VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

January 20, 2017

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Director, Division of Spent Fuel Management
Office of Nuclear Material Safety and Safeguards
Washington, DC 20555-0001

Serial No. 16-456
NRA/TJS R0
Docket No. 72-16
License No. SNM-2507

72-1030

VIRGINIA ELECTRIC AND POWER COMPANY
OLD DOMINION ELECTRIC COOPERATIVE
NORTH ANNA POWER STATION INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI)
LICENSE RENEWAL APPLICATION: RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION (CAC NO. L25121)

On May 25, 2016, Virginia Electric and Power Company (Dominion Virginia Power or Dominion) on behalf of itself and Old Dominion Electric Cooperative (ODEC) submitted an application for renewal of the North Anna Power Station (NAPS) site-specific Independent Spent Fuel Storage Installation (ISFSI) license SNM-2507 (Agency Documents Access and Management System (ADAMS) Accession No. ML16153A140). The Nuclear Regulatory Commission (NRC) acknowledged acceptance of the license renewal application on July 21, 2016 (ADAMS Accession No. ML16207A104).

On November 23, 2016, Dominion received from the NRC a Request for Additional Information (RAI) (ADAMS Accession No. ML16330A715) related to the application for renewal of the NAPS site-specific ISFSI license.

Attachment 1 provides the Dominion responses to the RAI. Enclosure 1 provides the associated revised NAPS ISFSI Safety Analysis Report (SAR) Supplement, dated 01/20/2017, with changes annotated by a revision bar in the right margin.

If you have any questions or require additional information, please contact Mr. Thomas Szymanski at (804) 273-3065.

NMSS20
NMSS26

Sincerely,

Mark D. Sartain
Vice President – Nuclear Engineering and Fleet Support

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Mark D. Sartain, who is Vice President – Nuclear Engineering and Fleet Support, of Virginia Electric and Power Company. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 20th day of January, 2017.

My Commission Expires: 12/31/20.

CRAIG D SLY
Notary Public
Commonwealth of Virginia
Reg. # 7518653
My Commission Expires December 31, 2020

Notary Public

Commitments made in this letter:

1. Perform an annual neutron radiation survey of each TN-32 dry storage cask.
2. Perform annual trending of the TN-32 dry storage cask neutron survey results.

Attachment 1: NAPS ISFSI License Renewal RAI Responses

Enclosure 1: Revised ISFSI SAR Supplement

cc: U.S. Nuclear Regulatory Commission
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Serial No. 16-456
Docket No. 72-16

Attachment 1

NAPS ISFSI License Renewal RAI Responses

North Anna Power Station ISFSI

Virginia Electric and Power Company

RAI 1-1

Provide the following additional information with respect to cumulative impacts for all resource areas. If no impact is expected please make a statement to that effect.

1. Clarify the amount of spent fuel expected to be generated by NAPS Unit 1 and Unit 2 throughout their license life and the amount of ISFSI storage capacity necessary to accommodate the generated spent fuel.

2. Dominion anticipates expanding the general-licensed ISFSI to store additional spent fuel from Units 1 and 2. Provide a description of the plans to expand the general-licensed ISFSI, including construction of additional pads and their locations. Discuss the potential cumulative impacts of this potential expansion for all resource areas. Provide a description of and quantify, where possible, the factors considered in evaluating the potential cumulative impacts. Provide mitigation measures that have been or would be taken to reduce or avoid potential cumulative impacts.

3. The specific-licensed ISFSI is authorized to store 84 TN-32 sealed surface storage casks on three pads. The general-licensed ISFSI Pad 2 occupies the location identified for a second pad under the specific-licensed ISFSI. Explain the process followed to locate the general-licensed ISFSI Pad 2 here and clarify whether this process would be used to locate any future pads under the general-licensed ISFSI.

4. Discuss the potential cumulative impacts of construction and operation of the proposed third nuclear power unit, designated as Unit 3.

Dominion's Environmental Report (ER) Supplement, submitted as part of the license renewal application, includes a description of the following activities associated with the NAPS, but that are not part of the license renewal request:

- Continued operation of the NAPS Units 1 and 2. These units operate under separate NRC licenses (NPF–4 and NPF–7, respectively) that will expire in 2038 and 2040, respectively. In the ER Supplement, Dominion states it considered the potential cumulative impacts of the ISFSI continued operations with the NAPS Units 1 and 2 operations.

- North Anna Unit 3 Combined License Application (COLA) is currently under review by the NRC. Dominion is proposing to construct and operate a third nuclear power unit, designated as Unit 3. In the ER Supplement, Dominion states it considered the potential cumulative impacts of the ISFSI continued operations with the reasonably foreseeable future action of construction and operation of the proposed Unit 3.

- General-licensed ISFSI Pad 2, which is located adjacent to the specific-licensed ISFSI Pad 1. In the ER Supplement, Dominion explains that it has no plans to expand the pad capacity under the specific-licensed ISFSI beyond Pad 1, but it retains the authority to do so. Dominion further clarifies that the potential environmental impacts of such expansion are considered and discussed in the ER Supplement (see page E-2). Dominion also explains that future dry cask storage of spent fuel at NAPS, including construction of any additional pads, would be anticipated to occur under the general license (see page E-3).

Although the proposed license renewal only applies to the NAPS specific-licensed ISFSI Pad 1, these actions are considered past, present, or reasonably foreseeable future actions that could affect the same resources impacted by the proposed action. The NRC will consider these actions in its cumulative impact analysis of the environmental review.

This information is necessary for the NRC staff to assess the environmental impacts of the proposed action, as required by 10 CFR 51.30.

Response

1. The NAPS Unit 1 and 2 operating licenses were renewed in 2003 for extended terms ending in 2038 and 2040, respectively (68 FR 15246). The ISFSI reinforced concrete pad No. 1 currently holds 27 TN-32 casks and has capacity remaining for a single TN-32 cask, potentially modified for a high burnup fuel demonstration. General-licensed ISFSI reinforced concrete pad No. 2 was constructed under Certificate of Compliance No. 1030 (COC 1030) and uses the NUHOMS® HD Horizontal Storage Module (HSM-H) and dry shielded canister (DSC). Reinforced concrete pad No. 2 currently holds 29 casks/modules with a capacity for 40 casks/modules total. The DSCs are designed to hold up to 32 intact pressurized water reactor (PWR) fuel assemblies. Dominion expects to discharge a total of 5,298 fuel assemblies from NAPS Units 1 and 2 through 2040, which equates to approximately 2,437 metric tons of uranium (MTU) based on 0.460 MTU/assembly. The projected quantity of spent fuel to be discharged minus the storage contents of the NAPS spent fuel pool would utilize the remaining capacity of the general-licensed ISFSI reinforced concrete pad No. 2 and would likely necessitate construction of one additional pad of similar capacity. The need for and actual capacity of a reinforced concrete pad No. 3 would depend on whether and when DOE begins to remove spent fuel from NAPS, and the storage capacity of casks that would be used on that pad.

2. Dominion's plans to expand dry cask storage capacity of spent fuel within the existing ISFSI under the general license have not been finalized. However, it is anticipated the next potential reinforced concrete pad (No. 3) would be located

within the current ISFSI and would be constructed to the west of reinforced concrete pad No. 1 (as shown in license renewal application Figure E3-2). Resource needs to construct and operate a potential reinforced concrete pad No. 3 would be similar to those utilized for the general-licensed reinforced concrete pad No. 2. For example, resources would include concrete, soil, steel, and cable. Cumulative environmental impact assessments for the ISFSI have been conducted and approved for both the SNM-2507 site-specific license and the 10 CFR Part 72, Subpart L general license, and are also addressed for the North Anna Power Station site in NUREG-1917, Supplemental Environmental Impact Statement for the Combined License (COL) for North Anna Power Station Unit 3 [ML100680117]. Additional information related to ISFSI cumulative impacts from construction and operation, drawn also from the EIS for an Early Site Permit (ESP) at the North Anna ESP Site, NUREG-1811 [ML063470330], is provided in Tables 1 and 2 below, respectively.

Table 1: Summary of Cumulative Impacts Related to Construction

Resource Category	Description of Cumulative Impact	Potential Cumulative Impacts Significance
Land Use	No impacts from construction beyond those in the original assessment (License Renewal Application Reference E9.7, Chapter 4), which concluded no additional disturbance for construction of the ISFSI beyond the approximately 11 acres previously analyzed.	SMALL, no mitigation warranted
Air Quality	No impacts from construction beyond those in the original assessment, which concluded control measures would be taken to limit impacts on air quality to acceptable levels.	SMALL, no mitigation warranted
Water Use and Quality	Water Use: Negligible; no impacts from construction beyond those in the original assessment, which	Water Use: SMALL, no mitigation warranted

Resource Category	Description of Cumulative Impact	Potential Cumulative Impacts Significance
	concluded the construction of the ISFSI involves no use or degradation of the regional water bodies and no irretrievable or irreversible commitments of water or waterways. Water Quality: Negligible; no impacts from construction beyond those in the original assessment, which concluded that the construction of the ISFSI involved no use or degradation of the regional water bodies.	Water Quality: SMALL, no mitigation warranted
Terrestrial Ecosystem	Negligible; no impacts from construction beyond those in the original assessment.	SMALL, no mitigation warranted
Aquatic Ecosystem	Negligible; no impacts from construction beyond those in the original assessment, which concluded no use or degradation of regional water bodies and its impact on navigation, fish and wildlife resources.	SMALL, no mitigation warranted
Socioeconomics, Environmental Justice, Historic and Cultural Resources	Negligible; Minority and low-income populations are located beyond the range of any expected construction effects, and no historic and cultural resource impacts are expected.	SMALL, no mitigation warranted
Non-radiological Health	Negligible; no impacts from construction beyond those in the original assessment.	SMALL, no mitigation warranted
Radiological Health	Negligible; no impacts from	SMALL, mitigation

Resource Category	Description of Cumulative Impact	Potential Cumulative Impacts Significance
	construction beyond those in the original assessment, which concluded exposure to construction workers is expected to be within NRC exposure limits.	is by station RP programs

Table 2: Summary of Cumulative Impacts Related to Operation

Resource Category	Description of Cumulative Impact	Potential Cumulative Impacts Significance
Land Use	None; the land occupied by the ISFSI was committed when the ISFSI was constructed.	SMALL, no mitigation warranted
Air Quality	None; the ISFSI does not release airborne emissions. Transfer of casks to the pads is infrequent and of short duration, resulting in minimal exhaust emissions.	SMALL, no mitigation warranted
Water Use and Quality	Water Use: None; the ISFSI does not require water for its operation, and does not discharge effluents to surface water. In addition, the ISFSI work force is drawn from the general plant work force, therefore, no additional sanitary waste is generated. Water Quality: None; the ISFSI does not require water for its operation, and does not discharge effluents to surface water.	Water Use: SMALL, no mitigation warranted Water Quality: SMALL, no mitigation warranted
Terrestrial Ecosystem	Operation of the ISFSI will have a minimal impact on local wildlife.	SMALL, no mitigation warranted
Aquatic Ecosystem	Operation of the ISFSI will have a minimal impact on local wildlife.	SMALL, no mitigation warranted
Socioeconomics, Environmental Justice, Historic and Cultural Resources	None; there are no dedicated ISFSI employees, minority and low-income populations are located beyond the range of any public dose effects, and no	SMALL, no mitigation warranted

Resource Category	Description of Cumulative Impact	Potential Cumulative Impacts Significance
	historic and cultural resource impacts are expected. Therefore, no socioeconomic, environmental justice, or historic and cultural resource impacts are expected from continued operations beyond those described in the original environmental assessment as negligible.	
Non-radiological Health	Operations have minimal effect on non-radiological public health. All work at the ISFSI is performed by general plant workers covered by the NAPS health and safety program. There are no activities at the ISFSI that would pose safety or health hazards different than those found in the general plant environment.	SMALL, no mitigation warranted
Radiological Health	Calculated dose from Units 1 & 2, ISFSI, and proposed Unit 3 is within 40 CFR 190 limit of 25 mrem per year for maximally exposed individual (MEI).	SMALL, mitigation is by station RP programs
Severe Accidents	Extreme wind, explosion, and fire evaluated as credible potential accident events that do not result in release of radioactive material or an increase in external radiation dose. Earthquake analysis shows the integrity of the casks is maintained. Loss of confinement barrier analysis	SMALL, no mitigation warranted

Resource Category	Description of Cumulative Impact	Potential Cumulative Impacts Significance
	shows the resulting dose is well below the 10 CFR 72.106(b) limit of 50 rem.	
Fuel Cycle, Transportation, and Decommissioning	Sealed Surface Storage Casks (SSSC) design features provide ease and simplicity for decommissioning. A specific decommissioning option will be chosen at the end of SSSC service lifetime. No transportation impacts are expected.	SMALL, no mitigation warranted
Waste Management	There are no non-radioactive wastes associated with operation of the ISFSI and no waste management impacts are expected from continued operation. The small volume of radioactive waste generated during cask loading is managed as part of normal plant operations.	SMALL, no mitigation warranted

3. Reinforced concrete pad No. 2 is installed at the ISFSI and is authorized under a 10 CFR Part 72, Subpart L general license. A 10 CFR 72.212 evaluation was completed to satisfy regulatory and industry design requirements and specifications for earthwork, construction, and operation. The pad was installed for a general license storage system in the location originally planned for SNM-2507 reinforced concrete pad No. 2, because the ISFSI facility is the only location at NAPS permitted for that use by NRC and a Louisa County Conditional Use Permit. Requirements and restrictions applicable to the location, construction, and operation of reinforced concrete pad No. 2 are expected to apply to any additional storage pads for general license storage systems.

4. Cumulative impacts from the construction and operation of NAPS Unit 3 are presented in the Environmental Impact Statement (EIS) for an ESP, NUREG-1811 [ML063470330] and SEIS for a COL, NUREG-1917 [ML100680117]. Upon

evaluating past, present, and reasonably-foreseeable future actions in the NAPS site area, the NRC concluded that potential cumulative impacts generally would remain SMALL, and additional mitigation would not be warranted. MODERATE ADVERSE to LARGE BENEFICIAL impacts were found to occur under temporary circumstances, with the exception of socioeconomics, which were found to have longer-lasting beneficial impacts to regional economies. Any contribution to the cumulative impacts from renewing the NAPS site-specific ISFSI license would be SMALL.

RAI 1-2

Provide a description of all maintenance or aging management activities that Dominion anticipates carrying out over the proposed 40-year renewal period and discuss the environmental impacts from such activities.

In the ER Supplement, Dominion states that no construction or refurbishment beyond normal maintenance and aging management is currently planned for TN-32 dry cask storage. Dominion further explains that maintenance activities, such as re-coating the casks, are the only activities expected over the proposed 40-year period of extended operation, and that there would be no environmental impacts from refurbishment or construction beyond those analyzed in the original environmental assessment (see page E-28).

This information is necessary for the NRC staff to assess the environmental impacts of the proposed action, as required by 10 CFR 51.30.

Response

Over the proposed 40-year license renewal period, Dominion anticipates normal maintenance activities of the TN-32 storage casks and reinforced concrete pad No. 1 to include cask surface re-coating, pressure switch calibration, upkeep of security monitoring equipment, and periodic inspections. Cask surface re-coating is anticipated every 10 to 15 years, and pressure switch calibration is anticipated every 36 months. ISFSI security monitoring equipment is maintained operable on a continuous basis and replaced on an as-needed basis.

Aging management activities to be carried out over the 40-year license renewal period include the TN-32 Dry Storage Cask Aging Management Program and the Monitoring of Structures Aging Management Program described in Appendix A of the license renewal application. As described in Appendix A, these programs are condition monitoring programs and include interseal pressure monitoring, radiation monitoring, and visual inspections.

Environmental impacts from anticipated normal maintenance and aging management activities over the 40-year license renewal period could include the generation of limited quantities of non-radioactive cleanup or replacement materials, such as would be used for re-coating or equipment repair/replacement. Accordingly, the environmental impacts of maintenance or aging management activities over the proposed 40-year license renewal period are expected to be SMALL. Any dose associated with occupational exposure will be monitored, maintained, and mitigated in accordance with the station's Radiological Protection Program.

RAI 1-3

Describe the NAPS' radiological protection programs that the specific-licensed ISFSI relies on for safe operation. Also, discuss how Dominion plans to maintain those NAPS' radiological protection programs that the specific-licensed ISFSI relies on after the expiration of the license for, or shutdown of, Units 1 and 2 (whichever comes first).

In the ER Supplement, Dominion states that the design and operational features of the TN-32 dry storage casks, along with the NAPS' radiological protection program, mitigate radiological impacts (see page E-28). If the specific-licensed ISFSI license renewal request is approved, the license would expire in 2058. The NAPS Units 1 and 2 licenses, however, expire in 2038 and 2040, respectively.

This information is necessary for the NRC staff to assess the environmental impacts of the proposed action, as required by 10 CFR 51.30.

Finally, the information the NRC uses to conduct and inform its National Environmental Policy Act environmental reviews, including the information in the ER Supplement, must be publicly available, as appropriate. Therefore, please ensure that the information included in response to RAIs 1-1 to 1-3 can be made publicly available.

Response

10 CFR 72.126 specifies the criteria for radiological protection at an independent spent fuel storage installation (ISFSI). As specified in Sections 7.1 and 9.4.1.3 of the North Anna (NAPS) ISFSI Safety Analysis Report (SAR), health physics procedures are used to implement a radiological protection plan associated with operation of the ISFSI.

The North Anna Power Station Radiological Protection (RP) Program is in place and implemented at the station and ISFSI, and meets the requirements of 10 CFR 20.1101. The RP Program is implemented by RP department procedures, which include Health Physics (HP) Administrative Procedures and HP Technical Procedures, such as ALARA and Radiological Environmental Monitoring. Specifically for safe work, a Radiation Work Permit (RWP) along with surveys and facility monitoring are required before workers can access the facility and during actual work. For safe operation, monitoring results are

evaluated periodically to determine regulatory compliance and operations in accordance with license requirements.

It is correct that the NAPS Units 1 and 2 licenses will expire in 2038 and 2040, respectively, and if approved, the specific-licensed ISFSI renewed license would expire in 2058. However, termination of the NAPS 1 and 2 licenses would not occur until sometime after permanent plant shutdown in 2038 and 2040. NRC does not allow license termination until after all radiological decontamination and dismantlement activities are complete and the final radiation survey has been documented. Between permanent plant shutdown and license termination, the NAPS Radiological Protection Program will remain in place and continue to meet the radiological protection criteria for the NAPS ISFSI as specified in the ISFSI SAR. Under the normal change process (10 CFR 72.48), the requirement for the Radiological Protection Program cannot be deleted from the ISFSI SAR without NRC approval.

Information provided in the responses to RAIs 1-1 through 1-3 does not contain information that is confidential or proprietary to Dominion and can be made publicly available.

RAI 2-1

Provide justification for excluding the lift beam and cask lid handling tools from the scope of renewal. Alternatively, include these components in the renewal scope, provide an aging management review, and describe the aging management activities used to manage the identified aging effects.

Table 2.3-2 of the renewal application states that the lift beam and lid handling tools are important to safety; however, these components were excluded from the scope of renewal based on the existence of inspection activities already performed to meet the requirements of the reactor operating license. However, NUREG-1927, Revision 1, states that all important-to-safety structures, systems, and components (SSCs) should be within the scope of renewal and should be addressed with an aging management review. Also, 10 CFR 72.42(a) states that renewal applications should include descriptions of aging management programs (AMPs) for the management of aging issues for SSCs important to safety.

The staff notes that the existence of current site monitoring and inspection procedures is not recognized in the NRC regulations and guidance as a basis for excluding SSCs from the scope of renewal. It is the staff's expectation that an aging management review be performed on all important-to-safety SCCs and, if appropriate, any existing activities that address aging management be incorporated by reference into the ISFSI renewal documentation.

This information is required to determine compliance with 10 CFR 72.42(a).

Response

As explained below, the cask lift beam and lid handling tools support cask operations in the Fuel and Decontamination Buildings and are governed by 10 CFR Part 50. They are not used during TN-32 cask transport to the ISFSI or cask handling operations conducted at the ISFSI.

In a letter dated February 12, 1997 [ML9702140263] (during review of the original ISFSI license application), Virginia Electric and Power Company (VEPCO) received RAI 5-1 that requested a statement be added to the ISFSI SAR indicating that lifting casks within the spent fuel and decontamination buildings is governed by the regulatory requirements of 10 CFR Part 50.

The April 14, 1997 response provided by VEPCO [ML9704250246] indicated that the requested statement was currently provided in Section 1.1 of the ISFSI SAR and would also be added to Section 5.1 of the ISFSI SAR.

In a subsequent request for additional information dated April 27, 1998 [ML9805010213], the NRC requested a description of the elements of the handling systems that were considered important to safety.

In the May 28, 1998 response [ML9806080301], VEPCO affirmed that the cask lift beam and lid lifting tools (handling tools) were important to safety and that Section 4.5 of the SAR would be revised to include the following:

> ".....The SSSC handling equipment (cask lift beam and cask lid handling tools) used during loading and unloading operations is also considered important to safety. The cask handling and auxiliary cranes are included in the Station NUREG-0612 Heavy Loads program in order to provide programmatic control....."

The NUREG-0612 Heavy Loads program was developed in response to Generic Letters 81-07, Control of Heavy Loads, and 85-11, Completion of Phase II "Control of Heavy Loads at Nuclear Power Plants." The North Anna NUREG-0612 Heavy Loads program was in place prior to submittal of the North Anna ISFSI License Application in 1995, and was therefore governed by 10 CFR Part 50.

The North Anna Power Station Heavy Loads program is described in Section 9.6 of the North Anna Power Station Updated Final Safety Analysis Report (UFSAR). Both UFSAR Table 9.6-1 and Section 9.6.4.4 include the cask lift beam and lid handling tools as components of the Heavy Loads program.

Material License SNM-2507 for independent storage of spent nuclear fuel and high-level radioactive waste was issued to VEPCO on June 30, 1998. SNM-2507 License Condition 16 specifies that fuel and cask movement and handling activities that are to be performed in the Fuel and Decontamination Buildings will be governed by the requirements of the North Anna Power Station, Units 1 and 2, Facility Operating Licenses (NFP-4 and NFP-7) and associated Technical Specifications.

In summary, the cask lift beam and lid handling tool components are important to safety, but are governed by 10 CFR Part 50, and therefore excluded from the scope of 10 CFR Part 72 license renewal.

RAI 2-2

Provide information to show that the earth berm is not credited in the calculations of dose at the controlled area boundary and justify that the berm should not be included in the renewal scope. Alternatively, include the berm in the scope of renewal and provide an aging management review and adequate aging management program for managing the aging effects of the berm.

In Table 2.3-2, Scoping Results, of the license renewal application for the NAPS specific-licensed ISFSI, the licensee states, "The ISFSI SAR Section 7.3.2 states: 'An earth berm was constructed inside the north and east perimeter fences of the ISFSI to reduce direct radiation.' The berm is not addressed in Technical Specifications or the Safety Evaluation Report. Additionally, the 10 CFR Parts 20, 72.104 and 72.106 dose analyses do not credit the berm as providing shielding."

Appendix A.1 of the "North Anna Power Station Units 1 & 2, Independent Spent Fuel Storage Installation (ISFSI), Safety Analysis Report" (ISFSI SAR) states, "The North Anna ISFSI Technical Specifications, and the TSAR, Revision 9A, however will govern the use of TN-32, Revision 0, casks at the North Anna ISFSI, except to the extent that specific analyses (e.g., criticality or thermal performance) from the FSAR, Revision 0, have been added to the ISFSI SAR."

Section 7.3.2.1 of the ISFSI SAR states that the shielding analyses performed for the TN-32 cask is described in "TN-32 Dry Storage Cask Final Safety Analysis Report, Revision 0, January 2000," (FSAR, Revision 0), listed as reference 1 in Section 7.3.4 of the ISFSI SAR. The staff did not find any other referenced analysis or discussion on the modeling of the earth berm within the shielding analysis and therefore assumes that the analysis used for shielding is that of FSAR, Revision 0.

However the modeling assumptions within FSAR, Revision 0 with respect to the earth berm are not consistent with the statement that the berm is not credited in the 10 CFR Parts 20, 72.104 and 72.106 dose analyses. For example, page 10.2-2 of the FSAR, Revision 0, states, "For the skyshine analyses, an earthen berm was added to the basic

long distance models. The berm was modeled as 4.2 meters high and was located 20 meters from the cask centerline." In addition, on page 10.2-2 of the same document, it states, "The dose rates from a typical ISFSI are evaluated based on the sky shine results from a single cask (without inserts) and assuming the presence of a berm." Also, from the MCNP input file on pages 5.5-26 to 5.5-29, it appears that the earth berm is included in the MCNP model (particularly cells 740, 780, 800, etc.), though the note on the input file states that there is no berm. Page 10.2-2 of the FSAR, Revision 0, also states that dose rates at the site boundary will depend on specific parameters, such as the presence of the berm; however, the staff did not find detailed information on how this is done at NAPS.

The applicant should clarify the licensing basis for the shielding and radiation protection evaluation for the NAPS specific-licensed ISFSI. If it is FSAR, Revision 0, the applicant should provide details on how the berm is excluded from the model. If the berm is credited in the shielding model, the applicant needs to justify why the earth berm is scoped out of the renewal. Otherwise, the berm should be scoped into the renewal and an aging management review conducted and adequate aging management program provided for the berm.

The NRC staff needs this information to determine compliance with 10 CFR 72.42(a), 10 CFR 72.104, 10 CFR 72.106, and 10 CFR 20.1301(a) and (b).

Response

The licensing basis for shielding and radiation protection is provided in the North Anna ISFSI SAR, Section 7.3.2, Shielding.

ISFSI SAR Section 7.3.2.1, SSSC Surface Dose Rates, indicates that the TN-32 SSSC loaded with fuel with an enrichment of 3.50 weight percent U-235, burnup of 45,000 MWD/MTU and cooling time of seven years has been chosen as the base case for analysis purposes. Although these same fuel parameters provide the basis for the source term used in the TN-32 Final Safety Analysis Report, Revision 0, January 2000 (TN-32 FSAR), the licensing basis provided in Section 7.3.2.1 of the ISFSI SAR for the shielding and radiation protection evaluation does not indicate that the TN-32 FSAR itself is the basis. Section 7.3.2.1 further indicates that Dominion conducted an independent analysis of the TN-32 surface dose rates using the MCNP Monte Carlo transport code. As described in SAR Section 7.3.2.2, these resultant TN-32 surface dose rates were used to calculate dose rates versus distance and verify compliance with the requirements of 10 CFR 72.104(a) and 10 CFR 20.1301.

In the ISFSI SAR, Section 7.5, Offsite Collective Dose Assessment, the controlled area boundary is defined as the North Anna site boundary. The nearest site boundary and nearest permanent resident are both to the south of the ISFSI, and as there is no earth berm between the ISFSI and site boundary, an earth berm was not credited as part of

the licensing basis. The earth berms were also not credited for reducing worker dose in Section 7.4, Estimated Onsite Collective Dose Assessment. The earth berms were constructed to limit direct radiation to site workers, in particular, for those in transit along the site entrance road adjacent to the north boundary of the ISFSI. Since the earth berms are not credited in either offsite or onsite dose analyses, they are scoped out of license renewal.

In summary, the analyses performed by Dominion to show compliance with 10 CFR 72.104(a) and 10 CFR 20.1301 do not rely on the analyses in the TN-32 FSAR which are not specific to any site. The Dominion analyses do not include any reduction in dose rates that might be provided by the earth berms constructed inside the north and east perimeter fences of the ISFSI. Since the earth berms are not credited in dose analyses and are not part of the licensing basis, they are not within the scope of license renewal.

RAI 2-3

If the NRC issues the license amendment for authorization to store high-burnup fuel (HBF) in a modified TN-32B cask under License No. SNM-2507, the staff requests Dominion, within 30 days following the amendment issuance, provide information on the HBF cask and whether the HBF itself, or any new SSCs that make up the cask modifications, are within the scope of license renewal and subject to an aging management review. The staff also requests updated application documents, as appropriate, to address the HBF cask.

Dominion has submitted a license amendment request for authorization to store HBF in a modified TN-32B cask under License No. SNM-2507, which is still under review by the staff in a separate licensing action. If the NRC approves the HBF amendment request, the HBF cask would then be a part of the licensing bases for the NAPS ISFSI and would need to be addressed in the license renewal application. Due to the concurrent timing of two review activities (i.e. the license amendment request to store HBF and the license renewal) and in order to ensure proper consideration of the two reviews, the NRC requests clarification on how Dominion will address the HBF cask in the renewal application.

This information is needed to determine compliance with 10 CFR 72.42(a).

Response

Dominion is participating with the Department of Energy, EPRI, AREVA Federal Services, and AREVA - Transnuclear (TN, also TN Americas LLC), to evaluate the effects of long-term dry storage on high burnup fuel (HBF) assemblies. A modified TN-32 cask, identified as TN-32B HBU, is planned to be loaded with 32 HBF assemblies and placed on ISFSI reinforced concrete pad No. 1. The plan for this demonstration program is for the Department of Energy to take possession of the TN-32B HBU cask

after approximately 10 years of storage time at the ISFSI, and transport it to an off-site research facility for further testing.

In lieu of supplementing the ISFSI license renewal application within 30 days of the issuance of the HBF license amendment, Dominion proposes the following license condition be included in renewed ISFSI material license SNM-2507:

> "Storage of high burnup fuel (≥ 45,000 MTU/MWD) in one TN-32B HBU cask design is authorized for a period not to exceed 20 years from the date fuel is initially loaded in the TN-32B HBU cask. If the storage period is expected to exceed the authorized storage period of 20 years, the licensee will submit supplemental information that will address additional aging management considerations for the high burnup fuel and the TN-32B HBU cask design at least two years prior to the expiration of the authorized 20-year storage period, in accordance with 10 CFR 72.42(b)."

RAI 2-4

Clarify how the licensing basis for the shielding and radiation protection evaluation for the NAPS specific-licensed ISFSI is maintained during the requested period of extended operation, considering storage of additional radioactive materials at the NAPS under different licenses (e.g., general-licensed ISFSI).

The NAPS ISFSI SAR includes dose analyses to demonstrate that the specific-licensed ISFSI meets the regulatory requirements of 10 CFR 72.104(a), which requires inclusion of dose contributions from other facilities (including new ISFSIs under different licenses) near the specific-licensed ISFSI. The NAPS ISFSI SAR discusses the assumptions used in the dose analyses, such as three storage pads filled with 84 TN-32 sealed surface storage casks (SSSCs), each pad having 28 SSSCs. However, in addition to the site's reactors, the specific licensed ISFSI is co-located with an ISFSI under a different license (i.e., a general license) that uses a different storage system design and may continue to increase in storage capacity over the period of extended operation of the specific-licensed ISFSI. Therefore, it is not clear that the SAR dose analyses will remain valid for the duration of the requested period of extended operation of the specific-licensed ISFSI, considering storage of additional radioactive materials at the NAPS in different storage systems and higher number of storage systems per pad under different licenses.

This information is required to determine compliance with 10 CFR 72.42(a) and 10 CFR 72.104(a).

Response

Shielding and radiation protection evaluations required by 10 CFR 72.212(b)(5) for the use of a dry storage system under a general license include an evaluation under paragraph (iii) which demonstrates that the requirements of 10 CFR 72.104(a) are met. This evaluation includes both the specific-license storage systems and the general license storage systems installed at the ISFSI, along with any general license storage systems that may be installed during the requested period of operation. As long as the general license dose evaluations continue to maintain compliance in accordance with 10 CFR 72.104(a), then the SAR dose analyses also remain valid. Any general license storage system additions would require evaluation under 10 CFR 72.48 for impacts to the specific-license SAR.

RAI 3-1

Clarify the material designation for the vent and drain port cover bolts in the TN-32 cask.

Table 1.2-2 of the TN-32 Topical Safety Analysis Report, Revision 9A, states that the vent and drain port cover bolts are constructed of stainless steel. In the renewal application, the aging management review (AMR) results table and the TN-32 Dry Storage Cask Aging Management Program (page A-6) defines the subject bolts as being constructed of low-alloy steel.

If the material designation as a low-alloy steel is correct, provide a reference to the applicable design basis information. If the material designation is not correct, provide the AMR for the corrected material and revise the material designation in other areas of the application, as appropriate.

This information is required to determine compliance with 10 CFR 72.24(c) and 10 CFR 72.42(a).

Response

A review of the TN-32 cask bolting materials has confirmed that the Vent and Drain Port Cover Bolts, as well as the Top Neutron Shield Bolts identified in Table AMR Results-1 (pp 3-17 and 3-18) are constructed of stainless steel. The applicable aging effect for stainless steel in an Atmosphere/Weather environment is loss of material due to crevice and pitting corrosion. Loss of material from TN-32 cask bolting is managed by the TN-32 Dry Storage Cask Aging Management Program (pp A-1 to A-6). The aging management review results table and the aging management program have been revised to identify the bolting material as stainless steel.

RAI 3-2

Justify why microbial degradation, salt scaling, and corrosion of reinforcing steel are not included as aging mechanisms for concrete. Alternatively, include these aging mechanisms in the aging management review and revise the Table of Aging Effects in the ISFSI SAR supplement.

The application excludes three aging mechanisms in the Monitoring of Structures Aging Management Program, Aging Management Review Results (Table AMR Results-3) and the Table of Aging Effects (Table C2.1-1; New ISFSI SAR Table 9.7-1):

(i) Microbial Degradation
(ii) Salt Scaling
(iii) Corrosion of Reinforcing Steel

Chloride attack of the reinforcing steels within concrete structures is a well-known phenomenon. The alkaline environment of the concrete typically results in a metal-adherent oxide film on the reinforcing steel bar surface, which passivates the steel. However, chloride ions can break down the passive layer, triggering corrosion that leads to cracking and spalling of the concrete. The applicant provided the limit of less than 500 ppm of chloride concentration and pH greater than 5.5 in groundwater to prevent the corrosion. However, some data suggests the limit of 300 ppm (ASME, 1995). Chlorides may already exist at low levels within the base mix constitutes, and chlorides can be concentrated in damp or dry environments.

Biodeterioration (Microbial Degradation) is caused by colonization of microbes and microorganisms that grow on concrete surfaces that offer favorable environmental conditions (e.g., available moisture, near neutral pH, presence of nutrients). Conducive environments may have elevated relative humidity (i.e., greater than about 60 percent), long cycles of humidification and drying, freezing and thawing, high carbon dioxide concentrations, high concentrations of chloride ions or other salts, or high concentrations of sulfates and small amounts of acids (Wei et al., 2013). Biodeterioration may lead to reduction of the protective cover depth, and increase both concrete porosity and the transport of aggressive chemicals (Sanchez-Silva and Rosowsky, 2008), and this degradation mode can promote a reduction in concrete pH, loss of concrete strength, and spalling/scaling.

Salt scaling is defined as superficial damage caused by freezing a saline solution on the surface of a concrete body. The damage is progressive and consists of the removal of small chips or flakes of material. Similar to freeze and thaw damage, salt scaling takes place when concrete is exposed to freezing temperatures, moisture, and dissolved salts.

The staff requests the bases for this exclusion. If the applicant determines that these aging mechanisms are credible, the aging mechanisms should be included in the aging management review and in the Table of Aging Effects (Table C2.1-1; New ISFSI SAR Table 9.7-1). This information is needed to determine if the aging management review is comprehensive in identifying all pertinent aging mechanisms and effects applicable to the SSCs within the scope of renewal and that a summary of the information is included in the renewal application and FSAR supplement.

This information is needed to determine compliance with the requirements of 10 CFR 72.42(a).
References:

ASME. "ASME Boiler and Pressure Vessel Code, Section XI, Subsection IWL." New York, New York: American Society of Mechanical Engineers. 1995.

Sanchez-Silva, M. and D. Rosowsky. "Biodeterioration of Construction Materials: State of the Art and Future Challenges." Journal of Materials in Civil Engineering. Vol. 20. pp. 352-365. 2008.

Wei, S., Z. Jiang, H. Liu, and M. Sanchez-Silva. "Microbiologically Induced Deterioration of Concrete–A Review." Brazilian Journal of Microscopy. Vol.44. pp. 1,001-1,007. 2013.

Response

As explained below, Dominion concludes that microbial degradation, salt scaling, and corrosion of reinforcing steel are appropriately excluded as aging mechanisms for concrete.

The high alkalinity of concrete, pH > 12.5, provides an environment which helps protect the reinforcing steel from corrosion. When pH is reduced by the intrusion of aggressive ions, corrosion may occur. An aggressive environment is defined in NUREG-1801 as pH < 5.5, chlorides > 500 ppm, or sulfates > 1,500 ppm, for extended periods. If reinforcing steel is exposed to an aggressive environment, corrosion is not significant if the concrete has a low water-to-cement ratio (0.35 to 0.45), adequate air entrainment (3% to 6%), and is designed in accordance with ACI 318-63 or ACI 349-85. These provisions ensure adequate concrete cover, low permeability, and proper reinforcement distribution, which will minimize crack development and the potential for corrosion of reinforcing steel.

The ISFSI reinforced concrete pad No. 1 conforms to the design requirements in ACI 349-85 and the construction requirements of ACI 301-89. The reinforcing steel has adequate concrete cover (three inches on the bottom and two inches on the top) and proper reinforcement distribution. These provisions minimize crack development and,

with the high alkalinity of the concrete (pH > 12.5), provide protection against corrosion of reinforcing steel. Table 3.4-2, "Groundwater Sample Results Summary," of the license renewal application details chloride, sulfate, and pH data history at the North Anna Power Station site and ISFSI. The results are within acceptable range for non-aggressive groundwater (pH > 5.5, chlorides < 500 ppm, and sulfates < 1,500 ppm). No outside agent such as deicing salt, which could be absorbed by the concrete and create an aggressive environment, is applied to reinforced concrete pad No. 1. Reinforced concrete pad No. 1 is sloped to ensure rainwater does not accumulate. Section 3.4.2, "Environments," of the license renewal application notes that the bottom elevation of reinforced concrete pad No. 1 is approximately 13 to 20 feet above the groundwater table, and is therefore not exposed to groundwater in the soil environment. Considering the environment and material properties described above, reinforced concrete pad No. 1 does not require aging management for corrosion of reinforcing steel in an atmosphere/weather or a soil environment.

Biodeterioration results from continuous exposure to aggressive biological environments. The degradation mechanisms are a result of an environment with continuous growth of microorganisms or biological byproducts, which in turn may result in an environment potentially adverse to the host material. The environments noted to be conducive to biodeterioration include underground structures, sewage systems, at-sea structures, and wastewater treatment systems. The ISFSI concrete is neither exposed to the biological sources of degradation nor physically configured to foster their growth.

Salt scaling is similar to freeze-thaw damage, but requires the presence of dissolved salts. No outside agent, such as deicing salt, is applied to the reinforced concrete pad No. 1. Additionally, Table 3.4-2, "Groundwater Sample Results Summary," of the license renewal application details chloride data history at the North Anna Power Station site and ISFSI. Results are within the acceptable range for non-aggressive groundwater (Chlorides < 500ppm). Table AMR Results-3, "Reinforced Concrete Pad No. 1," and Table C2.1-1, "Table of Aging Effects (New ISFSI SAR Table 9.7-1)," already include aging effects due to freeze-thaw.

Microbial degradation and salt scaling also are not aging mechanisms identified in NUREG-1800 or NUREG-1801. There has been no plant-specific Operating Experience (OE) involving microbial degradation or salt scaling degradation. Additionally, Dominion is not aware of any industry OE involving these aging mechanisms for ISFSIs located at other nuclear facilities.

Based on the above, microbial degradation, salt scaling, and corrosion of reinforcing steel are not mechanisms that produce aging effects requiring management for the reinforced concrete pad No. 1.

RAI 3-3

Clarify the TN-32 cask aging management review results for the silver lid seal, which is stated to be subject to loss of material, but no aging mechanism or aging management program is cited.

Table AMR Results – 1, "Transnuclear TN-32 Dry Storage Cask," of the renewal application includes loss of material as an aging effect for the silver lid seal in the atmosphere/weather environment. However, the table does not include an associated aging mechanism or aging management program. In addition, Table C2.1-1, "Table of Aging Effects (New ISFSI SAR Table 9.7-1)," of the renewal application does not identify any aging effects for silver.

If loss of material is a credible aging mechanism for the silver lid seal, provide an aging management activity that will ensure that the seal's pressure boundary function will be maintained in the period of extended operation.

This information is required to determine compliance with 10 CFR 72.42(a).

Response

Silver in an Atmosphere/Weather environment has no aging effects.

Table AMR Results-1, Transnuclear TN-32 Dry Storage Cask, mistakenly identifies loss of material as an aging effect for silver. Table AMR Results-1, Transnuclear TN-32 Dry Storage Cask has been revised to remove the loss of material aging effect for silver in an Atmosphere/Weather environment.

Additionally, the absence of silver in Table C2.1-1, "Table of Aging Effects (New ISFSI SAR Table 9.7-1)," accurately reflects that there are no aging effects for silver in an Atmosphere/Weather environment.

RAI 3-4

Justify why effects due to thermal and radiation exposure (e.g., cracking) and loss of shielding due to boron depletion are not included as aging effects/mechanisms for the neutron shields in the TN-32 cask. Alternatively, revise the aging management review tables and address these aging effects with an aging management program or time-limited aging analysis (TLAA).

Heat and radiation can induce changes in polymers that include embrittlement, decomposition, and changes in physical configuration (e.g., loss of hydrogen or water) (EPRI, 2002; McManus and Chamis, 1996; Cota, 2007; Fu, 1988). Shrinkage and embrittlement can result in (localized) losses of shielding material and lead to cracking.

In addition, if the borated radial neutron shield material is exposed to sufficient neutron fluence over time, the consumption of B-10 atoms could impact the material's shielding function.

This information is required to determine compliance with 10 CFR 72.42(a), 10 CFR 72.104, 10 CFR 72.106, and 10 CFR 20.1301(a) and (b).

References:

EPRI. "Technical Bases for Extended Dry Storage of Spent Nuclear Fuel." TR-1003416. Palo Alto, California: Electric Power Research Institute. 2002

McManus, H.L. and C.C. Chamis. "Stress and Damage in Polymer Matrix Composite Materials Due to Material Degradation at High Temperatures." NASA Technical Memorandum 4682. Cambridge, Massachusetts: Massachusetts Institute of Technology. 1996

Cota, S.S., V. Vasconcelos, M. Senne, Jr., L.OL. Carvalho, D.B. Rezende, and R.F. Cõrrea. "Changes in Mechanical Properties Due to Gamma Irradiation of High-Density Polyethylene." Brazilian Journal of Chemical Engineering. Volume 24, No. 02. pp. 259–265. 2007

Fu, L., R.A. Fouracre, and H.M. Banford. "An Investigation of Radiation Damage in Cured Epoxy Resin System Using Regression Experiment Design, Electrical Insulation and Dielectric Phenomena." 1988 Annual Report, Conference on Electrical Insulation and Dielectric Phenomena. IEEE Dielectrics and Electrical Insulation Society. October 1988

Response

License renewal application Table AMR Results-1, "Transnuclear TN-32 Dry Storage Cask," identifies the aging effect of loss of material due to radiolytic decomposition and thermal degradation for the Top Neutron Shield and Radial Neutron Shield. The loss of material aging effect was identified based on loss of hydrogen and changes in polymer properties that result from exposure to heat and radiation. Prolonged loss of material can result in cracking and potentially streaming of radiation from the TN-32 cask. As described in Section A2.1, Elements 3, 4, and 5, loss of material from the polymer shielding is managed by the TN-32 Dry Storage Cask Aging Management Program.

With respect to loss of shielding due to boron depletion, Section 6.3.2 of the TN-32 Final Safety Analysis Report, Revision 0, describes the analysis performed to evaluate loss of boron from the dry storage cask fuel basket over a period of 1000 years. The conservative analysis concluded that the fraction of boron depleted from the fuel basket is negligible. Based on the location of the radial neutron shield with respect to the fuel

basket, the neutron flux in the radial neutron shield is less than the flux in the fuel basket. As such, the loss of boron from the radial neutron shield is negligible. Based on the above, aging management for loss of shielding due to boron depletion is not required.

RAI 3-5

Discuss how the buildup of flammable gas generated in the radial neutron shield is managed in the period of extended operation.

TN-32 cask design uses polymer material or borated polymer material as neutron shields. Radiation degradation of polymer materials releases hydrogen or low-molecular weight hydrocarbons, which may reach flammable concentrations over extended periods of time. To alleviate this problem, a hole is made in the top of the lid neutron shield to provide a vent path for the buildup of gases. However, the application does not include discussion of flammable gas buildup in the radial neutron shield in the period of extended operation. The licensee needs to address how the potential flammable gas buildup aging effect in the radial neutron shield will be managed during the period of extended operation, including any means used to alleviate flammable gas buildup.

This information is required to determine compliance with 10 CFR 72.120(d).

Response

AREVA – Transnuclear (also TN Americas, LLC) considered the possibility of pressure buildup in the original design of the radial neutron shield. As indicated in Section 2.4.1 of the license renewal application, the buildup of pressure and flammable gases in the radial neutron shield is prevented by a relief valve located at the top of the radial neutron shield.

Hydrogen is the principal flammable gas generated in the neutron shield polymer material. Areva has performed a proprietary bounding analysis comparing the amount of hydrogen gas generated in the neutron shield polymer to the amount of hydrogen gas dissolved in the polymer over a 60-year period. The analysis concluded that the amount of hydrogen gas that can be dissolved by the polymer is significantly greater than the hydrogen gas generated in the polymer. Based on the above, aging management of the flammable gas buildup aging effect is not required for the period of extended operation.

RAI 3-6

Provide the technical basis for the proposed change to ISFSI SAR Section A.1.3, "Criticality Evaluation," where the stated time of the neutron poison effectiveness is proposed to be revised to 60 years.

The revisiting of a design-basis analysis to show that it is still valid for the period of extended operation typically would be considered a TLAA. As recommended in NUREG-1927, Revision 1, the renewal application should address a TLAA by either (1) demonstrating that the SSC will continue to perform its intended function or (2) managing the effects of aging through an aging management program.

No basis was provided in the renewal application for extending the time for which the poison material will continue to remain effective.

This information is required to determine compliance with 10 CFR 72.42(a) and 10 CFR 72.124.

Response

Sections A.1.1 and A.1.3 of the ISFSI SAR identify that the criticality evaluation presented in Section 6 of the TN-32 Dry Storage Cask Final Safety Analysis Report, Revision 0, is the analysis of record for the TN-32 dry storage casks stored at North Anna Power Station.

As indicated in Section 6.3.2 of the TN-32 Dry Storage Cask Final Safety Analysis Report, the original criticality design basis analysis results conclude that a negligible fraction of boron is depleted after a period of 1000 years. The analysis did not involve time-limited assumptions defined by the current operating period, and, therefore, does not meet the criteria to be identified as a time-limited aging analysis. The 20-year time period appearing in Section A.1.3 of the ISFSI SAR is intended to show that the design boron-10 concentration is adequate for the initial 20-year operating period defined by the license. The existing criticality evaluation bounds the requested 60-year operating period, and provides the basis for revising the ISFSI SAR statement from 20 to 60 years.

RAI 3-7

Clarify the basis for the proposed change to ISFSI SAR Section A.1.4, "Thermal Evaluation," where the stated time of safe storage of the spent fuel, based on the thermal design, is proposed to be revised from 20 to 60 years.

It is not clear whether this SAR statement is a summary statement of the thermal evaluation in general, or if the timeframe in the SAR statement is associated with a

specific time-related aspect of the design-basis thermal evaluation. The revisiting of a design-basis analysis to show that it is still valid for the period of extended operation typically would be considered a TLAA. As recommended in NUREG-1927, Revision 1, the renewal application should address a TLAA by either (1) demonstrating that the SSC will continue to perform its intended function or (2) managing the effects of aging through an aging management program.

This information is required to determine compliance with 10 CFR 72.42(a) and 10 CFR 72.128(a).

Response

Sections A.1.1 and A.1.4 of the ISFSI SAR identify that the thermal evaluation presented in Section 4 of the TN-32 Dry Storage Cask Final Safety Analysis Report, Revision 0, is the analysis of record for the TN-32 dry storage casks stored at North Anna Power Station.

Section 4.4 of the TN-32 Dry Storage Cask Final Safety Analysis Report indicates that the maximum decay heat and corresponding cask temperatures occur immediately following cask loading and are below the maximum component temperatures of the cask subcomponents. The temperatures of the cask subcomponents decrease as storage time increases. The analysis did not involve time-limited assumptions defined by the current operating period, and, therefore, does not meet the criteria to be identified as a time-limited aging analysis. The 20-year time period appearing in Section A.1.4 of the ISFSI SAR is intended to show that the thermal design of the TN-32 dry storage cask is adequate for the initial 20-year operating period defined by the license. The existing thermal evaluation bounds the requested 60-year operating period and provides the basis for revising the ISFSI SAR statement from 20 to 60 years.

RAI 3-8

Considering the effects of age on concrete strength, perform an analysis of the ISFSI pad to estimate the concrete compressive strength (fc') and modulus of elasticity (E) at the end of the requested period of extended operation. For any increase in the concrete modulus of elasticity, determine the applicable deceleration g-loads and re-evaluate the TN-32 SSSC structural capability to withstand the design basis cask tip-over and bottom-end drop accidents. Also revise, as appropriate, Appendix C, "ISFSI Safety Analysis Report Supplement."

Appendix 3A of TN-32 Dry Storage Cask Topical Safety Analysis Report (TSAR), Revision 9A, considered a concrete compressive strength of 3,000 psi in the target hardness method, per the EPRI Report NP-4830, to determine the maximum cask side impact deceleration. A design basis cask deceleration was then selected for the cask body and basket structural analyses in Appendices 3A and 3B, respectively. However,

in Appendix 3C of the TSAR, Revision 9A, a design basis deceleration with a different value was introduced in demonstrating the structural capability of the TN-32 SSSC basket undergoing inelastic response.

Concrete compressive strength is known to increase with age. As noted in NUREG/CR-6424, "Report on Aging of Nuclear Power Plant Reinforced Concrete Structures," after a 20-year placement, the average compressive strength can realize an increase of 67% with respect to the nominal, 28-day design basis strength. Also, given that the as-built concrete could have a higher than nominal strength, the applicant should use the as-built concrete for the analysis.

This information is needed to determine compliance with the requirements of 10 CFR 72.42(a).

Response

As the data in NUREG/CR-6424 show, the relationship between 28-day concrete compressive strength and a percentage increase in concrete compressive strength over time is inverse. That is, concrete with a higher initial compressive strength will realize a smaller percentage increase in strength over time, versus concrete with a lower initial compressive strength, which can realize a greater percentage increase in strength over time. Since the modulus of elasticity is a product of the square root of the compressive strength, it is less impacted.

NUREG/CR-6424, Table 2.13, provides compressive strength increases over time for three different concrete mixes. As noted above, the higher the 28-day strength, the lower the increase in strength, as a percentage. The highest 28-day strength given in NUREG/CR-6424 is 4873 psi (33.6 MPa), which results in an increase during the first 20 years of approximately 41%. As documented in a Dominion cask drop calculation, the as-built, average, 28-day compressive strength of reinforced concrete pad No. 1 was 5060 psi. Therefore, the increase in strength during the first 20 years would be less than 41%. As indicated by the NUREG/CR-6424 data, increases in concrete compressive strength are negligible beyond 20 years of concrete life.

In response to this RAI, Dominion's cask drop calculation has been conservatively revised utilizing a 67% increase in concrete compressive strength (above actual 28-day compressive strength, not nominal) and the corresponding modulus of elasticity. Under this conservative condition, significant margins remain between the calculated deceleration values and the SER deceleration values for all cask drop design basis accident conditions.

RAI 3-9

Clarify the extent of coverage for the periodic visual inspections of the TN-32 dry storage cask and the concrete pad. Revise Appendix C of the renewal application to provide these details in the ISFSI SAR supplement.

Neither the TN-32 Dry Storage Cask Aging Management Program nor the Monitoring of Structures Aging Management Program explicitly define the extent of coverage for the periodic visual inspections. For the concrete pad, the staff noted that Section 3.5.1 of American Concrete Institute (ACI) 349.3R-02 states that "[t]he scope of the visual inspection should include all exposed surfaces of the structure...."

If 100 percent of all accessible surfaces of both the casks and pad will not be inspected, provide the justification for the extent and location of the inspected areas.

This information is required to determine compliance with 10 CFR 72.42(a).

Response

(Refer to Table 1.2-2 and Figure 1049-70-1 of the TN-32 Dry Storage Cask Topical Safety Analysis Report for identification and location of the TN-32 dry storage cask subcomponents.)

Quarterly Visual Inspections

The visible outer surfaces of the following subcomponents within the scope of license renewal will be inspected by an individual standing at ground level:

- Bottom vertical surfaces (fully visible)
- Trunnions (partially visible)
- Flange vertical surfaces (fully visible)
- Shell (partially visible)
- Outer Shell (fully visible)

20-Year Visual Inspections of Cask Bottom

The bottom horizontal surface of the TN 32 cask bottom is fully visible when lifted off the reinforced concrete pad and with the aid of a remotely operated camera and will be visually inspected.

20-Year Visual Inspections with Protective Cover Removed

The visible outer surfaces of the following subcomponents within the scope of license renewal will be inspected by an individual standing at the top of the cask:

- Lid (partially visible)
- Lid Bolts and Neutron Shield Bolts (partially visible)
- Top Neutron Shield (partially visible)
- Flange horizontal surfaces including stainless steel weld overlay (partially visible)
- Trunnions (partially visible)

The dry storage cask subcomponents observed during routine inspections are constructed of either carbon steel, low-alloy steel, or stainless steel. The inspections of the cask subcomponents constructed of these materials serve as a leading indicator for cask subcomponents that cannot be inspected, and for cask subcomponents that have surfaces which are not 100 percent visible during the performance of visual inspections.

With the exception of the area of concrete beneath the dry storage casks, the accessible surfaces of reinforced concrete pad No. 1 are visible during the 5-year visual inspection. The normally inaccessible concrete beneath a dry storage cask is visible during opportunistic and the 20-year visual inspections conducted during dry storage cask lift operations.

The TN-32 Dry Storage Cask Aging Management Program and the Monitoring of Structures Aging Management Program have been revised to clarify the extent of coverage for the periodic visual inspections.

Changes to the ISFSI SAR Supplement (Appendix C)

Sections C2.1.1.1 and C2.1.1.2 of the ISFSI SAR Supplement have been revised to clarify the extent of visual inspections performed on the TN-32 dry storage casks and reinforced concrete pad No.1. The revised ISFSI SAR Supplement is provided in Enclosure 1.

RAI 3-10

Clarify and provide the justification for the timing of the initial 20 ± 5-year scheduled inspection of the TN-32 dry storage cask bottom and under the protective cover and the

first 5-year periodic visual inspection of the concrete pad. Revise Appendix C of the renewal application, as appropriate.

Neither the TN-32 Dry Storage Cask AMP nor the Monitoring of Structures AMP explicitly defines when the initial inspections of the normally inaccessible cask components and the concrete pad will occur. The inspection timing and its justification should be clear to support the licensee's development of the implementation procedures and NRC oversight of inspection activities.

This information is required to determine compliance with 10 CFR 72.42(a).

Response

Dry Storage Cask Visual Inspections

Pre-application visual inspections of a TN-32 dry storage cask bottom and the components beneath the protective cover were completed in October and November 2015, respectively. During the period of extended operation, the initial visual inspection of a cask bottom and the components beneath a protective cover will be scheduled to occur 20 $\pm$ 5 years from the date of the pre-application inspections.

The North Anna Power Station and the ISFSI are located in a rural area of Virginia, on Lake Anna, a freshwater lake, and are not located near industrial or chemical facilities. There is no exposure to brackish water, saltwater spray, or high-sulfur emissions which could result in accelerated corrosion rates. Results of previous inspections performed by Dominion on TN-32 dry storage casks have identified rust staining and blistering of coatings. However, the inspections have not identified loss of material from the base metal. Based on the location, and associated operating experience, a 20 $\pm$ 5 year inspection interval has been established and determined to be adequate to detect loss of material for the TN-32 cask bottom and the components beneath a protective cover within the scope of license renewal prior to the loss of intended function.

Reinforced Concrete Pad No.1 Visual Inspections

During the period of extended operation, the initial inspection of the concrete beneath a cask will be scheduled to occur coincident with the cask bottom inspection described above.

Visual inspection of reinforced concrete pad No. 1 was completed in November 2015 as part of the pre-application inspections performed to support ISFSI license renewal. During the period of extended operation, the initial visual inspection of reinforced concrete pad No. 1 will be scheduled to occur 5 years from the date of the pre-application inspection. An inspection frequency of 5-years has been established and is

consistent with industry guidance contained in ACI 349.3R, Evaluation of Existing Nuclear Safety Related Concrete Structures.

Changes to the ISFSI SAR Supplement (Appendix C)

Sections C2.1.1.1 and C2.1.1.2 of the ISFSI SAR Supplement have been revised to more clearly state the timing of the TN-32 dry storage cask and reinforced concrete pad No.1 visual inspections. The revised SAR Supplement is provided in Enclosure 1.

RAI 3-11

Provide details on the thermo luminescent dosimeter (TLD) measurements and perimeter fence radiation surveys that support their capability to detect neutron shield degradation, including localized degradation (e.g., shrinkage, cracking) of the individual casks. Specifically,

1. Demonstrate that the combination of TLD monitoring and perimeter radiation surveys will be capable of detecting neutron shield degradation of each individual cask.

2. For the perimeter surveys, provide details on the locations where radiation will be measured and recorded.

3. Provide the acceptance criteria that will be used to determine the upward trend of dose rates that indicates a loss of intended function of the neutron shield, including a description of how the criteria account for decay of the spent fuel source term.

4. Provide details regarding the trending of the TLD dose measurements and perimeter radiation surveys, including the specific method and procedures of the engineering evaluation used for determining trends in the dose rates.

5. Add the details of the perimeter surveys to Appendix C of the renewal application (proposed ISFSI SAR supplement).

The renewal application indicates that TLDs located along the ISFSI perimeter fence will be used to ensure the casks' neutron shielding continues to perform its function during the period of extended operation. Section A.2.1 of the renewal application, "TN-32 Dry Storage Cask Aging Management Program," states that TLD radiation monitoring is supplemented by quarterly gamma and neutron radiation surveys at the ISFSI perimeter fence. The Acceptance Criteria program element states:

> The aging management program [TN32 Dry Storage Cask Aging Management Program] will be enhanced to include annual trending of TLD neutron and gamma radiation measurements at the ISFSI perimeter fence. The acceptance

criterion for radiation monitoring is the absence of an increasing trend (as determined by Engineering evaluation) in neutron and gamma quarterly TLD readings at the ISFSI perimeter fence.

However, it is not clear from the information presented in the application, how the TLD measurements, perimeter radiation surveys, and the trending evaluations will be able to identify degradation of the neutron shields of individual casks.

This information is required to determine compliance with 10 CFR 72.42(a), 10 CFR 72.104(a), 10 CFR 72.106, and 10 CFR 20.1301(a) and (b).

Response

1. Radiation monitoring of the ISFSI is provided by thermoluminescent dosimeters (TLDs) at the ISFSI perimeter fence. The licensing basis for radiation monitoring at the ISFSI perimeter is documented in Sections 7.1.2, 7.3.3, and 7.6 of the ISFSI Safety Analysis Report (SAR) and in the original Technical Specification Bases B 3.3.3 issued with Material License SNM-2507. In the event of unexpected TLD readings or radiation trends, the neutron and gamma radiation surveys conducted at the ISFSI perimeter fence provide supplemental data for assessment of the condition. The portable instrument radiation surveys conducted quarterly at the ISFSI perimeter fence were not considered essential to meeting the radiation monitoring requirements of Regulatory Guide 8.8 (June 1978), Information Relevant to Ensuring That Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Reasonably Achievable, and therefore, are not credited for aging management of the TN-32 dry storage casks.

   The polymer material used in the TN-32 dry storage cask radial neutron shield is encased in rigid aluminum boxes around the cask shell. This structure minimizes movement and displacement of the polymer material that may result from loss of material and ultimately cracking. Although neutron streaming from the cask is considered unlikely, Dominion will further enhance the TN-32 Dry Storage Cask Aging Management Program to include performance of neutron radiation surveys of each TN-32 dry storage cask.

   A neutron survey will be performed annually at one location for each TN-32 dry storage cask. The neutron dose rate will be recorded at a distance of approximately six feet from the cask at an approximate elevation corresponding to the maximum neutron flux, and on a line perpendicular to the long axes of reinforced concrete storage pad No. 1. An elevation corresponding to the maximum neutron flux, is the most likely location for degradation of the radial neutron shield to occur. A tissue equivalent proportional counter, such as the REM 500 neutron survey meter, will be used to measure neutron dose rate. The

REM 500 survey meter has a relatively linear dose rate response across a broad spectrum of neutron energies which provides a more representative indication of the neutron dose rate at the cask perimeter.

Dominion is also aware of the difficulty in measuring neutron radiation dose with TLDs. Degradation of the neutron shield can result in variations in neutron energies and flux levels at the cask exterior surface. To improve detection of the intermediate and fast neutron energy spectrum, each TLD at the ISFSI perimeter fence will be equipped with an additional chip, such as a CR 39 polycarbonate chip, or equivalent. The CR 39 chip has a relatively flat response to neutron energies in the range of 200 KeV to 6 MeV. This additional chip, in conjunction with the ISFSI perimeter TLDs currently in use at North Anna Power Station, will provide a more representative indication of neutron dose resulting from thermal, intermediate, and fast neutron radiation.

The enhanced neutron detection capability of TLDs located at the ISFSI perimeter fence, supplemented with annual neutron surveys of each TN-32 dry storage cask, will provide reasonable assurance that the neutron shield aging effects of concern are adequately managed during the period of extended operation.

2. Neutron and gamma radiation levels are measured and recorded at the location of the ISFSI perimeter fence TLDs, and at a minimum, at a location between two TLDs. Currently two TLDs are mounted on the North ISFSI perimeter fence and two TLDs are mounted on the South ISFSI perimeter fence. One TLD is mounted on the East ISFSI perimeter fence and one TLD is mounted on the West ISFSI perimeter fence.

3. The acceptance criteria for trending of quarterly neutron and gamma TLD readings, and for trending of annual individual cask neutron survey results, is the absence of an increasing trend in radiation values, as determined by engineering evaluation. ISFSI Technical Specification Limiting Condition for Operation 3.3.1 places limits on the maximum combined neutron and gamma dose rates at the sides and top of a TN-32 dry storage cask prior to transporting a dry storage cask to reinforced concrete pad No. 1. These limits are intended to ensure that the dry storage cask average surface dose rates during transport, storage, and unloading are within the values contained in the SAR. The limits provide assurance that the dose to the general public is minimized, and the dose to occupational workers is as low as reasonably achievable.

   After transport of a cask to the ISFSI, additional factors influence the measured dose at an individual cask, including the radiation emitted from adjacent casks and the decay of the spent fuel neutron source term. A direct correlation cannot be made between the measured dose rate for a cask located at the ISFSI to the

dose rate measured for the cask prior to transport to the ISFSI (and the Technical Specification dose rate limits). However, the absence of an increasing trend would demonstrate that measured dose rates remain within the values contained in the SAR.

4. In accordance with Dominion radiation survey procedures, neutron and gamma TLD readings are recorded quarterly and neutron survey results of individual casks will be recorded annually. Degradation of the radial neutron shield material resulting from aging occurs slowly over a period of years. A portable instrument survey, recently conducted during the TN-32 dry storage cask pre-application inspection, did not detect elevated neutron radiation dose rates or a reading inconsistent with other readings at similar radial locations on the cask. Annual trending of quarterly neutron and gamma TLD readings and annual cask survey results provides sufficient time to detect age-related degradation of the shielding material, and to perform corrective actions, prior to a loss of intended function.

   Dominion has performed a review of quarterly ISFSI perimeter fence TLD neutron and gamma readings recorded over a 10-year period and no unusual trend in neutron radiation, or unexpected radiation values were identified. The TLDs located at the ISFSI perimeter fence will be equipped with the CR 39 chip, or equivalent, and at least two separate radiation values recorded, prior to entering the period of extended operation (PEO). Neutron radiation survey values for each cask will be determined by conducting a minimum of two separate surveys prior to entering the PEO. Baseline radiation values will be established subsequent to these activities.

   Movement or placement of additional TN-32 dry storage casks at the ISFSI can influence baseline radiation values. In the event a TN-32 dry storage cask is removed or additional casks are placed on reinforced concrete pad No.1, new baseline values will be established.

   Dominion will develop procedures for annual trending of radiation values prior to entering the PEO. Engineering personnel will obtain the radiation survey results of the TN-32 dry storage casks and the four prior quarterly ISFSI perimeter fence TLD neutron and gamma dose values. The annual neutron dose rates recorded at each cask and the quarterly neutron and gamma TLD readings will be plotted and trended. A separate graph will be plotted for each cask radiation survey. Neutron and gamma TLD readings will also be plotted on separate graphs, with each TLD location uniquely identified on each graph. Each graph will be updated annually so that trends can be easily observed on each graph over the 40-year PEO. The trending evaluation will consider information pertaining to cask loading and movement to assist in evaluating trends in ISFSI dose rates. After entering the PEO, the initial trending evaluation will be completed no later than October 2018.

Identification of an increasing trend in radiation values will require the condition to be entered in the Corrective Action Program. Immediate corrective actions may include verification of meter calibration, performance of additional cask surveys, or placement of temporary shielding in the event shielding degradation is confirmed.

5. The ISFSI SAR accurately describes the use of portable instruments for the conduct of work performed near or on the storage pads. As indicated in Sections 7.1.1 and 7.1.2 of the ISFSI SAR, radiation surveys are performed with portable instruments during maintenance and surveillance activities performed at or near reinforced concrete pad No. 1.

   Portable instrument surveys conducted at the ISFSI perimeter provide supplemental information to health physics and engineering personnel to aid in the assessment of unexpected radiation readings or abnormal radiation trends. The radiation surveys conducted at the ISFSI perimeter fence with portable instruments are not included in the SAR. ISFSI SAR Section 7.6 indicates that thermoluminescent devices are in place along the ISFSI perimeter fence for routine monitoring of dose.

   Based on the above, the addition of perimeter survey details to the ISFSI SAR Supplement is not required.

Changes to the ISFSI SAR Supplement (Appendix C)

Section C2.1.1.1 of the ISFSI SAR Supplement will be revised to include annual neutron radiation surveys of each TN-32 dry storage cask and annual trending of the survey results. The revised ISFSI SAR Supplement is included as Enclosure 1.

RAI 3-12

For the TN-32 Dry Storage Cask AMP and the Monitoring of Structures AMP, clarify the criteria for when a visual inspection result is entered into the Corrective Action Program.

The renewal application contains some ambiguities regarding the criteria for writing a corrective action report.

In some cases, the application states that a condition report is written when AMP acceptance criteria are not met, including:

- Section A2.1, Element 7, "Corrective Actions"
- Section C2.1.1.1
- Section A2.2, Element 7, "Corrective Actions"
- Section C2.1.1.2

In other cases, the threshold for writing a condition report is stated to be conditions "adverse to quality," including:

- Section A2.1, Element 5, "Monitoring and Trending"
- Section A2.1, Element 6, "Acceptance Criteria"
- Section A2.2, Element 5, "Monitoring and Trending"

Finally, in one case, the threshold for writing a condition report is stated to be "unacceptable results"

- Section A2.2, Element 6, "Acceptance Criteria (for cracking)

The staff notes that inspection results that do not meet the AMP acceptance criteria may not necessarily be considered conditions adverse to quality. As a result, the language in various parts of the AMPs discussed above could be interpreted differently. NUREG-1927, Revision 1, states that all conditions that do not meet the AMP acceptance criteria should be entered into the Corrective Action Program.

The staff requests clarification in all areas of the renewal application of whether all inspection results that do not meet AMP acceptance criteria will be entered into the Corrective Action Program. If not, state the threshold for which an inspection result will be entered into the Corrective Action Program.

This information is required to determine compliance with 10 CFR 72.42(a).

Response

In accordance with controlled Station procedures, a Condition Report is required to be entered into the Dominion Corrective Action Program based on either of two types of findings:

- Deviating conditions that are adverse to quality
- Failure to meet acceptance criteria during component inspection or testing

For both the TN-32 dry storage casks and the reinforced concrete pad No. 1, a Condition Report is submitted for a visual inspection result with a finding of either adverse to quality or failure to meet acceptance criteria.

Therefore, there are no areas of the ISFSI license renewal application where inspection results that do not meet acceptance criteria are not required to be entered into the Corrective Action Program. This is consistent with the statements from the application identified in the RAI.

RAI 3-13

Clarify the concrete inspection acceptance criteria in Appendices A and C of the renewal application.

The description of the Monitoring of Structures Aging Management Program in Section A2.2 of the renewal application provides a list of acceptance criteria for the concrete pad inspections. However, that list is stated to apply to "...cracking of concrete surfaces..." It is unclear as to whether that list is also meant to apply to the other identified aging effects: loss of material and change in material properties.

Revise the acceptance criteria to clearly address all of the identified aging effects.

This information is required to determine compliance with 10 CFR 72.42(a).

Response

Section A2.2, Element 6: Acceptance Criteria, indicates "Visual inspections for reinforced concrete pad No. 1 will determine whether adverse conditions such as cracking, loss of material, or change in material properties are present. Indications of adverse conditions will be documented using a Condition Report."

Similarly, Section C2.1.1.2 indicates "... cracking, change in material properties (white stains, indicative of leaching), and loss of material from reinforced concrete pad No. 1 will be identified and managed during the period of extended operation prior to loss of intended function."

Section A2.2, Element 6, concludes by stating that "Unacceptable results for cracking of concrete surfaces will require initiation of a Condition Report in accordance with the Dominion Corrective Action Program". The summary statement was not intended to exclude the other identified aging effects: loss of material and change in material properties as otherwise noted above. For clarity, the concluding paragraph of Section A2.2, Element 6, will be changed to state: "Unacceptable results for cracking, loss of material, or change in material properties of concrete surfaces will require initiation of a Condition Report in accordance with the Dominion Corrective Action Program."

RAI 3-14

Provide justification for the use of the Institute of Nuclear Power Operations (INPO) Consolidated Event System (ICES) for share operating experience to ensure continued AMP effectiveness.

Sections A2.1 and A2.2 of the renewal application, Element 10, "Operating Experience," state that operating experience will be identified and reported via the Institute of Nuclear Power Operations Consolidated Event System.

NUREG-1927, Revision 1 recommends that, to confirm the effectiveness of an AMP or to identify the need to enhance an AMP, renewal applicants should reference the specific system for sharing operating experience. However, it is unclear to the staff whether the ICES is capable of effectively obtaining and sharing dry storage operating experience.

NEI 14-03, Revision 1, "Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management," recommends the use of the new Aging Management INPO Database (AMID) system to collect and disseminate dry cask storage aging management information. In addition, NEI 14-03 recommends that licensees document and share their periodic assessments of AMP effectiveness ("tollgates") through AMID. NUREG-1927 references the AMID system as one means of sharing operating experience within the industry to ensure AMP effectiveness.

The staff notes that a unique feature of the AMID system is the lower threshold for sharing information in comparison to the ICES. For example, NEI 14-03, Section 4.5.2 recommends that aging-related conditions are reported if any of the following are found: new or unexpected aging effects, new or unexpected trends, unexpected inspection results, aging mechanisms found through new or improved tests methods, and when deficiencies are found that indicate an AMP is not effective. These categories of inspection findings would not necessarily be expected to be reported under the ICES (absent a more significant associated deficiency), so it is not clear if the use of this system is appropriate.

This information is required to determine compliance with 10 CFR 72.42(a).

Response

At the time of submittal of the Dominion ISFSI License Renewal Application, guidance for the use of the Aging Management INPO Database (AMID) was not formalized. Subsequently, NEI 14-03, *Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management,* Revision 2 was submitted by NEI to the NRC for endorsement and NEI 16-10, *ISFSI Aging Management INPO Database (AMID) User's Guide*, Revision 0, has been developed for industry use.

Dominion will utilize AMID, as well as the recommendations contained in NEI 14-03, in the review and sharing of operating experience. As indicated in Sections C2.1.1.1 and C2.1.1.2 of the ISFSI license renewal application, Dominion will assess the effectiveness of the TN-32 Dry Storage Cask Aging Management Program (AMP) and the Monitoring of Structures AMP on a five-year frequency. These AMP effectiveness

reviews and the ISFSI component inspection results will be evaluated and entered into the AMID database using the screening criteria as recommended by NEI 14-03.

The TN-32 Dry Storage Cask AMP and the Monitoring of Structures AMP have been revised to include the use of AMID and the recommendations of NEI 14-03 for reviewing and sharing of operating experience.

Changes to the ISFSI SAR Supplement (Appendix C)

Sections C2.1.1.1 and C2.1.1.2 of the ISFSI SAR Supplement have been revised to incorporate the use of AMID and NEI 14-03 in the review and sharing of operating experience and reporting of inspection results. The revised ISFSI SAR Supplement is provided in Enclosure 1.

Serial No. 16-456
Docket No. 72-16

Enclosure 1

Revised ISFSI SAR Supplement
(Pages C-1 through C-11)

North Anna Power Station ISFSI

Virginia Electric and Power Company

APPENDIX C: ISFSI SAR SUPPLEMENT

C1.0 INTRODUCTION

This appendix provides a proposed supplement to the North Anna ISFSI Safety Analysis Report (SAR). Section C2.0 of this appendix contains a proposed new section for the ISFSI SAR to be added under Chapter 9, Conduct of Operations. Section C3.0 of this appendix identifies changes to the existing ISFSI SAR that are necessary to reflect the period of extended operation.

The proposed new ISFSI SAR Section 9.7, Aging Management, provides a brief description of the activities for managing the effects of aging. This proposed new ISFSI SAR section also provides a summary of the analysis of time-limited aging analyses (TLAAs) for the period of extended operation. Following issuance of the renewed license (SNM-2507) for the North Anna ISFSI, Dominion will incorporate the proposed supplement in the North Anna ISFSI SAR as part of a periodic SAR update in accordance with 10 CFR 72.70(c).

C2.0 PROPOSED NEW NORTH ANNA ISFSI SAR SECTIONS

C2.1 Aging Management (New ISFSI SAR Section 9.7)

Renewal of North Anna ISFSI license SNM-2507 involved 1) Scoping, 2) Aging Management Review (AMR), and 3) Aging Management. Scoping of systems, structures and components (SSCs) identified the ISFSI major components in the scope of license renewal. The AMR process evaluated the SSCs in the scope of license renewal for applicable aging effects and mechanisms based on material and environment. Aging Management Programs (AMPs) were developed to adequately manage the effects of aging.

The scoping results identified the TN-32 dry storage cask, the spent fuel assemblies stored in the cask, and reinforced concrete pad No. 1 as being in the scope of license renewal.

The AMR addressed aging effects/mechanisms that could adversely affect the ability of the structures or components to perform their intended functions during the period of extended operation. The results of the AMR determined that there are aging effects that require aging management for both the TN-32 dry storage cask and reinforced concrete pad No. 1. The potential aging effects for the cask and concrete pad No. 1 are identified in Table C2.1-1, Table of Aging Effects (New ISFSI SAR Table 9.7-1).

Table C2.1-1 Table of Aging Effects (New ISFSI SAR Table 9.7-1)

Material	Environment	Aging Effect	Mechanism
Aluminum	Atmosphere / Weather	Loss of Material	Crevice Corrosion
			Pitting Corrosion
			Galvanic Corrosion
Carbon Steel and Low-Alloy Steel	Atmosphere / Weather	Loss of Material	Crevice Corrosion
			Pitting Corrosion
			Galvanic Corrosion
			General Corrosion
Stainless Steel	Atmosphere / Weather	Loss of Material	Crevice Corrosion
			Pitting Corrosion
Polypropylene (encased in carbon steel)	Air	Loss of Material	Radiolytic Decomposition
			Thermal Degradation
Borated Polyester (encased in Aluminum)	Air	Loss of Material	Radiolytic Decomposition
			Thermal Degradation
Concrete	Atmosphere / Weather	Loss of Material	Freeze-thaw
		Cracking	Freeze-thaw
			Reaction with Aggregates
		Change in Material Properties	Leaching of Calcium Hydroxide
	Soil	Cracking	Reaction with Aggregates
			Settlement

A review of AMPs needed to manage the effects of aging identified existing aging management activities and the need to add new aging management activities. The AMPs provide reasonable assurance that the ISFSI reinforced concrete pad No. 1 and TN-32 dry storage cask subcomponents within the scope of license renewal will continue to perform their intended functions consistent with the design basis for the period of extended operation. The following sections describe aging management program activities used to manage the effects of aging.

C2.1.1 Aging Management Programs (New ISFSI SAR Section 9.7.1)

C2.1.1.1 TN-32 Dry Storage Cask Aging Management Program (New ISFSI SAR Section 9.7.1.1)

This Aging Management Program defines the aging management activities which are necessary to help ensure the integrity of the TN-32 dry storage casks manufactured by AREVA-Transnuclear.

The North Anna ISFSI is a facility to place and store spent fuel in licensed containers (dry storage casks) until such time that the fuel may be shipped off-site for final disposition. The TN-32 dry storage casks at the North Anna ISFSI are designed for outdoor storage.

The aging management activities described and credited to manage the effects of aging for the TN-32 dry storage casks will provide reasonable assurance that there will not be a loss of intended function.

Specifically, the TN-32 Dry Storage Cask Aging Management Program ensures loss of material from the cask subcomponents will be identified and managed during the period of extended operation prior to loss of intended function.

The TN-32 Dry Storage Cask Aging Management Program includes 1) continuous interseal pressure monitoring of the in-service dry storage casks, 2) quarterly visual inspection of dry storage casks that are in-service at the North Anna ISFSI, and 3) quarterly TLD radiation monitoring at the ISFSI perimeter fence. Section C2.1.1.1.1 identifies additional program activities that ensure the aging effect of concern is adequately managed during the period of extended operation.

Pressure monitoring of the dry storage cask provides a means to detect seal degradation. Visual inspections identify degradation of the physical condition of the exterior surfaces of the TN-32 dry storage cask. These inspections check for loss of material (corrosion) from the TN-32 dry storage cask. Radiation monitoring provides a means to detect degradation of shielding material internal to the TN-32 dry storage casks.

C2.1.1.1.1 Program Enhancements (New ISFSI SAR Section 9.7.1.1.1)

~~The following additional activities are included in the TN-32 Dry Storage Cask Aging Management Program to ensure the aging effect of concern is adequately managed during the period of extended operation:~~

1. Perform an engineering evaluation every five years to review industry and plant-specific operating experience (including work order history). The initial operating experience

evaluation during the period of extended operation will be scheduled to occur in January 2020. [RAI 3-14]
The evaluation will also review previous inspection results to determine if any adverse trends are identified warranting additional corrective actions to manage the loss of material from the TN-32 dry storage casks. Each element of the TN-32 Dry Storage Cask Aging Management Program will be reviewed to determine if updates are required based on lessons learned from the operating experience review. The results of the engineering evaluation will be entered into the Aging Management INPO Database (AMID), using the screening criteria as recommended in NEI 14-03, Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management. [RAI 3-14]

2. Perform an opportunistic visual inspection of a TN-32 dry storage cask bottom and under the protective cover in the event a cask is lifted or a protective cover is removed.
3. Perform a visual inspection of a TN-32 dry storage cask bottom and under the protective cover at least every 20 ± 5 years following the pre-application inspection in October and November 2015. [RAI 3-10]. The selection criteria for this scheduled inspection will utilize the same criteria as that used for the pre-application inspection. The five-year periodic reviews of operating experience, as well as changes to the aging management program resulting from the review, will be considered during cask selection.
4. Perform an annual neutron radiation survey of each TN-32 dry storage cask. [RAI 3-11]
5. Perform an annual evaluation of TN-32 dry storage cask neutron survey results and ~~gamma quarterly TLD~~ ISFSI perimeter fence neutron and gamma TLD readings to confirm the absence of an increasing trend (as determined by engineering evaluation). [RAI 3-11]

As recommended by NEI 14-03, inspection results will be reviewed to determine if the results should be entered in the AMID database. [RAI 3-14]

C2.1.1.1.2 **Acceptance Criteria (New ISFSI SAR Section 9.7.1.1.2)**

The acceptance criterion for interseal pressure monitoring is:

- The absence of a low pressure alarm

~~Visual inspections identify degradation of the physical condition of the exterior surfaces of the TN-32 dry storage cask. These inspections check for loss of material (corrosion) from the TN-32 dry storage cask. Pressure monitoring of the dry storage cask provides a means to detect seal degradation. Radiation monitoring provides a means to detect degradation of shielding material internal to the TN-32 dry storage casks.~~

The acceptance criteria for the quarterly visual inspection are:

- No coating defects (bubbling/blistering of paint)
- No loose debris in contact with the cask(s)
- No rust spots and stains
- No rust stains on the concrete
- No physical damage
- No baseplate corrosion at the concrete/cask interface

The acceptance criterion for the opportunistic and 20 ± 5 -year scheduled visual inspections is:

- ~~n~~No detectable loss of material from the base metal as determined by the results of the VT-1 and/or VT-3 visual inspection.

The acceptance criterion for the annual evaluation of dry storage cask neutron survey results, and neutron and gamma TLD readings, is:

- The absence of an increasing trend (as determined by engineering evaluation)

Monitoring and inspection results that exceed established acceptance criteria will be entered into the Corrective Action Program. Engineering evaluations determine if conditions identified as adverse to quality are significant enough to compromise the ability of a TN-32 dry storage cask to perform its intended functions.

C2.1.1.1.3 **Extent of Visual Inspections (New ISFSI SAR Section 9.7.1.1.3**

Quarterly, the visible outer surfaces of the following dry storage cask subcomponents within the scope of license renewal will be inspected by an individual standing at ground level: [RAI 3-9]

- Bottom vertical surfaces
- Trunnions
- Flange vertical surfaces
- Shell
- Outer Shell

During opportunistic and 20 ± 5-year visual inspections conducted with the dry storage cask protective cover removed, the visible outer surfaces of the following dry storage cask subcomponents within the scope of license renewal will be visually inspected by an individual standing at the top of the cask: [RAI 3-9]

- Lid
- Lid Bolts and Neutron Shield Bolts
- Top Neutron Shield
- Flange horizontal surfaces including stainless steel weld overlay
- Trunnions

During opportunistic and 20 ± 5-year visual inspections conducted during dry storage cask lift operations, the horizontal surface of a dry storage cask bottom will be visually inspected.

~~The acceptance criterion for interseal pressure monitoring is the absence of a low pressure alarm.~~

~~The acceptance criterion for the annual evaluation of neutron and gamma quarterly TLD readings is the absence of an increasing trend (as determined by engineering evaluation).~~

~~Monitoring and inspection results that exceed established acceptance criteria will be entered in the Corrective Action Program. Engineering evaluations determine if conditions identified as adverse to quality are significant enough to compromise the ability of a TN-32 dry storage cask to perform its intended functions.~~

C2.1.1.2 **Monitoring of Structures Aging Management Program (New ISFSI SAR Section 9.7.1.2)**

The Monitoring of Structures Aging Management Program is a new program, which defines the aging management activities ~~which~~ that are necessary to help ensure the integrity of reinforced concrete pad No. 1. Reinforced concrete pad No. 1 on which the TN-32 dry storage casks rest is an above-ground, outdoor installation. The Monitoring of Structures Aging Management Program verifies the capability of reinforced concrete pad No. 1 to perform its intended functions.

Specifically, the Monitoring of Structures Aging Management Program ensures that cracking, change in material properties (white stains, indicative of leaching), and loss of material from reinforced concrete pad No. 1 will be identified and managed during the period of extended operation prior to loss of intended function.

Periodic visual monitoring is performed to determine the surface condition of reinforced concrete pad No. 1, which is a leading indicator for the overall integrity of the pad. Visual inspections detect surface defects resulting from the aging mechanisms of reaction with aggregates, freeze-thaw, leaching of calcium hydroxide, or settlement.

C2.1.1.2.1 **Program Activities (New ISFSI SAR Section 9.7.1.2.1)**

The Monitoring of Structures Aging Management Program includes the following activities:

1. Perform an engineering evaluation every five years to review industry and plant-specific operating experience (including work order history). The initial operating experience evaluation during the period of extended operation will be scheduled to occur in January 2020. [RAI 3-14] The evaluation will also review previous inspection results to determine if any adverse trends are identified warranting additional corrective actions to manage the loss of material, cracking, and change in material properties for reinforced

concrete pad No. 1. Each element of the Monitoring of Structures Aging Management Program will be reviewed to determine if updates are required based on lessons learned from the operating experience review. The results of the engineering evaluation will be entered into the Aging Management INPO Database (AMID), using the screening criteria as recommended in NEI 14-03, Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management. [RAI 3-14]

2. Perform a visual inspection of ~~the visible~~ all exposed [RAI 3-9] surfaces of reinforced concrete pad No. 1 every five years. The initial visual inspection during the period of extended operation will be scheduled to occur in November 2020. [RAI 3-10]
3. Perform groundwater sampling at the ISFSI site to determine values for chlorides, sulfates, and pH at two groundwater wells every five years.
4. Perform an opportunistic inspection of the normally inaccessible area of reinforced concrete pad No. 1 beneath a TN-32 dry storage cask in the event a dry storage cask is lifted.
5. Perform an opportunistic visual inspection of ~~the inaccessible~~ all exposed below-grade ~~portions~~ surfaces of reinforced concrete pad No. 1, if made available by excavation. [RAI 3-9]

As recommended by NEI 14-03, inspection results will be reviewed to determine if the results should be entered in the AMID database. [RAI 3-14]

~~Periodic visual monitoring is performed to determine the surface condition of reinforced concrete pad No. 1, which is a leading indicator for the overall integrity of the pad. Visual inspections detect surface defects resulting from the aging mechanisms of reaction with aggregates, freeze-thaw, leaching of calcium hydroxide, or settlement.~~

~~Surface indications of age related degradation for reinforced concrete pad No. 1 include:~~

- ~~Loss of material~~
- ~~Cracking~~
- ~~Change in material properties (white stains, indicative of leaching)~~

C2.1.1.2.2 **Acceptance Criteria (New ISFSI SAR Section 9.7.1.2.2)**

The acceptance criteria listed in ACI 349.3R is used for all visual inspections.

~~Chlorides, sulfates, and pH are monitored. Groundwater sampling is performed at two locations at the ISFSI every five years.~~ The acceptance criteria for groundwater monitoring are:

1. Chlorides < 500ppm
2. Sulfates <1,500ppm
3. pH >5.5

Reinforced concrete pad No. 1 is not located in the groundwater. However, a groundwater chemistry monitoring program will be established to provide supplemental information for identifying conditions conducive to underground aging mechanisms.

Monitoring and inspection results that exceed established acceptance criteria are entered into the Corrective Action Program. Engineering evaluations determine if conditions identified as adverse to quality are significant enough to compromise the ability of reinforced concrete pad No. 1 to perform its intended functions.

C2.2 Time-Limited Aging Analyses (New ISFSI SAR Section 9.7.2)

As required by 10 CFR 72.42(a)(1), an application for a renewed ISFSI license must include ISFSI-specific TLAAs. The TLAA identification process required a review of the design basis documents and calculations to provide a reasonable assurance that TLAAs were identified.

Once a TLAA is identified, an evaluation is performed to disposition each ISFSI-specific TLAA using one of three different approaches described below:

i. The analyses will remain valid for the period of extended operation.

ii. The analyses have been projected to the end of the period of extended operation.

iii. The effects of aging on the intended function(s) will be adequately managed for the period of extended operation.

Based on review of design basis documents and calculations, no TLAAs were identified for the North Anna ISFSI.

C3.0 PROPOSED CHANGES TO EXISTING NORTH ANNA ISFSI SAR

C3.1 ISFSI SAR Section A.1.3: Criticality Evaluation

Revise the second to last paragraph of the ISFSI SAR Section A.1.3 to reflect evaluation of the fixed neutron poison in the TN-32 dry storage cask:

> "....An appraisal of the fixed neutron poisons has shown that they will remain effective for the ~~20~~ 60-year storage period, and there is no credible way to lose them. The analysis and evaluation of the criticality design and performance have demonstrated that the cask will provide for the safe storage of spent fuel for a minimum of ~~20~~ 60 years with an adequate subcritical margin."

This change reflects the extended license period to 60 years and is based on previous analysis showing that boron depletion is negligible for storage periods well beyond 60 years.

C3.2 ISFSI SAR Section A.1.4: Thermal Evaluation

Revise the last paragraph of ISFSI SAR Section A.1.4 to reflect evaluation of the thermal design of the TN-32 dry storage cask:

> "The thermal design of the TN-32 cask is in compliance with 10 CFR 72 and applicable design and acceptance criteria have been satisfied. The evaluation of the thermal design provides reasonable assurance that the TN-32 cask will allow the safe storage of spent fuel for ~~20~~ 60 years."

This change reflects the extended license period to 60 years. Since the maximum temperature for the cask and the fuel stored within the cask during the storage period is realized immediately after loading spent fuel into the cask and fuel temperature decreases

with time, the thermal calculations supporting storage for the extended license period remain valid.