas identified for investigation are:

- propagation of cladding flaws, cladding fatigue, and low temperature cladding creep;
- fuel assembly hardware corrosion and fatigue;
- neutron absorber degradation;
- microbiologically influenced corrosion; and
- concrete degradation in unexposed areas.

As reported in NUREG/CR-7116, some postulated degradation processes, such as helium induced straining of cladding due to alpha decay or propagation of incipient pellet-clad-interaction cracks in cladding, may be dismissed as being of little or no significance. The staff should first disposition these and other less credible degradation mechanisms, as early as possible, and then concentrate their resources on the higher priority mechanisms.

The staff has concluded that with the materials in use today no degradation phenomena would be expected to compromise DCSS safety functions during the licensing period. However, the staff did identify technology and information gaps that need to be addressed to make definitive conclusions regarding degradation mechanisms that could affect fuel integrity during storage for periods in excess of 120 years.

We agree with the staff that inspections, experiments, and analyses to quantify the potential for degradation due to SCC of stainless steel canisters and hydrogen embrittlement of fuel cladding are needed.

There is a wealth of data demonstrating that welded austenitic stainless steel structures exposed to marine environments are susceptible to chloride SCC. Residual tensile stresses due to welding and post weld grinding are sufficient to nucleate and propagate stress corrosion cracks.

Aging management programs should address the development and progression of SCC of stainless steel canisters currently in service in marine environments. These programs should also consider the potential for preventive maintenance techniques to mitigate SCC. In addition, the staff should update guidance to ensure that future DCSSs destined for service in marine environments are fabricated using materials and processes known to significantly reduce the potential for SCC.

Both industry and DOE played important roles in developing the list of needed technical information. DOE has issued a technical gap analysis and is developing plans for long-term research activities for EST. The Extended Storage Collaboration Program (ESCP) organized by EPRI also plays an important role in developing the list of needed technical information. ESCP includes participants from EPRI, DOE and its laboratories, Nuclear Waste Technical Review Board, NEI, other industry representatives (both licensees and dry cask storage vendors), and representatives from other countries with nuclear power programs.

The staff has comprehensively reviewed and systematically assessed the need for further study and evaluation of materials degradation phenomena that might challenge one or more of the six functions (criticality control, confinement, shielding, thermal performance, structural integrity, and fuel retrievability) important to safety in DCSSs over a projected life in excess of 120 years.

The staff should finalize the technical information needs report, continue their technical investigations in high-priority areas, and identify potential regulatory issues for EST.

We look forward to continued discussions with the staff on this matter.

Sincerely,

/RA/

J. Sam Armijo
Chairman

REFERENCES

1. NMSS Memorandum, Subject: Issuance of Draft Report on Identification and Prioritization of the Technical Information Needs Affecting Potential Regulation of Extended Storage and Transportation of Spent Nuclear Fuel, May 2, 2012 (ML12122A922)

2. Staff Requirements: COMDEK–09–0001—Revisiting the Paradigm for Spent Fuel Storage and Transportation Regulatory Programs, February 18, 2010 (ML100491511)

3. Staff Requirements: COMSECY–10–0007—Project Plan for Regulatory Program Review to Support Extended Storage and Transportation of Spent Nuclear Fuel, December 6, 2010 (ML103400287)

4. Hanson, B., H. Alsaed, C. Stockman, D. Enos, R. Meyer, and K. Sorenson, "Used Fuel Disposition Campaign Gap Analysis to Support Extended Storage of Used Nuclear Fuel," U.S. Department of Energy, FCRD-USED-2011-000136, January 31, 2012

5. Evaluation of the Technical Basis for Extended Dry Storage and Transportation of Used Nuclear Fuel, United States Nuclear Waste Technical Review Board – Executive Summary, December 2010

6. NUREG/CR-7116, SRNL-STI-2011-00005, "Materials Aging Issues and Aging Management for Extended Storage and Transportation of Spent Nuclear Fuel," November 2011 (ML11321A182)

7. EPRI, "Extended Storage Collaboration Program (ESCP) – Progress Report and Review of Gap Analyses," Technical Report 1022914, Palo Alto, California: Electric Power Research Institute, April 2012

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