USED FUEL DISPOSITION CAMPAIGN

Summary and Evaluation of NRC RAIs on Applications for Renewal of Licenses for ISFSIs for Dry Cask Storage Systems

Fuel Cycle Research & Development

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Introduction

The Nuclear Regulatory Commission (NRC) staff issued a series of Requests for Additional Information (RAIs) that are associated with the review of applications for renewal of site specific licenses for Independent Spent Fuel Storage Installations (ISFSI) for Dry Cask Storage Systems (DCSS). Three ISFSIs, Surry, H.B. Robinson and Oconee, have received their ISFSI license renewals for 40 years; two ISFSIs, Calvert Cliffs and Prairie Island have been docketed for NRC license renewal applications. Fort St. Vrain and GE-Morris, which are one-of-a-kind facilities, have received their ISFSI license renewals for 20 years. The storage systems deployed at these ISFSIs are varied in designs, and their exposure environments are also varied which can significantly affect aging degradation of the structure, system and components (SSCs) of the dry cask storage systems.

Purpose

The NRC RAIs from these ISFSI license renewal applications were compiled and evaluated by Idaho National Laboratory (INL) and Argonne National Laboratory (ANL). The reviews were conducted to discern if any of these NRC RAIs identified additional information needs beyond those identified in current gap analyses, identify current and planned R&D that may contribute toward resolution of the RAIs, and identify those RAIs relevant for inclusion in generic aging management plans (AMPs) and time-limited aging analyses (TLAAs) for extended storage and transportation of used nuclear fuel. Existing renewal experience is only available for site specific licenses. The first CoC renewal application is expected in 2012 with potential RAIs to follow. Therefore, this review does not contain any RAIs related to CoC renewals.

Analysis

RAIs are used to clarify how an applicant meets NRC positions established prior to the submittal of the application. It is standard practice by ISFSI and CoC applicants to review previous RAIs to enhance the quality of their individual applications. This review identified RAIs related to the technical gaps for extended storage and transportation outlined by DOE and is one method intended to enhance DOE's RD&D plans to address the gaps by ensuring it is responsive to current industry licensing needs. The criteria for selecting RAIs for inclusion were 1) aging related, 2) related to the gaps identified in UFD gap analyses shown in Table 1[2,3], and 3) germane to AMPs and TLAAs for DCSSs/ISFSIs being developed by ANL. RAIs considered in this review are found in Appendix A.

Table 1: Technical Gap Analyses and R&D Priority for Extended Storage and Transportation

Technical Gap	Priority during Storage	Priority during Transportation
Cross-Cutting / General		
Thermo mechanical simulations/ Temperature and stress profiles	High	High
Sub criticality, Burn Up credit.	High	High
Understanding of Drying Issues	High	N/A
Monitoring Technology	High	High
Re-examination of INL Dry-Cask Storage System	Medium	N/A
Fuel Transfer Options	High	N/A
Cladding		
Annealing of Radiation Damage	Medium	Low

Technical Gap	Priority during Storage	Priority during Transportation
Hydrogen re-orientation and embrittlement	High	High
Delayed hydride cracking	High	High
Oxidation	Medium	Low
Thermal creep	Medium	Low
Assembly Hardware		
Corrosion and stress corrosion cracking	Medium	Medium
Neutron Poisons		
Thermal aging effects	Medium	High
Embrittlement and Cracking	Medium	High
Creep	Medium	Medium
Corrosion (blistering)	Medium	Medium
Container		
Atmospheric corrosion (including marine environment)	High	High
Aqueous corrosion: general, localized, SCC, galvanic	High	High
Bolted cask: thermo-mechanical fatigue of seals and bolts	Medium	Medium
Overpack and Pad		
Freeze Thaw	Medium	N/A
Corrosion of embedded steel	Medium	N/A

Applications for license renewals must include TLAAs that demonstrate that SSCs important to safety will continue to perform their intended function for the requested period of extended operation; and AMPs that describe the management of issues associated with aging that could adversely affect SSCs important to safety. ANL used the review of RAIs to develop a report that examined the issues related to managing aging effects on the SSCs in DCSSs for extended long-term storage of used fuels. The report summarized seven generic AMPs and five generic TLAAs.

AMPs:
- Structures Monitoring Program
- Protective Coating Monitoring and Maintenance Program
- External Surfaces Monitoring of Metal and Polymeric Components Program
- Ventilation Surveillance Program
- Welded Canister Seal and Leakage Monitoring Program
- Bolted Cask Seal and Leakage Monitoring Program
- Canister Structural and Functional Integrity Monitoring Program

TLAAs:
- Fatigue of Metal and Concrete Structures and Components
- Corrosion Analysis of Metal Components
- Environmental Qualification (EQ) of Electric Equipment
- Time-Dependent degradation of Neutron-Absorbing Materials
- Time-Dependent degradation of Radiation-Shielding Materials.

The applicability of the RAIs to the development of generic AMPs and TLAAs is not discussed further in this document. A high level summary of the relationship between some of the RAIs and proposed generic AMPs and TLAAs is found in Appendix B. More information regarding these generic AMPs and TLAAs can be found in "Managing Aging Effects on Dry Cask Storage Systems for Extended long-Term Storage and transportation of Used Fuel" FCRD-USED-2012-000119[1].

RAIs pertinent to the DOE UFD gap analyses and AMP and TLAA development are included in Appendix C. Appendix C includes the ISFSI owner, RAI number, RAI and applicant response, a description of applicability to generic AMP/TLAAs, and the related technical gap as noted in Table 1 with proposed R&D as identified in the Used Nuclear Fuel Storage and Transportation Research Development and Demonstration Plan[4].

The Nuclear Energy Institute notified the NRC of its concerns regarding a perceived action by the NRC to establish new regulatory positions through RAIs on individual applications (Letter to Mr. Doug Weaver, NRC, and 2-16-2012) rather than industry notification through generic letters or rulemaking. . This evaluation did not attempt to determine whether RAIs implied a new NRC position. Therefore, Table 2 may include some of these RAIs even if industry does not believe the RAI was appropriate for a license application review. Nevertheless, it is possible R&D or development of a generic AMPs/TLAAs related to the RAI may still be appropriate because of the applicability to multiple or previously loaded designs or the desire to enhance future designs.

Results

The RAI review did not reveal any additional gaps that would suggest a need for R&D beyond those identified in existing gap analyses[2,3]. As expected, many of the RAIs focus on aging management and the continued efficacy of DCSS components during extended storage to meet future retrieval and transportation needs. Also expected was the strong focus on canister integrity as it is the primary barrier for environmental protection and confinement of the used nuclear fuel in most DCSS designs. These two observations suggest these areas are high priority for those pursuing license extensions today.

Each RAI in Appendix C is related to one or more of the gaps identified in the UFD gap analyses. DOE-NE has proposed RD&D to address each of the high and medium gaps from these analyses. A summary of proposed RD&D to address the gaps related to each RAI is included. This proposed RD&D is not intended to provide an immediate solution to the RAIs. However, RD&D efforts are ongoing between industry and DOE to address some immediate needs and develop the technical bases for extended storage. A summary of the RAIs related to the UFD data gap analyses included:

- Eleven RAIs related to monitoring/inspection and degradation of cask closure systems for welded or bolted containers.
- Seven RAIs related to the overpack and concrete structures. The RAIs related to concrete structures and overpacks included two RAIs related to the Ft. St.Vrain Modular Vault Dry Storage building and one RAI related to the degradation of concrete elements in wet pool storage.
- One RAI related to cladding/temperature profiles/and drying.
- One RAI related to neutron poisons.
- Eighteen RAIs were relevant for inclusion in the generic AMPs and TLAAs. The majority of these RAIs were related to five generic AMPs.

- Five RAIs were identified for inclusion in two generic TLLAs.

- One observation addressed the need for data to demonstrate high burn up fuel cladding would continue to satisfy the safety requirements for a 40-year license renewal period. Observations are not required to satisfy a licensing requirement. It is the industry position that the existing regulatory bases provide reasonable assurance of adequate public health and safety for high burn up fuel for terms of at least 80 years and that adherence to guidance does not require renewals based on acquisition of additional data, commitments or aging management for fuel. However, this RAI has raised concerns in the industry that if unresolved, may impact future storage renewals for high burn up fuel. This RAI is one of the primary reasons industry has called on DOE to conduct a long term demonstration to provide the confirmatory technical basis for the extended storage of high burn up fuel.

- Two RAIs requested results of lead canister inspections to demonstrate no adverse conditions for the dry cask storage system. Use of representative lead canister inspection data is expected to provide bounding data for aging of a DCSS. Consequently, lead canister data is included in generic aging management plans for canister integrity. DOE is supporting an inspection program with EPRI for several DCSSs to satisfy relicensing requirements and an inspection of the INL NUHOMS system to better design inspection delivery systems that are able to navigate inside a concrete overpack or storage module. The results from these inspections are also anticipated to advise DOE's RD&D program for future research on canister integrity.

- Another RAI focused on inspection to determine if the structure supporting the canister inside a DSCC will perform during unloading and will not degrade during the renewal period. Though this RAI is addressed through the proper selection of corrosion resistant materials, DOE is supporting inspections of canisters and support structures inside the overpack and testing delivery systems for these inspections.

- An additional RAI inquired about stainless steel components and whether they were subject to aging effects of SCC and corrosion. DOE has a university proposal team researching SCC. DOE is also part of the EPRI sponsored team (DOE, Japan's Central Research Institute of Electric Power Industry, and US cask vendors, US utilities) to research SCC and the threshold conditions for chloride concentration.

  Some RAIs are anticipated to provide guidance for further research and refinement of the DOE RD&D program based on actual experience.

- One RAI for a vault system addressed methods for leak testing and the frequency and acceptance criteria for the tests. The information gleaned from this applicant response may be helpful for DOE's RD&D program to determine monitoring methods for leak testing as well as identify monitoring frequency and acceptance criteria protocols in generic AMPs.

- One RAI addressed the inspection and surveillance program(s) used to monitor the effects of aging on the electrical and instrumentation and control (I&C) components. Storage of fuel at GE Morris is in a pool inside an operating facility that requires electrical and instrumentation and control equipment. Most ISFSIs are in a dry storage configuration and meet requirements through passive systems that do not require electrical and instrumentation and control components. As the DOE RD&D plan prepares for development and application of monitoring and inspection equipment for dry storage ISFSIs, the components considered in the GE Morris surveillance program for this RAI may provide insight for

development of improved monitoring and inspection technology.

- One more RAI inquired about how cask seals are inspected for aging management. This RAI focused on corrective actions implemented as a result of seal lid failure. The RAI provides important insights for DOE's RD&D program for design and deployment of monitoring systems and consideration of redundant seal systems for extended storage.

Summary

The review of the NRC RAIs for site specific renewals of storage systems revealed that the DOE is planning or conducting RD&D that addresses many of the industry needs. The NRC RAIs and the applicant's responses are a continuing and evolving process to meet the regulatory requirements and provide the technical basis for license renewal and CoC amendments. New RAIs may arise with the renewal of CoC applications and continued evaluation of the RAIs will provide an opportunity to ensure ongoing RD&D is responsive to industry needs.

This evaluation examined RAIs from site specific renewal licenses. CoC renewal applications are expected in late 2012 and beyond. Renewal of CoCs will present additional challenges because the canisters have multiple amendments and multiple licensees. For an efficient licensing process, industry will require generic resolutions for some questions. In most cases, the challenges are not technical and are administrative, however, DOE may be able to provide additional support in the areas of aging management and inspections that would demonstrate canister inspections performed at sites are applicable to other sites with similar conditions.

References

1. Chopra, O.K, et al. *Managing Aging Effects on Used Fuel Dry Cask Storage Systems for Extended Long-Term Storage and Transportation of Used Fuel*, Us. Department of Energy, FCRD-USED-2012-000119, ANL-12/29, June 30, 2012.

2. U.S. Department of Energy, *Gap Analysis to Support Extended Storage of Used Nuclear Fuel*, FCRD-USED-20111-000136, January 2012.

3. U.S. Department of Energy, *UFD Storage and Transportation Working Group Report*, FCRD-USED-2011-000323, AUGUST, 2011, DRAFT.

4. U.S. Department of Energy, *Used Nuclear Fuel Storage and Transportation Research, Development, and Demonstration Plan*, FCRD-FCT-2012-000053. March 2012.

Appendix A

There are seven Independent Spent Fuel Storage Installations (ISFSI) have submitted license renewal applications.

1. Calvert Cliffs Nuclear Power Plant owned by Constellation Energy Group
2. Fort St. Vrain managed by the Department of Energy, Idaho Operations Office
3. Morris Operation owned by General Electric Company
4. Oconee Nuclear Station owned by Duke Power Company, LLC (Duke Energy Carolinas, LLC)
5. Surry owned by Virginia Electric and Power Company
6. H. B Robinson owned by Progress Energy Carolinas (PEC)
7. Prairie Island owned by Northern States Power Company (Xcel Energy)

Table 1. ISFSI that have apply for license renewal applications

Facility Name	Company	Facility Type	Time Period	License Renewed	Docket #
Calvert Cliffs	Constellation Energy Nuclear Group, LLC (CENG)	ISFSI	40 years	Being Processed	07200008
Fort St. Vrain	Department of Energy	ISFSI	20 years	Jul 2011	07200009
Morris Operation	General Electric	ISFSI	20 years	Dec 2004	07200001
Oconee	Duke Power Company, LLC (Duke Energy Carolinas, LLC)	ISFSI	40 years	May 2009	07200004
H. B. Robinson	Progress Energy Carolinas (PEC),	ISFSI	40 years	Mar 2005	07200003
Surry	Virginia Electric and Power Company	ISFSI	40 years	Feb 2005	07200002
Prairie Island	Northern States Power Company (Xcel Energy)	ISFSI	---	Applied Oct 2011	07200010

Note: Prairie Island license expires on October 31, 2013.

Calvert Cliffs ISFSI

Calvert Cliffs submitted a license renewal application on September 17, 2010.

On December 16, 2010, the NRC requested supplemental information stating that the license renewal application "… did not provide technical information in sufficient detail to enable the NRC staff to complete its detailed review …." Calvert Cliffs responded to the RAI on February 10, 2011 in a 94 page letter. Calvert Cliffs was asked to provide:

1. 20-year interval "lead" cask storage system inspection
   (required to evaluate compliance with 10 CFR 72.24(d))

   Provide the results of the lead canister inspection to demonstrate no adverse DSC conditions. **CCNPP Response:** The lead canister inspection for the Calvert Cliffs ISFSI is currently scheduled to occur in April 2012. This date was chosen because NUREG-1927, Appendix E indicates that the inspection is required to be performed before the end of the initial 20-year ISFSI operating license, and on a 20-year frequency thereafter.

   On March 2, 2012, the NRC issued a request for supplemental information (RSI). The RSI letter contained one RSI. Calvert Cliffs responded to the RSI on July 27, 2012 in a 16 page letter. The RSI and response is as follows:

   a. RSI-1 Provide the results to the staff of the lead canister inspection scheduled June 27, 2012, within 30days of completion. **CCNPP Response:** On June 27th and 28th, 2012, Calvert Cliffs performed an inspection of the interior of two horizontal storage modules (HSMs), and the exterior of the dry shielded canisters (DSCs) they contained. The results are contained in the submittal.

2. Time Limited Aging Analysis
   (necessary to ensure compliance with 10 CFR 72.24(d) and 10 CFR 72.120)
   b. Provide a thermal fatigue analysis for the DSC support structure contained within the HSM which demonstrates whether or not thermal fatigue of the DSC support structure needs to be accounted as an aging mechanism. **CCNPP Response:** The existing HSMs installed at Calvert Cliffs are designed to store a NUHOMS-24P DSC and a NUHOMS-32P DSC. Given the climate conditions at Calvert Cliffs, the thermal effects resulting in stress reversal will only occur during the spring and fall seasons. During the winter the rail assemblies will only experience tension, while in the summer they will only experience compression. Therefore in the fatigue analysis, a thermal cycle is only experienced during half the days of the year. Using this assumption the expected thermal cycles to be experienced during the 60-year storage life can be calculated as10,980 cycles. This value is well below the American Society of Mechanical Engineers code requirements of thermal fatigue for components with greater than 20,000 cycles. Therefore, since there is no fatigue caused by the thermal cycling during a 60-year service life, thermal cycling is evaluated as having negligible impact on the rails for the requested 60-years of service.

5. Provide justification that originally backfilled helium remains within the spent fuel canisters during the extended license period. *(required to evaluate compliance with 10 CFR 72.120(d), and 10 CFR 72 .122 (a, l))* **CCNPP Response:** Calvert Cliffs' DSCs do not use any mechanical seals to form the pressure boundary between the DSC top and the DSC cylinder body. Instead Calvert Cliffs employs the use of multiple separate seal welds to ensure pressure boundary integrity is maintained. The process used at Calvert Cliffs is that after spent fuel is placed into the DSC, the

shield plug is seal welded to the DSC. Then after helium is backfilled into the DSC, the DSC vent and siphon port opening and the top cover plate are seal welded to the DSC canister. These seal welds are installed using safety-related materials in accordance with safety-related procedures. The seal welds are then tested for leakage to ensure leakage is less than the Technical Specification limit of 10-4 atm-cc/sec.

On April 28, 2011, the NRC issued a request for additional information (RAI). Calvert Cliffs responded to the RAI on June 28, 2011 in a 45 page letter. The RAI and responses are as follows:

Chapter 3: Aging Management Reviews

3-4. Provide rationale that the underground concrete subcomponents of the HSM exposed to a soil or groundwater environment are not subject to the aging effects of cracking, loss of bond, and loss of material due to corrosion. **CCNPP Response:** The aging effects of the underground concrete subcomponents of the HSM exposed to a soil or groundwater environment are monitored through the same inspection credited for the above ground concrete portion of the HSM. The groundwater pH, chloride and sulfate concentrations are such that negligible chemical attack is expected.

3-5. Provide rationale that the stainless steel subcomponents of the HSM exposed to a yard or yard-salt environment are not subject to the aging effects of stress corrosion cracking and loss of material due to corrosion. **CCNPP Response:** Calvert Cliffs is aware that the susceptibility of the stainless steel dry storage containers (DSC) to stress corrosion cracking when exposed to a marine air environment has recently emerged as a potential issue through the conduct of testing performed in NUREG/CR-7030. Calvert Cliffs and Constellation Energy Nuclear Group are participating with industry (NEI/EPRI/vendor) initiatives evaluating this issue and will follow recommendations and guidance that might come from these initiatives and that are applicable to Calvert Cliffs.

Appendix A: Aging Management Program

A-3. Provide the review results of the CAP mentioned in the operating experience program element of Section A2.1, HSM AMP, which indicates that any deficiencies identified for the HSM have been administrative and were not related to the effects of aging. Include the records associated with the instance where minor cracking was noted on top of the HSMs that required cosmetic crack repair. Provide an evaluation regarding the root cause of the concrete cracking, and justify why this condition will not lead to accelerated component degradation during the license renewal period. **CCNPP Response:** These issues were identified during performance of a visual inspection of the HSMs concrete surfaces. Each of these identified issues was entered into Calvert Cliff's corrective action process and maintenance work orders were developed as applicable. The issues listed in Reference 5 were evaluated as not impacting the HSMs ability to perform its safety function. To provide a more thorough assessment of the current conditions, Calvert Cliffs commits to conduct an engineering evaluation of the identified concrete degradations, performed by a qualified structural engineer.

Fort St. Vrain ISFSI

Fort St. Vrain submitted a license renewal application on November 10, 2009. On July 18, 2011 the Fort St. Vrain license was renewed for 20 years. The renewed license expires on November 30, 2031. In renewing the Fort St. Vrain license, the NRC required that Section 9.8 of the Safety Analysis Report (SAR) for the Fort St. Vrain facility be modified to include sampling of six fuel storage canisters.

On April 12, 2010, the NRC issued a request for additional information (RAI). The RAI letter contained twenty-three RAIs; they are as follows:

1. Clarify how a loss of mechanical properties in the structural concrete of the Modular Vault Dry Storage (MVDS) building from irradiation are measured and/or estimated. Has the structural integrity of the MVDS been reevaluated based on the loss of material properties? Has any system, structure and component (SSC) meeting the requirements of scoping criteria been reevaluated based on the degradation mechanisms cited in Section 3.9.4? *(This information is needed to determine compliance with 10 CFR 72.120.)*

14. Clarify if the concrete exterior to the Modular Vault Dry Store (MVDS) building, at an elevated height is considered accessible, and how often it is inspected. *(This information is needed to determine compliance with 10 CFR 72.120.)*

16. Clarify what method is used for the routine leak testing performed on the Fuel Storage Canisters (FSCs). Also clarify the frequency of the leak rate testing, and the acceptance criteria for the tests. *(This information is needed to determine compliance with 10 CFR 72.122.)*

Morris Operation

Morris Operation submitted a license renewal application on May 22, 2000. This facility "is the first to request a license renewal and it is the only operating commercial water basin ISFSI not co-located at a nuclear power plant site in the United States."

On May 16, 2003, the NRC issued a request for additional information (RAI). The RAI letter contained seventy-one RAIs in seven different sections; they are as follows: Morris Operations responded to the RAI on September 24, 2004 in a 65 page letter. The RAI and responses are as follows:

SECTION 3 – MONITORING AND MAINTENANCE PROGRAMS

3-5. Describe the inspection and surveillance program(s), per consistent with your response to RAI 3-1, used to monitor the effects of aging on the electrical and instrumentation and control (I&C) components required to:

a. monitor pool water level [10 CFR 72.122(h)(2)], **MO Response:** The instrument that monitors basin water level (LI-102-51) is a differential pressure (D/P) detector utilizing a D/P transmitter that senses the D/P between the atmosphere above the basin and the pressure on a leg submerged in the basin water.

b. monitor pool water leakage [10 CFR 72.122(h)(2)], **MO Response:** The instrument that monitors basin water leakage (LI-102-52) is a differential pressure (D/P) detector utilizing a D/P transmitter that senses the D/P between the atmosphere in the Basin Leak Detection (BLD) sump and the pressure on a submerged leg at the bottom of the BLD sump. Instrument air is supplied continuously to the submerged leg. The D/P transmitter sends a signal to the Control Room where basin level is recorded on the Main Process Control Panel.

c. provide continuous monitoring of storage confinement systems [10 CFR 72.122(h)(4)] **MO Response:** The basin leak detection system and criticality monitoring system is described in the CSAR.

d. monitor systems that are important to safety [10 CFR 72.122(i)], **MO Response:** The basin leak detection system for the basin liner. The basin expansion gate pump out system detects any leaks of basin water into the annulus area of the expansion gate.

e. support criticality monitoring systems [10 CFR 72.124(c)], **MO Response:** RIA-930-9 and RIA-930-11 are the criticality detection instruments. They are connected to two

separate detectors in different locations in the basin area. These detectors continuously monitor radiation levels in the basin area and when radiation level exceeds a set point, the criticality horns would automatically sound. In addition, there is an ARM located in the basin that would alarm before the criticality monitors.

f. support radiological alarm systems [10 CFR 72.126(b)], **MO Response:** The criticality monitoring system continuously monitors radiation levels in the basin area. Alarms would sound in the control room and on the SIMS system.

g. monitor direct and effluent radiation levels [10 CFR 72.126(c)]. **MO Response:** The stack gas monitoring system (equipment number SP-879) continuously samples the inlet to the sand filter and the takes two independent samples of the stack effluent. An alpha/beta counting unit analyzes these samples. The SIMS monitors flow through the sampling system. Stack flow is also continuously monitored by the SIMS and recorded on a regular basis.

3-9. Outline the aging management program, consistent with your response to RAI 3-1, for the basin structure concrete elements. Reinforced concrete structures when subjected to operational and environmental conditions and loads may degrade over time. i.e. concrete may crack and lose materials, steel may corrode. Consider in your response the following American Concrete Institute (ACI) standards regarding concrete degradation; ACI 224.1R "Causes, Evaluation and Repairs of Cracks in Concrete Structures, ACI 349.3R "Evaluation of Existing Nuclear Safety-Related Concrete Structures", and ACI 222R "Corrosion of Metals in Concrete." **MO Response:** Aging Management for the concrete structures is described in CSAR Appendix A-8, Aging Management**.**

Oconee

Oconee submitted a license renewal application on January 30, 2008 and the license was renewed in May 2009 for 40 years. The current license now expires on January 31, 2050.

On October 1, 2008, the NRC issued a request for additional information (RAI). The RAI letter contained seventeen RAIs in six different sections. Duke Energy responded to the RAI on January 30, 2009 in a 218 page letter. The RAI and responses are as follows:

CHAPTER 3.0 AGING MANAGEMENT REVIEWS

3-1. In "DSC [Dry Storage Canister] Support Assembly" it states "stainless steel cover plates are attached to the longitudinal support rails to provide sliding surfaces for the DSC's. The Sliding Surface of the DSC support rails is coated with a dry film lubricant." Placements of those stainless steel cover plates were not identified on the original drawings from the NUTECH NUHOMS -24P Topical Report.

c) Evaluate possible effects of dry surface condition during the unloading process and why this condition will not lead to accelerated component degradation for the license renewal period. **Duke Response:** Future irretrievability of the DSC was considered and addressed in the original design by the selection of corrosion and wear resistant materials and suitable lubricants.

(This information is needed to determine compliance with 10 CFR Part 72.122.)

3-3. The sixth paragraph states that "With respect to below grade concrete (and reinforcing steel), no aging effects/mechanisms were identified." "Structural support (SS)" and "heat transfer (HT)" were selected as intended functions for Concrete Below Grade in Table 3.2-1; therefore, at a minimum, provide reasons for not including exposed surfaces of the Concrete Below Grade within the HSM space in the inspection/monitoring under the Aging Management

Activity/Program (AMA/AMP). Refer to RAI A-3 below. Provide justification for not identifying any long term effect of degradation mechanisms; namely: corrosion, fatigue, thermal stresses, irradiation; for the below-grade concrete and reinforcing steel. *(This information is needed to determine compliance with 10 CFR Part 72.120.)* **Duke Response:** No parameters of the Oconee groundwater or lake water chemistry exceed the limits where degradation could occur. The Oconee groundwater and lake water pH ranges are equal to or above the threshold limit of where potential degradation of the concrete may occur. The chloride and sulfate concentration ranges are well below both threshold concentrations. Therefore, the potential for the Concrete Below Grade within the HSM space to degrade due to chemical attack is negligible.

APPENDIX B TIME LIMITED AGING ANALYSES

B-1. Provide the analysis mentioned in Section B2.2.1, "DSC Shell Cracking Due to Fatigue," which demonstrates that fatigue does not need to be considered. Provide copies of references and measurement data cited in your response. Justify the conclusion, including reasons for not including the DSC shell in the inspection/monitoring and/or AMA/AMP. *(This information is necessary to ensure compliance with 10 CFR 72.24(d) and 120.)* **Duke Response:** This response is Transnuclear Propriety information and is provided in the attachment.

Surry (Dominion)

Surry (Dominion) submitted a license renewal application on April 29, 2002 for a period of 40 years. On February 25, 2005, the NRC granted the request and issued a renewed license that now has an expiration date of July 31, 2046.

On June 13, 2003, the NRC issued a request for additional information (RAI). The RAI letter contained twenty-six RAIs in five different sections. Virginia Electric and Power Company (VEPCO) responded to the RAI on October 6, 2003 in a 77 page letter. The RAI and responses are as follows:

MATERIALS:

4. Provide an evaluation or data that demonstrates that the properties of zirconium fuel cladding continue to be sufficient to satisfy the safety requirements for the proposed 40-year license renewal period. **VEPCO Response:** As indicated in the Appendix to ISG-1 1, Revision 2, clad creep is the dominant mechanism for cladding deformation under normal conditions of storage. However numerous laboratory programs and studies (also listed in the Appendix to ISG-1 1, Revision 2) provide data and analyses that support the following conclusions listed in this Appendix:(1) deformation caused by creep will proceed slowly over time and will decrease the rod pressure; (2) the decreasing cladding temperature also decreases the hoop stress, and this too will become exceedingly small; (3) in the unlikely event that breaching of the cladding due to creep occurs, it will not result in gross rupture. Based on these conclusions, the NRC has established a maximum cladding temperature limit of 400°C for normal conditions of storage, and for short-term operations including cask drying and backfilling.
13. Clarify how the Maximum Cumulative Usage Factor (CUF) for fatigue was calculated for Castor V/21 casks and Castor X/33 casks. **VEPCO Response:** Calculation of the maximum cumulative usage factor (CUF) for fatigue for the CASTOR V/21 and CASTOR X/33 are documented in Section 4.2 of Topical Safety Analysis Report (TSAR) for the for each cask which were reviewed and approved by the NRC.

AGING MANAGEMENT REVIEWS:

1. Clarify whether the aging management evaluation of the TN-32 poison plates considered the analysis in Appendix A.5 of the Surry SAR, which addresses the criticality evaluation for a period of only 20 years. **VEPCO Response:** Appendix A.5 of the ISFSI FSAR addresses the

depletion of boron in the TN-32 poison plates and concludes the depletion has a negligible impact on the criticality analysis. Chapter 6 of the TN-32 Final Safety Analysis Report (FSAR) shows the fractional depletion calculation of ^{10}B in the neutron absorber plate in the TN-32 baskets. The results show that for 1,000 year duration, the fractional depletion of ^{10}B is only 1x10-4. This is negligible depletion.

AGING MANAGEMENT ACTIVITIES:

1. Discuss how cask seals are inspected under the inspection activities as stated in Table 3.2-4 for aging management. Clarify if the corrective actions and resolution of the TN-32 seal lid failures have addressed an additional 40-year service life for protection against normal conditions, anticipated occurrences, credible accidents, and natural phenomena events within the current licensing basis. Specify whether the cask seals could be in an undetected degraded state that meets normal operating conditions, but not in the required state of integrity to withstand credible accidents. **VEPCO Response:** This RAI consists of three parts and is addressed below accordingly. 1) Continuous pressure monitoring of the cask cover gas is the method to used to verify the integrity of the seals in the dry storage cask closure covers.2) As part of the corrective action to the TN-32 lid seal failures, a root cause evaluation was performed. This evaluation identified a design problem with the overpressure monitoring system environmental cover penetration (Coax connector) that allowed water intrusion into the main cask lid area and, subsequently, the outboard metallic (aluminum) seals. The implemented corrective action replaced the original penetration with a water-tight seal and relocated the penetration to the side of the cover.3) The potential for an undetected degraded state of the metallic seals in any cask design cannot be dismissed but is accounted for by the redundant seal system design per the requirements of 10CFR72.236(e).

H. B. Robinson

H. B. Robinson submitted a license renewal application on February 27, 2004 for a period of 40 years. On March 30, 2005, the NRC granted the request and issued a renewed license that now has an expiration date of August 31, 2046.

On December 16, 2004, Process Energy Carolinas, Inc. (PEC) submitted answers to the NRC on a request for additional information (RAI) submitted by the NRC on October 7, 2004. The October 7, 2004 letter has not been located. The PEC letter contained four RAIs; they are as follows:

NRC Request 4: Provide additional detail for fatigue analysis of Dry Shielded Canister shell cracking in Section B2.2, "Evaluations and Disposition," of the Identified Time Limited Aging Analyses (TLAAs). Include sources of fatigue considered, a summary of previous analysis (number of cycles and conditions), and results from the new analysis, including the comparison of the original and updated cumulative usage factors. **PEC Response:** The original fatigue evaluation of the DSC estimated a fatigue usage factor of 0.21 during a 50-year operational life of the ISFSI. That evaluation is based on a number of conservative assumptions and approaches, which, although not necessarily representative of the actual conditions encountered during the design life of the system, produced an upper bound estimation of the alternating stress intensities and the resulting fatigue usage factor. The fatigue evaluation considered both the daily and seasonal fluctuation of the ambient temperature. Three types of cyclic loads were considered in the fatigue evaluation: temperature, pressure, and seismic loads. The evaluation used maximum alternating stress intensities, and conservatively estimated the number of cycles associated with each load to determine the fatigue usage factor.

Prairie Island

Prairie Island submitted a license renewal application on October 20, 2011 for a period of 40 years.

On February 14, 2012, the NRC issued a request for supplemental information (RSI) stating that the license renewal application "… did not contain sufficient technical information." The RSI letter contained ten RSI in three different sections and ten general observations. Northern States Power Company, Minnesota Corporation (NSPM), responded to the ten RSI on February 29, 2012 in a 312 page letter. The RSI and responses are as follows:

Materials

Specify what industrial codes are used to describe the acceptance criteria for visual examinations of systems, structures and components (SSCs). **NSPM Response:** The Corrective Action Program requirements are established in accordance with the requirements of the NSPM Quality Assurance Topical Report and 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

Confinement

R-1. Clarify the use of airborne radioactivity monitoring for verifying site dose. **NSPM Response:** Sections 7.3.3 and A.7.3.3 of the Prairie Island ISFSI Safety Analysis Report (SAR) state that there are no credible events which could result in releases of radioactive products or unacceptable increases in direct radiation. Area radiation and airborne radioactivity monitors are therefore not needed at the ISFSI. For the PINGP, NSPM maintains a Radiological Environmental Monitoring Program (REMP) which includes airborne radioactivity monitoring. The data collected from the site's environmental monitors is reported to the NRC in the Annual REMP Report in accordance with the requirements of the PINGP Technical Specifications. As part of monitoring the air environment around the plant site, airborne particulates are collected on membrane filters by continuous pumping at five locations, one of which is a control. Filters are changed and counted weekly. Particulate filters are analyzed for gross beta activity.

R-2. Provide historical smear sample data for the casks located at the ISFSI. **NSPM Response:** As part of a March 12, 1991 Settlement Agreement between NSPM and the Minnesota Department of Public Safety and the Minnesota Environmental Quality Board, NSPM has performed quarterly masslinn smear surveys of at least 50% of the dry storage casks on the pads to ensure that cask surfaces are clean. NSPM also performs quarterly smear surveys of the concrete pads using canvas smears. Since NSPM first started contamination monitoring of the casks and pads in 1995, no surveys have exceeded 100 dpm/100 cm^2 (beta radiation) which is ten times below the limit set forth in the March 1991 agreement.

Northern States Power Company, Minnesota Corporation (NSPM), responded to the ten observations on April 26, 2012 in a 17 page letter. The RSI and responses are as follows:

Observations

O-1. Demonstrate the condition of the high burnup fuel in dry cask storage for the length of time the high burnup fuel will be in storage in the proposed Prairie Island renewal period of 20 to 60 years. **NSPM Response:** NSPM followed the guidance of NUREG-1927, "Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance," (Reference 4) to develop its license renewal application. Section 3.4.3 of NUREG-1927 titled, "Aging Management Activity," addresses the aging management activities for dry cask storage system (DCSS) interiors and fuel cladding. Since the DCSS interior and fuel cladding cannot reasonably be inspected, NUREG-1927 recommends the following for aging management of high burnup fuel: "The staff should assess whether the applicant has considered the most recent revision of ISG-11 [Interim

Staff Guidance] and research results in this area, especially with respect to high-burnup fuel. Research into fuel performance in storage is ongoing. It is expected that the applicants would monitor these developments to ensure that they have identified potential degradation effects. There is presently no data regarding potential long-term degradation of high-burnup fuel cladding. Thus, the applicant should provide any new supporting data demonstrating high-burnup fuel performance during extended storage. As an example, should an applicant have the opportunity for a DCSS interior and cladding inspection, the licensee should report any inspection findings in its evaluations." If this strategy is not adequate to address the NRC's concerns on high burnup fuel, then generic communication is needed to document the NRC's specific concerns, and to provide additional guidance to the industry on the recommended path forward.

O-2. Justify why the Pressure Monitoring System is not included with Systems, Structures and Components (SSCs) that are within the scope of the licensing renewal. **NSPM Response:** Prairie Island did not include the Pressure Monitoring System as a System, Structure, or Component within the scope of license renewal because the system is not classified as Safety-Related or Important to Safety. The Prairie Island ISFSI Safety Analysis Report (SAR) Sections 4.5.4 and A4.5.4, *Protective Cover and Overpressure System,* state that the Pressure Monitoring System has no safety function. SAR Section 4.5.4 for the TN-40 cask design states "The protective cover and overpressure system serve no safety function ..." SAR Section A4.5.4 for the TN40HT cask design states "The weather cover and overpressure system serve no safety function and are thus classified as not important to safety."

O-3. Justify seven-year inspection intervals under the ISFSI Inspection and Monitoring Activities Program. **NSPM Response:** The inspection interval under the ISFSI Inspection and Monitoring Activities Program for the concrete pads and earthen berm is five years, as described in Section A2.4 of Appendix A, "Aging Management Program," in Enclosure 3 of Reference 1. NSPM changed the frequency of its Structures Monitoring Program inspection from a seven-year frequency to a five-year frequency in February 2011.

O-4. Provide a plan for servicing and responding to events from the ISFSI when the reactor site support is no longer available. **NSPM:** NSPM Island is seeking renewal of the ISFSI license on the basis of the existing ISFSI and plant programs that are currently in place. Prairie Island is obligated to keep these programs in place, unless the NRC authorizes a change to these programs via a license amendment or other regulatory process.

O-5. Evaluate whether or not the top nozzle anchors should be considered in the aging management review. **NSPM Response:** NSPM evaluated whether or not the top nozzle anchors should be considered in the aging management review, and determined that there are no associated aging effects or mechanisms that require aging management activities. The upper nozzle anchors are an alternate means of securing the upper nozzle to the guide tubes of the fuel assemblies that are susceptible to the top nozzle stress corrosion cracking phenomenon. The upper nozzle anchors have a structural support (SS) intended function. They are also made of stainless steel and are in an Air/Gas environment.

O-6. Explain why NSPM identified no aging effects/mechanisms for subcomponents in air/gas environments. **NSPM Response:** NSPM utilized EPRI Report 1010639 "Non-Class 1 Mechanical Implementation Guideline and Mechanical Tools," Revision 4, January 2006, to identify potential aging effects for the metallic subcomponents of the casks. Appendix D of that report discusses the identification of aging effects of components subjected to an

Air/Gas environment and includes Table 4-1, which contains a summary of the potential aging effects of components in an Air/Gas environment. The table contains criteria that must be met (or present) in order for the applicable aging effect/mechanism to occur.

O-7. Equate the alarm setpoint for the interseal pressure monitoring system to leakage of helium through the metallic seals. **NSPM Response:** The original design and licensing basis for the TN-40 cask design did not include an analysis to equate the alarm setpoint to helium leakage through the metallic seals. However, an analysis that compares interseal pressure to helium leakage is contained in the TN-40 SAR Section 3.3.2.1, *Confinement Barriers and Systems*. This analysis includes graphical depictions of the monitoring system pressure for various test leak rates and was used to determine the allowed helium test leakage rate of 1.0×10^{-5} atm-cc/sec.

O-8. Describe the vent path for the buildup of gases in the radial neutron shield. Reference the applicable SAR sections. **NSPM Response:** The vent path for the build-up of gases in the radial neutron shield is through a pressure relief valve, which is described in the Prairie Island ISFSI Safety Analysis Report (SAR) Sections 3.2.5.4.4 and A3.2.5.4.4, *Outer Shell*. The valve has a 1 psi relief pressure.

O-9. Provide a summary of the Operations procedure for the daily alarm surveillance of the interseal pressure monitoring system. Also, provide details of any preventative maintenance of the equipment in the interseal pressure monitoring system. **NSPM Response:** Operations verifies twice daily that there are no alarms on the overpressure monitoring panel and that the interseal pressure for each cask is above 60 psig. Operations records the interseal pressure for each cask twice a week. The annual calibration of the OP monitoring system includes steps to check the transmitter, valve manifold, and fittings for helium leaks. It also checks that the interseal pressure for all the casks are within 4 psi of each other. If the interseal pressures are not within 4 psi, an Action Request is initiated in the NSPM Corrective Action Program to evaluate the condition. The preventive maintenance replacement program requires that the OP monitoring system circuitry cards be replaced every 10 years. The cards were last replaced during the summer of 2011.

Appendix B

ISFSI	RAI	Summary of RAI and Response	AMP Structures Monitoring Program (V.S1)
Calvert Cliffs	4-28-11 (ML111180260) 6-28-2011 (ML11180A270)	RAI #3-4. Provide a rationale that the underground concrete subcomponents of the HSM exposed to a soil or groundwater environment are not subject to the aging effects of cracking, loss of bond, and loss of material due to corrosion. RAI Response. The aging effects of the underground concrete subcomponents of the HSM exposed to a soil or groundwater environment are monitored through the same inspection credited for the above ground concrete portion of the HSM. The groundwater pH and chloride and sulfate concentrations are such that negligible chemical attack is expected.	The Aging Management Plan for a Structures Monitoring Program (V.S1) recommends a ground water sampling frequency of every 6 months, rather than five years, to account for potential seasonal variations due to effects such as winter salting, unless one can demonstrate that there are no seasonal variations in the groundwater chemistry. A site-specific program is recommended, if the ground water is aggressive with respect to below-grade concrete. Similarly, if one cannot confirm that the existing concrete has air content of 3% to 6%, a site-specific AMP is recommended to manage potential aging from freeze-thaw cycles. AMP V.S1 also recommends monitoring of concrete at the anchor bolt blockouts for cracking due to freeze-thaw cycles.
Calvert Cliffs	4-28-11 (ML111180260) 6-28-2011 (ML11180A270)	RAI #A-3. Provide an evaluation regarding the root cause of the concrete cracking, and justify why this condition will not lead to accelerated component degradation during the license renewal period. RAI Response. Calvert Cliffs commits to conduct an engineering evaluation of the identified concrete degradations, performed by a qualified structural engineer.	The Aging Management Plan for a Structures Monitoring Program (V.S1) has been modified by the statement "For concrete cracking, root cause of the cracking is evaluated to ensure that condition of concrete will not lead to accelerated structural degradation during the license renewal period
Oconee	10-1-2008 (ML082680204) 1-30-2009 (ML090370066)	RAI #3-3. Provide justification for not identifying any long term effect of degradation mechanisms; namely: corrosion, fatigue, thermal stresses, irradiation; for the below-grade concrete and reinforcing steel. RAI Response. The Oconee groundwater and lake water pH ranges and chloride and sulfate concentration ranges are such	See Aging Management Plan for a Structures Monitoring Program (V.S1) for Calvert Cliffs RAI 3-4 4-28-11 ML111180260 and 6-28-2011 ML11180A270 above.

		that the potential for the concrete below grade within the HSM space to degrade due to chemical attack is negligible.	
Oconee	10-1-2008 (ML082680204) 1-30-2009 (ML090370066)	RAI #3-3. The sixth paragraph states that "With respect to below grade concrete (and reinforcing steel), no aging effects/mechanisms were identified." "Structural support (SS)" and "heat transfer (HT)" were selected as intended functions for Concrete Below Grade in Table 3.2-1; therefore, at a minimum, provide reasons for not including exposed surfaces of the Concrete Below Grade within the HSM space in the inspection/monitoring under the Aging Management Activity/Program (AMA/AMP). Provide justification for not identifying any long term effect of degradation mechanisms; namely: corrosion, fatigue, thermal stresses, irradiation; for the below-grade concrete and reinforcing steel. RAI Response. No parameters of the Oconee groundwater or lake water chemistry exceed the limits where degradation could occur. The Oconee groundwater and lake water pH ranges are equal to or above the threshold limit of where potential degradation of the concrete may occur. The chloride and sulfate concentration ranges are well below both threshold concentrations. Therefore, the potential for the Concrete Below Grade within the HSM space to degrade due to chemical attack is negligible.	See Aging Management Plan for a Structures Monitoring Program (V.S1) for Calvert Cliffs RAI 3-4 4-28-11 ML111180260 and 6-28-2011 ML11180A270 above.
GE-Morris	5-16-2003 (ML031400313)	RAI #3-9. Outline the aging management program for the basin structure concrete elements. Reinforced concrete structures, when subjected to operational and environmental conditions and loads, may	The standards referenced in the RAI have been included in The Aging Management Plan for a Structures Monitoring Program (V.S1).

	9-24-2004 (ML042730294)	degrade over time. i.e., concrete may crack and lose materials, and steel may corrode. Consider in your response the following American Concrete Institute (ACI) standards regarding concrete degradation; ACI 224.1R "Causes, Evaluation and Repairs of Cracks in Concrete Structures," ACI 349.3R "Evaluation of Existing Nuclear Safety-Related Concrete Structures", and ACI 222R "Corrosion of Metals in Concrete." RAI Response. Aging Management for the concrete structures is described in CSAR Appendix A-8, Aging Management.	
Ft. St. Vrain	4-12-2010 (ML100980230) (not available on ADAMS)	RAI #12. Clarify how a loss of mechanical properties in the structural concrete of the Modular Vault Dry Storage (MVDS) building from irradiation are measured and/or estimated. Has the structural integrity of the MVDS been reevaluated based on the loss of material properties? Has any system, structure and component (SSC) meeting the requirements of scoping criteria been reevaluated based on the degradation mechanisms cited in Section 3.9.4? RAI Response. Response not available on ADAMS, but telephone conversation record of 7-20-2010 (ML102020056) states that the applicant will submit a supplement to their RAIs by 7-30-2010. An e-mail exchange (ML102730127) between DOE-ID and the NRC dated 9-29-2010 indicates that DOE-ID has submitted responses to the RAIs.	The MVDS building is unique to the Ft. St. Vrain ISFSI; however, the issue raised in this RAI is generic to the Aging Management Plan for a Structures Monitoring Program V.S1. Reduction of strength and modulus due to long-term exposure to gamma radiation may require further evaluation in a site-specific AMP.
Ft. St. Vrain	4-12-2010 (ML100980230)	RAI #14. Clarify if the concrete exterior to the Modular Vault Dry Store (MVDS) building, at an elevated height is considered	The Aging Management Plan for a Structures Monitoring Program (V.S1) recommends annual inspections of the structural concrete. AMP V.S1 may need to include guidance on

	(not available on ADAMS)	accessible, and how often it is inspected. RAI Response. Response not available on ADAMS; see entry two rows above.	the selection of representative samples of cracks to be monitored where accessibility is an issue.
			AMP External Surfaces Monitoring of Metal & Polymeric Components (V.M1)
Calvert Cliffs	12-16-2010 (ML103540592) 2-10-11 (ML110620120)	RAI #1. Provide results of lead canister inspection to demonstrate no adverse dry cask storage conditions. State how selected lead canister bounds conditions of all the DSCs under renewal. RAI Response. Lead canister inspection is scheduled to occur in April 2012. This canister was chosen because it will have the highest integrated thermal and gamma source term and the second highest integrated neutron source term.	The Aging Management Plan for External Surfaces Monitoring of Metal and Polymeric Components V.M1 will include lead canister in the inspection requirements. A lead canister for inspection is one with highest thermal load and longest service time, and/or other factors that cause degradation.
Calvert Cliffs	4-28-11 (ML111180260) 6-28-2011 (ML11180A270)	RAI #3-5. Provide rationale that the stainless steel subcomponents of the HSM exposed to a yard or yard-salt environment are not subject to the aging effects of stress corrosion cracking and loss of material due to corrosion. RAI Response. Calvert Cliffs is participating with industry initiatives evaluating the threshold for chloride concentration, stress conditions, and temperature conditions necessary for stress corrosion cracking to be a concern.	The Aging Management Plan for External Surfaces Monitoring of Metal and Polymeric Components V.M1 identifies cracking and leakage in stainless steel welded canisters due to (SCC) when exposed to moisture and aggressive environments.
Oconee	10-1-2008 (ML082680204)	RAI #3-1c. In "DSC [Dry Storage Canister] Support Assembly" it states "stainless steel cover plates are attached to the longitudinal support rails to provide sliding surfaces for the	The Aging Management Plan for External Surfaces Monitoring of Metal and Polymeric Components V.M1 includes inspection of the longitudinal support rails.

	1-30-2009 (ML090370066)	DSC's. The Sliding Surface of the DSC support rails is coated with a dry film lubricant." Evaluate possible effects of dry surface condition during the unloading process and why this condition will not lead to accelerated component degradation for the license renewal period. RAI Response. Future irretrievability of the DSC was considered and addressed in the original design by the selection of corrosion and wear resistant materials and suitable lubricants.	
			AMP Welded Canister Seal & Leakage Monitoring Program (V.M3)
Calvert Cliffs	12-16-2010 (ML103540592) 2-10-11 (ML110620120)	RAI #5. Provide justification that originally backfilled helium remains within the spent fuel canisters during the extended license period. RAI Response. Multiple separate seal welds are used to ensure pressure boundary integrity. These seal welds are installed using safety-related materials and are then tested for leakage.	Aging Management Plan for Welded Canister Seal and Leakage Monitoring Program V.M3 includes periodic examination of the confinement boundary seal welds using volumetric or surface techniques to ensure pressure boundary integrity and no helium leakage.
			AMP Bolted Cask Seal and Leakage Monitoring (V.M4)

Ft. St. Vrain	4-12-2010 (ML100980230) (Not available on ADAMS)	RAI #16. Clarify what method is used for the routine leak testing performed on the Fuel Storage Canisters (FSCs). Also clarify the frequency of the leak rate testing, and the acceptance criteria for the tests. RAI Response. Response not available on ADAMS, but telephone conversation record of 7-20-2010 (ML102020056) states that the applicant will submit a supplement to their RAIs by 7-30-2010. An e-mail exchange (ML102730127) between DOE-ID and the NRC dated 9-29-2010 indicates that DOE-ID has submitted responses to the RAIs.	Aging Management Plan for Bolted Cask Seal and Leakage Monitoring Program V.M4 recommends frequency of leak rate testing and acceptance criteria. Analyses of effects of thermo-mechanical fatigue and corrosion (including marine environments) on metallic seals and bolts may be necessary for the determination of the frequency of leak rate testing and acceptance criteria.
Surry	6-13-2003 (ML031671468) 10-6-2003 (ML032900118)	RAI #1 (Aging Management Activities). Discuss how cask seals are inspected under the inspection activities as stated in Table 3.2-4 for aging management. Clarify if the corrective actions and resolution of the TN-32 seal lid failures have addressed an additional 40-year service life for protection against normal conditions, anticipated occurrences, credible accidents, and natural phenomena events within the current licensing basis. Specify whether the cask seals could be in an undetected degraded state that meets normal operating conditions, but not in the required state of integrity to withstand credible accidents. RAI Response. 1) Continuous pressure monitoring of the cask cover gas is the method used to verify the integrity of the seals in the dry storage cask closure covers. 2) As part of the corrective action to the TN-32 lid seal failures, a root cause evaluation was performed. This evaluation identified a design problem with the overpressure	Aging Management Plan for Bolted Cask Seal and Leakage Monitoring Program V.M4 includes inspection methods, corrective actions, and operating experience. This RAI and response on the TN-32 seal lid will be included in the operating experience of AMP V.M4.

		monitoring system environmental cover penetration (Coax connector) that allowed water intrusion into the main cask lid area and, subsequently, the outboard metallic (aluminum) seals. The implemented corrective action replaced the original penetration with a water-tight seal and relocated the penetration to the side of the cover. 3) The potential for an undetected degraded state of the metallic seals in any cask design cannot be dismissed but is accounted for by the redundant seal system design per the requirements of 10CFR72.236(e).	
			AMP Canister Structural & Functional Integrity Monitoring (V.M5)t
Calvert Cliffs	12-16-2010 (ML103540592) 2-10-11 (ML110620120)	RAI #5. Provide justification that originally backfilled helium remains within the spent fuel canisters during the extended license period. RAI Response. Multiple separate seal welds are used to ensure pressure boundary integrity. These seal welds are installed using safety-related materials and are then tested for leakage.	Aging Management Plan for Canister Structural and Functional Integrity Monitoring Program V.M5 consists of (a) an assessment of compliance with the applicable NRC ISG documents to verify that storage canisters were designed, fabricated, erected, and tested to quality standards commensurate with the importance to safety of the function to be performed, and (b) based on whether or not the storage canisters were prepared in accordance with applicable ISG documents, a monitoring and/or inspection program to detect any degradation of the functional and structural integrity of the canister internals, and to ensure that the operation of the storage canister is within the required functional and operating limits. The monitoring program tracks temperatures and radiation levels at selected locations such as cask surfaces close to the fuel assemblies and air inlets and outlets. Abrupt changes in levels of temperature and/or radiation could indicate degradation of fuel cladding, degradation of neutron-absorbing and gamma-shielding materials, helium leakage, or a breach in the confinement boundary of the canister.
			TLAA Fatigue of Metal & Concrete Structures and Concrete Structures & Components (-IV.2)
Calvert Cliffs	12-16-2010 (ML103540592)	RAI #2. Provide thermal fatigue analyses for the DSC and	Time-Limited Aging Analysis for Fatigue of Metal and Concrete Structures and

	2-10-11 (ML110620120)	support structure that demonstrates whether or not thermal fatigue needs to be accounted as an aging mechanism. RAI Response. Thermal fatigue analyses provided to demonstrate that fatigue failure is not expected over a 60-year service life.	Components TLAA IV.2 considers thermal fatigue for the ASME Section III Class I components such as the DSC and support structure.
Surry	6-13-2003 (ML031671468) 10-6-2003 (ML032900118)	RAI #13 (Materials). Clarify how the Maximum Cumulative Usage Factor (CUF) for fatigue was calculated for Castor V/21 casks and Castor X/33 casks. RAI Response. Calculations of the maximum cumulative usage factor (CUF) for fatigue for the two casks are documented in Section 4.2 of the respective Topical Safety Analysis Reports.	See Calvert Cliffs TLAA IV.2 for RAI 2 12-16-2010 ML103540592 and 2-10-11 ML110620120 above.
Oconee	10-1-2008 (ML082680204) 1-30-2009 (ML090370066)	RAI #B-1. Provide the analysis mentioned in Section B2.2.1, "DSC Shell Cracking Due to Fatigue," which demonstrates that fatigue does not need to be considered. Justify the conclusion, including reasons for not including the DSC shell in the inspection/monitoring and/or AMA/AMP. RAI Response. This response is Transnuclear Propriety information and is provided in a separate attachment not included in the ADAMS file.	See Calvert Cliffs TLAA IV.2 for RAI 2 12-16-2010 ML103540592 and 2-10-11 ML110620120 above.
Robinson	10-7-2004 (not in ADAMS) 12-16-2004 (ML043560284)	RAI. Provide additional detail for fatigue analysis of Dry Shielded Canister shell cracking. RAI Response. The fatigue evaluation considered both daily and seasonal fluctuation of the ambient temperature as well as pressure fluctuations and seismic loads. A summary of the analysis is provided in the response.	See Calvert Cliffs TLAA IV.2 for RAI 2 12-16-2010 ML103540592 and 2-10-11 ML110620120 above.

			TLAA Environmental Qualification of Electric Equipment (IV.4)
GE-Morris	5-16-2003 (ML031400313) 9-29-2003 (ML032751539) 9-24-04 (ML042730294)	RAI #3-5. Describe the inspection and surveillance program(s) used to monitor the effects of aging on the electrical and instrumentation and control (I&C) components. RAI Response. Itemized response provided for various components.	Time Limited Aging Analysis for Environmental Qualification (EQ) of Electric Equipment IV.4 is a time-limited aging analysis on environmental qualification and aging of electrical and instrumentation components
Surry	6-13-2003 (ML031671468) 10-6-2003 (ML032900118)	RAI #4 (Materials). Provide an evaluation or data that demonstrates that the properties of zirconium fuel cladding continue to be sufficient to satisfy the safety requirements for the proposed 40-year license renewal period. RAI Response. As indicated in the Appendix to ISG-1 1, Revision 2, clad creep is the dominant mechanism for cladding deformation under normal conditions of storage. However numerous laboratory programs and studies (also listed in the Appendix to ISG-11, Revision 2) provide data and analyses that support the following conclusions listed in this Appendix:(1) deformation caused by creep will proceed slowly over time and will decrease the rod pressure; (2) the decreasing cladding temperature also decreases the hoop stress, and this too will become exceedingly small; (3) in the unlikely event that breaching of the cladding due to creep occurs, it will not result in gross rupture. Based on these conclusions, the NRC has established a maximum cladding temperature limit of 400°C for normal conditions of storage, and for short-term operations including cask drying and backfilling.	
Surry	6-13-2003 (ML031671468)	RAI #1 (Aging Management Reviews). Clarify whether the aging management evaluation of	This may be a generic issue requiring aging management.

	10-6-2003 (ML032900118)	the TN-32 poison plates considered the analysis in Appendix A.5 of the Surry SAR, which addresses the criticality evaluation for a period of only 20 years. RAI Response. Appendix A.5 of the ISFSI FSAR addresses the depletion of boron in the TN-32 poison plates and concludes the depletion has a negligible impact on the criticality analysis. Chapter 6 of the TN-32 Final Safety Analysis Report (FSAR) shows the fractional depletion calculation of 10B in the neutron absorber plate in the TN-32 baskets. The results show that for 1,000 year duration, the fractional depletion of 10B is only $1x10^{-4}$. This is negligible depletion.	

Appendix C

Summary and Evaluation of RAIs Related to AMPs, TLAAs, and Identified R&D Gaps

RAI/ISFSI	RAI Summary/Response	AMP/TLAA Evaluation	R&D Technical Gap/Evaluation
		TLAA EQ of Electric Equipment IV.4	Monitoring
GE Morris 5-16-2003 (ML031400313) 9-29-2003 (ML032751539) 9-24-04 (ML042730294)	RAI #3-5. Describe the inspection and surveillance program(s) used to monitor the effects of aging on the electrical and instrumentation and control (I&C) components. RAI Response. Itemized response provided for various components	Time Limited Aging Analysis for Environmental Qualification (EQ) of Electric Equipment IV.4 is a time-limited aging analysis on environmental qualification and aging of electrical and instrumentation components	Storage of fuel at GE Morris is in a pool inside an operating facility that requires electrical and instrumentation and control equipment. Most ISFSIs are in a dry storage configuration and as such meet requirements through passive systems that do not require electrical and instrumentation and control components. As the RD&D plan prepares for development and application of monitoring and inspection equipment for dry storage ISFSIs, the components considered in the GE Morris surveillance program may provide insight for improved R&D.
			Cladding/Temperature Profiles/Drying
Surry 6-13-2003 (ML031671468) 10-6-2003 (ML032900118)	RAI #4 (Materials). Provide an evaluation or data that demonstrates that the properties of zirconium fuel cladding continue to be sufficient to satisfy the safety requirements for the proposed 40-year license renewal period. RAI Response. As indicated in the Appendix to ISG-1 1, Revision 2, clad creep is the dominant mechanism for cladding deformation under normal conditions of storage. However numerous laboratory programs and studies (also listed in the Appendix to ISG-11, Revision 2) provide data and analyses that support the following conclusions listed in this Appendix:(1) deformation caused by		Establishing that cladding continues to satisfy safety requirements for proposed license renewal periods is a generic issue that may be more prominent beyond the current licensing basis. Very little, if any, data is publicly available on the newer cladding alloys and on high burnup cladding (>45 GWd/MTU) fuel (See ISG-11, Rev. 3). Proposed R&D includes: Analyzing long term low temperature annealing, hydride reorientation and embrittlement, delayed hydride cracking, oxidation, and low temperature creep with advanced modeling and simulation with some experimental work to support the models Small scale testing and in service inspections will be used to assess drying kinetics and develop models to better quantify residual water Development of more accurate models of temperatures and

RAI/ISFSI	RAI Summary/Response	AMP/TLAA Evaluation	R&D Technical Gap/Evaluation
	creep will proceed slowly over time and will decrease the rod pressure; (2) the decreasing cladding temperature also decreases the hoop stress, and this too will become exceedingly small; (3) in the unlikely event that breaching of the cladding due to creep occurs, it will not result in gross rupture. Based on these conclusions, the NRC has established a maximum cladding temperature limit of 400°C for normal conditions of storage, and for short-term operations including cask drying and backfilling.		temperature profiles in spent fuel storage systems in collaboration with EPRI inspections
Prairie Island 4-26-2012 Observation	O-1. Demonstrate the condition of the high burnup fuel in dry cask storage for the length of time the high burnup fuel will be in storage in the proposed Prairie Island renewal period of 20 to 60 years. **O-1 NSPM Response:** NSPM followed the guidance of NUREG-1927, "Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance," (Reference 4) to develop its license renewal application. Section 3.4.3 of NUREG-1927 titled, "Aging Management Activity," addresses the aging management activities for dry cask storage system (DCSS) interiors and fuel cladding. Since the DCSS interior and fuel cladding cannot reasonably be inspected, NUREG-1927		In addition to that noted above, a confirmatory demonstration is planned to address the condition of high burn up fuel after extended storage. Initial characterization of fuel prior to emplacement in the demonstration will provide baseline data.

RAI/ISFSI	RAI Summary/Response	AMP/TLAA Evaluation	R&D Technical Gap/Evaluation
	recommends the following for aging management of high burnup fuel:		
			Neutron Poisons
Surry 6-13-2003 (ML031671468) 10-6-2003 (ML032900118	RAI #1 (Aging Management Reviews). Clarify whether the aging management evaluation of the TN-32 poison plates considered the analysis in Appendix A.5 of the Surry SAR, which addresses the criticality evaluation for a period of only 20 years. RAI Response. Appendix A.5 of the ISFSI FSAR addresses the depletion of boron in the TN-32 poison plates and concludes the depletion has a negligible impact on the criticality analysis. Chapter 6 of the TN-32 Final Safety Analysis Report (FSAR) shows the fractional depletion calculation of 10B in the neutron absorber plate in the TN-32 baskets. The results show that for 1,000 year duration, the fractional depletion of 10B is only $1x10^{-4}$. This is negligible depletion		Proposed R&D is planned to evaluate the continued efficacy of neutron poisons during extended dry storage in order to meet future retrieval and transportation criticality safety. R&D includes: Separate effects testing to understand changes in areal density of poison isotopes and changes in spacing between fuel assemblies. Source term analyses to determine accurate ranges of radiation exposure profiles for neutron poisons as a function of storage configuration, burnup and duration. Thermal modeling to determine neutron poison thermal profiles as a function of extended storage. Experiments to determine neutron poison material structural properties, as function of a range of individual and compounded thermal, mechanical, chemical, and radiation stressors.
			Welded Container/Monitoring/Inspection
		AMP External Surface Monitoring of Metal & Polymeric Components V.M1	
Calvert Cliffs 12-16-2010 (ML103540592)	RAI #1. Provide results of lead canister inspection to demonstrate no adverse dry cask storage conditions. State how	The Aging Management Plan for External Surfaces Monitoring of Metal and Polymeric	Current R&D includes: Canister inspection support for EPRI task team to demonstrate no adverse dry cask storage conditions.

RAI/ISFSI	RAI Summary/Response	AMP/TLAA Evaluation	R&D Technical Gap/Evaluation
2-10-11 (ML110620120) 4-28-11 (ML111180260) 6-28-2011 (ML11180A270) Oconee 10-1-2008 (ML082680204) 1-30-2009 (ML090370066)	selected lead canister bounds conditions of all the DSCs under renewal. RAI Response. Lead canister inspection is scheduled to occur in April 2012. This canister was chosen because it will have the highest integrated thermal and gamma source term and the second highest integrated neutron source term. RAI #3-5. Provide rationale that the stainless steel subcomponents of the HSM exposed to a yard or yard-salt environment are not subject to the aging effects of stress corrosion cracking and loss of material due to corrosion. RAI Response. Calvert Cliffs is participating with industry initiatives evaluating the threshold for chloride concentration, stress conditions, and temperature conditions necessary for stress corrosion cracking to be a concern RAI #3-1c. In "DSC [Dry Storage Canister] Support Assembly" it states "stainless steel cover plates are attached to the longitudinal support rails to provide sliding surfaces for the DSC's. The Sliding Surface of the DSC support rails is coated with a dry film lubricant." Evaluate possible effects of dry surface condition during	Components V.M1 will include lead canister in the inspection requirements. A lead canister for inspection is one with highest thermal load and longest service time, and/or other factors that cause degradation The AMP V.M.1 identifies cracking and leakage in stainless steel welded canisters due to (SCC) when exposed to moisture and aggressive environments AMP V.M.1 includes inspection of longitudinal support rails	Canister inspection of the INL NUHOMS system to demonstrate delivery and inspection technology. Proposed R&D includes a review of sensing technologies applicable to monitoring canister integrity including characterizations of maturity, sensitivity, environmental compatibility, physical compatibility and deployment of monitoring technologies. Current R&D includes: Two university programs to study the parameters of SCC and develop a time dependent model for failure of the welds Support for an EPRI sponsored team to research SCC and the threshold conditions for chloride concentrations. Inspections of canisters to observe corrosion evidence Proposed R&D will investigate the feasibility of deployment of technologies to monitor conditions conducive to corrosion and stress corrosion cracking of canister weld and base material (temperature, RH, salt) and directly monitor the existence of corrosion and cracking

RAI/ISFSI	RAI Summary/Response	AMP/TLAA Evaluation	R&D Technical Gap/Evaluation
	the unloading process and why this condition will not lead to accelerated component degradation for the license renewal period. RAI Response. Future irretrievability of the DSC was considered and addressed in the original design by the selection of corrosion and wear resistant materials and suitable lubricants.		
		AMP Welded Canister Seal and Leakage Monitoring Program V.M3/ AMP Canister Structural and Functional Integrity Monitoring Program V.M5	
Calvert Cliffs 12-16-2010 (ML103540592) 2-10-11 (ML110620120)	RAI #5. Provide justification that originally backfilled helium remains within the spent fuel canisters during the extended license period. RAI Response. Multiple separate seal welds are used to ensure pressure boundary integrity. These seal welds are installed using safety-related materials and are then tested for leakage.	Aging Management Plan for Welded Canister Seal and Leakage Monitoring Program V.M3 includes periodic examination of the confinement boundary seal welds using volumetric or surface techniques to ensure pressure boundary integrity and no helium leakage Aging Management Plan for Canister Structural and Functional Integrity Monitoring Program V.M5 consists of (a) an assessment of compliance with the applicable NRC ISG documents to verify that storage canisters	Proposed R&D includes: • Development of inspection techniques for seal welds that are obscured by the overpack • Deployment of technologies to monitor conditions conducive to corrosion and stress corrosion cracking of canister weld and base material (temperature, RH, Direct monitoring of seal and gasket integrity • Development of monitoring techniques to detect small leaks from the primary confinement boundary, or alternative methods for determining loss of helium backfill

RAI/ISFSI	RAI Summary/Response	AMP/TLAA Evaluation	R&D Technical Gap/Evaluation
		were designed, fabricated, erected, and tested to quality standards commensurate with the importance to safety of the function to be performed, and (b) based on whether or not the storage canisters were prepared in accordance with applicable ISG documents, a monitoring and/or inspection program to detect any degradation of the functional and structural integrity of the canister internals, and to ensure that the operation of the storage canister is within the required functional and operating limits. The monitoring program tracks temperatures and radiation levels at selected locations such as cask surfaces close to the fuel assemblies and air inlets and outlets. Abrupt changes in levels of temperature and/or radiation could indicate degradation of fuel cladding, degradation of neutron-absorbing and gamma-shielding materials, helium leakage, or a breach in the confinement boundary of the canister.	
		TLAA Fatigue of Metal and Concrete Structures and Components TLAA IV.2	

RAI/ISFSI	RAI Summary/Response	AMP/TLAA Evaluation	R&D Technical Gap/Evaluation
Calvert Cliffs 12-16-2010 (ML103540592) 2-10-11 (ML110620120) Surry 6-13-2003 (ML031671468) 10-6-2003 (ML032900118) Oconee 10-1-2008 (ML082680204) 1-30-2009 (ML090370066) Robinson 10-7-2004 (not in ADAMS) 12-16-2004 (ML043560284)	RAI #2. Provide thermal fatigue analyses for the DSC and support structure that demonstrates whether or not thermal fatigue needs to be accounted as an aging mechanism. RAI Response. Thermal fatigue analyses provided to demonstrate that fatigue failure is not expected over a 60-year service life. RAI #13 (Materials). Clarify how the Maximum Cumulative Usage Factor (CUF) for fatigue was calculated for Castor V/21 casks and Castor X/33 casks. RAI Response. Calculations of the maximum cumulative usage factor (CUF) for fatigue for the two casks are documented in Section 4.2 of the respective Topical Safety Analysis Reports RAI #B-1. Provide the analysis mentioned in Section B2.2.1, "DSC Shell Cracking Due to Fatigue," which demonstrates that fatigue does not need to be considered. Justify the conclusion, including reasons for not including the DSC shell in the inspection/monitoring and/or AMA/AMP RAI Response. This	Time-Limited Aging Analysis for Fatigue of Metal and Concrete Structures and Components TLAA IV.2 considers thermal fatigue for the ASME Section III Class I components such as the DSC and support structure	Proposed R&D for fatigue includes: Development and deployment of monitoring equipment and techniques to detect small leaks from the primary confinement boundary Proposed R&D for fatigue includes: Deployment of technologies to monitor thermal fatigue damage and relaxation in bolts. Development of techniques to directly monitor the integrity of seals and gaskets

RAI/ISFSI	RAI Summary/Response	AMP/TLAA Evaluation	R&D Technical Gap/Evaluation
	response is Transnuclear Propriety information and is provided in a separate attachment not included in the ADAMS file RAI. Provide additional detail for fatigue analysis of Dry Shielded Canister shell cracking. RAI Response. The fatigue evaluation considered both daily and seasonal fluctuation of the ambient temperature as well as pressure fluctuations and seismic loads. A summary of the analysis is provided in the response.		
			Bolted Container/Monitoring/Inspection
		AMP Bolted Cask Seal and Leakage Monitoring Program V.M4	
Ft. St. Vrain 4-12-2010 (ML100980230) (Not available on ADAMS) Surry 6-13-2003 (ML031671468)	RAI #16. Clarify what method is used for the routine leak testing performed on the Fuel Storage Canisters (FSCs). Also clarify the frequency of the leak rate testing, and the acceptance criteria for the tests. RAI Response. Response not available on ADAMS, but telephone conversation record of 7-20-2010 (ML102020056) states that the applicant will submit a supplement to their RAIs by 7-30-2010. An e-mail exchange (ML102730127) between DOE-ID and the NRC dated 9-29-2010 indicates	Aging Management Plan for Bolted Cask Seal and Leakage Monitoring Program V.M4 recommends frequency of leak rate testing and acceptance criteria. Analyses of effects of thermo-mechanical fatigue and corrosion (including marine environments) on metallic seals and bolts may be necessary for the determination of the frequency of leak rate testing and acceptance criteria	The information gleaned from this applicant response may be helpful for DOE's R&D program to determine monitoring methods for leak testing as well as identify monitoring frequency and acceptance criteria protocols in generic AMPs. Proposed R&D includes: • Deployment of technologies to monitor thermal fatigue damage and relaxation in bolts • Development of techniques to directly monitor the integrity of seals and gaskets Development and deployment of monitoring equipment and techniques to detect small leaks from the primary confinement boundary

RAI/ISFSI	RAI Summary/Response	AMP/TLAA Evaluation	R&D Technical Gap/Evaluation
10-6-2003 (ML032900118)	that DOE-ID has submitted responses to the RAIs. RAI #1 (Aging Management Activities). Discuss how cask seals are inspected under the inspection activities as stated in Table 3.2-4 for aging management. Clarify if the corrective actions and resolution of the TN-32 seal lid failures have addressed an additional 40-year service life for protection against normal conditions, anticipated occurrences, credible accidents, and natural phenomena events within the current licensing basis. Specify whether the cask seals could be in an undetected degraded state that meets normal operating conditions, but not in the required state of integrity to withstand credible accidents. RAI Response. 1) Continuous pressure monitoring of the cask cover gas is the method used to verify the integrity of the seals in the dry storage cask closure covers. 2) As part of the corrective action to the TN-32 lid seal failures, a root cause evaluation was performed. This evaluation identified a design problem with the overpressure monitoring system environmental cover penetration (Coax connector) that allowed water intrusion into the	AMP VM4 includes inspection methods, corrective actions, and operating experience. This RAI and response on the TN-32 seal lid will be included in the operating experience of AMP V.M4.	This RAI provides important insights to inform DOE's R&D program for design and deployment of monitoring systems and consideration of redundant seal systems for extended storage. Proposed R&D includes: • Deployment of technologies to monitor thermal fatigue damage and relaxation in bolts • Development of techniques to directly monitor the integrity of seals and gaskets • Development of systems for early detection of confinement boundary degradation • Collaboration with the EPRI-led teams on metallic seal integrity.

RAI/ISFSI	RAI Summary/Response	AMP/TLAA Evaluation	R&D Technical Gap/Evaluation
	main cask lid area and, subsequently, the outboard metallic (aluminum) seals. The implemented corrective action replaced the original penetration with a water-tight seal and relocated the penetration to the side of the cover. 3) The potential for an undetected degraded state of the metallic seals in any cask design cannot be dismissed but is accounted for by the redundant seal system design per the requirements of 10CFR72.236(e).		
		AMP for Structures Monitoring V-S1	Overpack and Pad
Calvert Cliffs 4-28-11 (ML111180260) 6-28-2011 (ML11180A270) 4-28-11 (ML111180260) 6-28-2011 (ML11180A270)	RAI #3-4. Provide a rationale that the underground concrete subcomponents of the HSM exposed to a soil or groundwater environment are not subject to the aging effects of cracking, loss of bond, and loss of material due to corrosion RAI Response. The aging effects of the underground concrete subcomponents of the HSM exposed to a soil or groundwater environment are monitored through the same inspection credited for the above ground concrete portion of the HSM. The groundwater pH and chloride and sulfate concentrations are such that negligible chemical attack is expected. RAI #A-3. Provide an evaluation regarding the	The Aging Management Plan for a Structures Monitoring Program (V.S1) recommends a ground water sampling frequency of every 6 months, rather than five years, to account for potential seasonal variations due to effects such as winter salting, unless one can demonstrate that there are no seasonal variations in the groundwater chemistry. A site-specific program is recommended, if the ground water is aggressive with respect to below-grade concrete. Similarly, if one cannot confirm that the existing concrete has air content of 3% to 6%, a site-specific AMP is recommended to manage potential	R&D is proposed to investigate the feasibility of deployment of monitoring technologies that can detect early stages of concrete and embedded steel damage. Specific activities include: Characterizations of maturity, sensitivity, environmental compatibility, physical compatibility, and longevity of sensors to measure concrete and embedded steel stressors. Investigation of non destructive technologies for detecting corrosion of embedded steel. Modeling, testing, and development of technologies to monitor, inspect, prevent and remediate the freeze-thaw and corrosion of embedded steel degradation mechanisms. Development of a test bed to examine severe freeze-thaw cycles.

RAI/ISFSI	RAI Summary/Response	AMP/TLAA Evaluation	R&D Technical Gap/Evaluation
Oconee 10-1-2008 (ML082680204) 1-30-2009 (ML090370066) 10-1-2008 (ML082680204) 1-30-2009 (ML090370066)	root cause of the concrete cracking, and justify why this condition will not lead to accelerated component degradation during the license renewal period RAI Response. Calvert Cliffs commits to conduct an engineering evaluation of the identified concrete degradations, performed by a qualified structural engineer. RAI #3-3. Provide justification for not identifying any long term effect of degradation mechanisms; namely: corrosion, fatigue, thermal stresses, irradiation; for the below-grade concrete and reinforcing steel. RAI Response. The Oconee groundwater and lake water pH ranges and chloride and sulfate concentration ranges are such that the potential for the concrete below grade within the HSM space to degrade due to chemical attack is negligible. RAI #3-3. The sixth paragraph states that "With respect to below grade concrete (and reinforcing steel), no aging effects/mechanisms were identified." "Structural support (SS)" and "heat transfer (HT)" were selected as intended functions for Concrete Below Grade in Table 3.2-1; therefore, at a minimum, provide reasons for not including	aging from freeze-thaw cycles. AMP V.S1 also recommends monitoring of concrete at the anchor bolt blockouts for cracking due to freeze-thaw cycles. The Aging Management Plan for a Structures Monitoring Program (V.S1) has been modified by the statement "For concrete cracking, root cause of the cracking is evaluated to ensure that condition of concrete will not lead to accelerated structural degradation during the license renewal period	

RAI/ISFSI	RAI Summary/Response	AMP/TLAA Evaluation	R&D Technical Gap/Evaluation
	exposed surfaces of the Concrete Below Grade within the HSM space in the inspection/monitoring under the Aging Management Activity/Program (AMA/AMP). Provide justification for not identifying any long term effect of degradation mechanisms; namely: corrosion, fatigue, thermal stresses, irradiation; for the below-grade concrete and reinforcing steel RAI Response. No parameters of the Oconee groundwater or lake water chemistry exceed the limits where degradation could occur. The Oconee groundwater and lake water pH ranges are equal to or above the threshold limit of where potential degradation of the concrete may occur. The chloride and sulfate concentration ranges are well below both threshold concentrations. Therefore, the potential for the Concrete Below Grade within the HSM space to degrade due to chemical attack is negligible		
GE Morris 5-16-2003 (ML031400313)	RAI #3-9. Outline the aging management program for the basin structure concrete elements. Reinforced concrete structures, when subjected to operational and environmental conditions and loads, may degrade over time. i.e., concrete may crack and lose materials, and steel may corrode. Consider in your response the following American	The standards referenced in the RAI have been included in The Aging Management Plan for a Structures Monitoring Program (V.S1).	Because the UFDC effort has focused on dry storage systems so far, no R&D has yet been identified for evaluating concrete in pool storage. Future updates of The Gap Analyses will evaluate pool storage

RAI/ISFSI	RAI Summary/Response	AMP/TLAA Evaluation	R&D Technical Gap/Evaluation
9-24-2004 (ML042730294)	Concrete Institute (ACI) standards regarding concrete degradation; ACI 224.1R "Causes, Evaluation and Repairs of Cracks in Concrete Structures," ACI 349.3R "Evaluation of Existing Nuclear Safety-Related Concrete Structures", and ACI 222R "Corrosion of Metals in Concrete." RAI Response. Aging Management for the concrete structures is described in CSAR Appendix A-8, Aging Management.		
Ft. St. Vrain 4-12-2010 (ML100980230) (not available on ADAMS) Ft. St. Vrain 4-12-2010 (ML100980230) (not available on	RAI #12. Clarify how a loss of mechanical properties in the structural concrete of the Modular Vault Dry Storage (MVDS) building from irradiation are measured and/or estimated. Has the structural integrity of the MVDS been reevaluated based on the loss of material properties? Has any system, structure and component (SSC) meeting the requirements of scoping criteria been reevaluated based on the degradation mechanisms cited in Section 3.9.4? RAI Response. Response not available on ADAMS, but telephone conversation record of 7-20-2010 (ML102020056) states that the applicant will submit a supplement to their RAIs by 7-30-2010. An e-mail exchange (ML102730127) between DOE-ID and the NRC	The MVDS building is unique to the Ft. St. Vrain ISFSI; however, the issue raised in this RAI is generic to the Aging Management Plan for a Structures Monitoring Program V.S1. Reduction of strength and modulus due to long-term exposure to gamma radiation may require further evaluation in a site-specific AMP	The R&D gap "Overpack" notes that "A large volume of data in the peer-reviewed literature indicates that irradiation damage will not be a significant degradation mechanism." Further, "In the DCSS systems, the level of irradiation over the extended operation is not expected to reach a level that is sufficient to cause significant mechanical strength reduction of concrete, therefore, the irradiation effect is not considered to be a significant aging degradation mechanism" (ASTM C1562, Section A5.4.8.2). However, the MVDS building is unique to the Ft. St. Vrain ISFSI and the impacts of irradiation on this vault structure may require additional evaluation.

RAI/ISFSI	RAI Summary/Response	AMP/TLAA Evaluation	R&D Technical Gap/Evaluation
ADAMS)	dated 9-29-2010 indicates that DOE-ID has submitted responses to the RAIs RAI #14. Clarify if the concrete exterior to the Modular Vault Dry Store (MVDS) building, at an elevated height is considered accessible, and how often it is inspected. RAI Response. Response not available on ADAMS; see entry two rows above.	The Aging Management Plan for a Structures Monitoring Program (V.S1) recommends annual inspections of the structural concrete. AMP V.S1 may need to include guidance on the selection of representative samples of cracks to be monitored where accessibility is an issue.	
Prairie Island 4-26-2012 Observation	O-1. Demonstrate the condition of the high burnup fuel in dry cask storage for the length of time the high burnup fuel will be in storage in the proposed Prairie Island renewal period of 20 to 60 years. **O-1 NSPM Response:** NSPM followed the guidance of NUREG-1927, "Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance," (Reference 4) to develop its license renewal application. Section 3.4.3 of NUREG-1927 titled, "Aging Management Activity," addresses the aging management activities for dry cask storage system (DCSS) interiors and fuel cladding. Since the DCSS interior and fuel cladding cannot reasonably be inspected, NUREG-1927 recommends the following for aging management of high burnup fuel:		