UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR MATERIAL
SAFETY AND SAFEGUARDS
WASHINGTON, DC 20555-0001

April 16, 2013

NRC INFORMATION NOTICE 2013-07: PREMATURE DEGRADATION OF SPENT FUEL STORAGE CASK STRUCTURES AND COMPONENTS FROM ENVIRONMENTAL MOISTURE

ADDRESSEES

All holders of, applicants for, and registered users of spent fuel storage system certificates of compliance (CoCs) as well as all holders of and applicants for an independent spent fuel storage installation (ISFSI) license under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste."

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of recent operating experience on environmental moisture causing premature degradation of structures and components important to safety during spent nuclear fuel storage operations. The NRC expects recipients to review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

<u>Peach Bottom Atomic Power Station ISFSI</u>

On October 11, 2010, a cask seal pressure monitoring system low pressure alarm was received for Cask TN-68-01 during storage at the Peach Bottom Atomic Power Station ISFSI. Cask TN-68-01 is a bolted closure cask system with a double mechanical O-ring seal (cask lid seal) that provides confinement between the lid and cask interface. The cask had been in service at Peach Bottom since June 2000. Figure 1 shows a cross sectional view of the lid region for a TN-68 cask. A protective cover was installed on the lid region to protect the system from external weathering. During disassembly and removal of the protective cover, the licensee found streaks of rust on the underside of the cover, a pronounced pattern of rust directly under the access plate, and water or signs of moisture around most of the bolt lid holes and bolts. The licensee found the elastomer O-ring seal on the bottom of the protective cover to be completely intact and sealed against the top of the cask lid. After performing a sequence of helium leak tests, the licensee identified that the outer sealing surface of the main cask lid seal was leaking at a rate greater than allowed by the CoC technical specifications. The licensee returned the

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spent fuel assemblies to the spent fuel pool to perform additional inspections on the cask lid and seals. The initial evaluation revealed corrosion of the outer portion of the cask lid seal, lower than expected torque on some of the main lid bolts, and corrosion on the threads of the lid bolts. The inner portion of the cask lid seal remained intact; therefore, the cask's primary confinement was not compromised.

A root cause evaluation concluded that the seal leakage was caused by corrosion of the outer portion of the cask lid seal from water infiltration through the access plate in the protective cover. The water infiltration caused galvanic corrosion of the outer portion of the cask lid seal due to the presence of moisture at the interface of the aluminum-clad cask lid seal and the stainless steel clad cask body sealing surface. The presence of the moisture at the interface of the two dissimilar metals set up a galvanic cell that caused the aluminum to corrode and allowed helium to leak through the outer portion of the cask lid seal. The root cause evaluation further stated that the helium leak was attributed to inadequate sealing of the access plate in the protective cover and a lack of any verification of the integrity of the water-tight cover. The primary corrective actions developed by the cask vendor and the licensee involved improving the access plate design and developing a method for verifying protective cover seal integrity. Additional corrective actions, which were incorporated into operating procedures immediately after the event, included a change to the lid bolt torquing process and ensuring access plate gaskets and O-rings were inspected at installation.

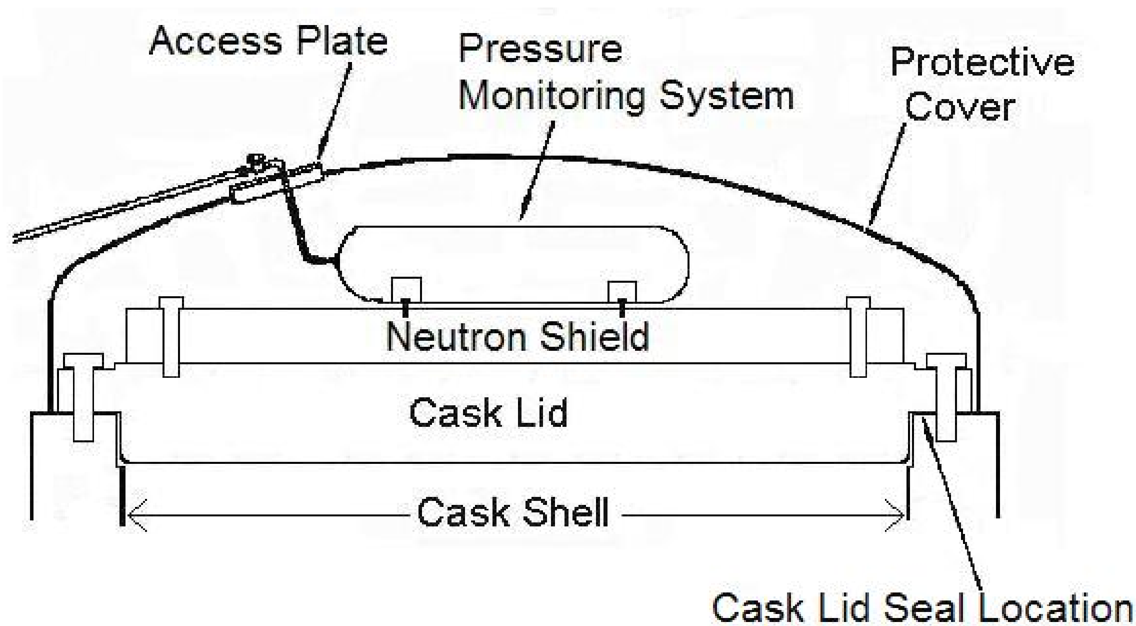

Figure 1

Additional information is available in "Peach Bottom Atomic Power Station—NRC Inspection Report 05000277/12010010," dated July 8, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML111890441).

<u>Three Mile Island, Unit 2 ISFSI at the Idaho National Laboratory Site</u>

The Three Mile Island, Unit 2 ISFSI uses NUHOMS-12T horizontal storage modules (HSMs). The HSMs were delivered to the Idaho National Laboratory site in 1999 as precast concrete components. The storage system consists of an external rectangular reinforced concrete vault (i.e., HSM) with a storage canister resting horizontally on internal rails inside the HSM. The prefabricated modules consist of a body and a roof joined together by anchor bolts. All sections were a minimum of 0.6-meters (2-feet) thick. In 2000, the licensee noted cracks in the HSMs, and concluded they were cosmetic and insignificant. However, in 2007, the licensee observed continued cracking, crazing and spalling as well as increased efflorescence on the HSM surfaces. The efflorescence was a solid, whitish crystalline material which was determined through sampling and analysis to be calcium carbonate. The licensee performed an evaluation in 2007, during which it determined that the HSMs were capable of performing their design basis functions. In 2008, the licensee noted that 28 of the 30 HSMs had cracks, mostly emanating from the anchor bolt blockout holes with widths up to 0.95 centimeters (0.38 inches). At that time, the licensee determined that the HSMs appeared to be prematurely deteriorating and that continued crack growth could impact the ability of the HSMs to fulfill their originally planned 50-year design service life. Subsequent evaluations by the licensee initiated the development of an annual inspection plan for the HSMs and base mat as well as an examination of the inside of the HSMs. The evaluation also recommended that the licensee retain the services of a company experienced and qualified in testing and evaluating concrete to determine the degradation mechanism and make recommendations both for repairs and to prevent further degradation. Although the cracking was discussed with the storage system vendor, the licensee chose an independent vendor to perform an evaluation of the HSMs and base mat concrete in 2009. The evaluation included a field investigation and laboratory analysis to evaluate the concrete material quality, strength, and long-term durability potential. The conclusion reached was that water had entered the anchor bolt blockout holes on the roof of the HSMs. Subsequent freeze and thaw cycles initiated the crack formation. Repetition of the process resulted in both continued crack growth and the efflorescence growth identified in 2007. In addition to identifying the root cause of the cracking, the report also suggested repairs (injecting resin into the cracks), preventative actions (e.g., installing caps over the anchor bolt blockout holes), and monitoring (use of crack gauges). The licensee incorporated the suggested corrective actions.

Additional information is available in “Three Mile Island, Unit 2, ISFSI—NRC Inspection of the Independent Spent Fuel Storage Installation—Inspection Report 07200020/2012-001,” dated August 14, 2012 (ADAMS Accession No. ML12228A457).

DISCUSSION

The instances described above illustrate how the intrusion of water can potentially decrease the effective life of both the structures and components of a spent fuel storage system. In one instance, the presence of water not only caused chemical degradation through oxidation of one metal, but it also facilitated the formation of a galvanic cell between two dissimilar metals that contributed to the degradation of the secondary confinement barrier of the storage system. In another instance, water contributed to an accelerated aging process of concrete structures of the spent fuel storage system. Water entered cracks and crevices around the anchor bolt blockout holes in the concrete structure, and when subjected to freezing temperatures, generated mechanical forces that produced cracks in the concrete. These cracks provided additional and larger pathways for water to enter the interior of the concrete which resulted in larger cracks from subsequent freezing temperatures and promoted efflorescence. If remedial actions had not been taken, this accelerated aging process could have inhibited the ability of the concrete structure to perform its design function of protecting the canister system containing the radioactive material, as well as protecting personnel from ionizing radiation, during normal and accident conditions.

The effects of weathering and environmental moisture may lead to degradation of structures, systems, and components. Several phenomena are discussed in NUREG-1536, “Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility,” NUREG-1567, “Standard Review Plan for Spent Fuel Dry Storage Facilities,” and Table D-1 of NUREG-1927, “Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licensees and Certificates of Compliance” (ADAMS Accession Nos. ML101040620, ML003686776, and ML111020115, respectively). Identifying potential moisture entry points, such as cracks, crevices and joints in both vertical and horizontal storage systems, can facilitate the incorporation of gaskets and sealing materials into both the design of and maintenance of spent nuclear fuel storage systems to minimize premature degradation of structures and components important to safety. Adequate drainage of the base mat (i.e., ISFSI pad) may also prove advantageous for the following reasons. First, pooled water may cause premature degradation of the base mat. Second, since humidity and deliquescence have been shown to contribute to stress corrosion cracking in marine environments (see Information Notice IN2012-20, ADAMS Accession Nos. ML12139A440), the combination of pooled water and heat from canisters containing irradiated spent nuclear fuel could produce humid conditions within the storage system.

These examples show the importance of periodically monitoring the physical condition of a spent nuclear fuel storage system. By obtaining baseline measurements and performing periodic evaluations, accelerated degradation can be detected before the structures and components of a storage system are unable to perform their intended function, and corrective actions can be implemented. Such information may prove useful in assessing aging management in license renewal applications.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below or to the appropriate Spent Fuel Storage and Transportation (SFST) project manager.

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