PrairieIslandISFSIPEm Resource

From: Li, Zhian
Sent: Wednesday, August 27, 2014 1:36 PM
To: Torres, Ricardo; Jordan, Natreon; Csontos, Aladar; Lupold, Timothy; Rahimi, Meraj; Einziger, Robert; Borowsky, Joseph; Nguyen, John-Chau
Cc: Coggins, Angela
Subject: RE: Latest Draft Prairie Island SER
Attachments: 2014-08-25 Prairie Island ISFSI LRA Draft SER Rev 20 (ZL comments).docx

Importance: High

Nate,

I have incorporated the comments on my sections by either accepting the suggested revision in its entirety or revision of my writeup. With that I think I have addressed all of the comments on which I need to take actions.

I also have some comments on other sections. Attached is the file. Please take a look at it and let me know if you want to schedule a team meeting to morrow or just resolve them between you and the authors of the concerned sections.

Thanks,

Zhian

From: Torres, Ricardo
Sent: Monday, August 25, 2014 8:31 AM
To: Jordan, Natreon; Csontos, Aladar; Lupold, Timothy; Rahimi, Meraj; Einziger, Robert; Borowsky, Joseph; Li, Zhian; Nguyen, John-Chau
Cc: Coggins, Angela; Dunn, Darrell
Subject: RE: Latest Draft Prairie Island SER

All,

Attached is the latest –formatted- version of the PI SER.

John – please take a look at some of the comments addressed to the PM. Zhian/Nate/myself will address the remaining ones.

Not sure if there's a SFST SP site for PI, but for now please make sure you keep track of any changes by changing the rev# and adding your initials to the file name.

Thanks,
Ricardo

From: Jordan, Natreon
Sent: Thursday, August 21, 2014 6:26 PM
To: Csontos, Aladar; Lupold, Timothy; Rahimi, Meraj; Einziger, Robert; Borowsky, Joseph; Li, Zhian; Nguyen, John-Chau; Torres, Ricardo
Subject: FW: Latest Draft Prairie Island SER

Team,

Attached is the latest version of the draft Prairie Island SER. We've made a lot of progress over the last two weeks. Keep in mind while reviewing that there are still some additional work needed before this is ready for

concurrence. It should be noted that the CNWRA is working on some of the formatting aspects of the document. Secondly, there are a couple of comments and clarifications that need to be addressed by NRC staff once the appropriate individuals return to the office next week. Finally, we are working with OGC to address some aspects related to the SER which should help to tie up any loose ends as we finish up. Overall, I think the team is doing a tremendous job and is on pace to complete this effort either by or well before the established schedule.

Thanks to All Involved,
-Nate

From: Torres, Ricardo
Sent: Thursday, August 21, 2014 4:57 PM
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Cc: Yi-Ming Pan (ypan@swri.org) (ypan@swri.org); Asadul Chowdhury (achowdhury@swri.org); Jordan, Natreon; Csontos, Aladar
Subject: Latest Draft Prairie Island SER

Art,

Please find attached the latest draft of the Prairie Island SER. Thanks for your help.

Ricardo

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Master Draft 1 (dated: 8/21/2014) Version 20

SAFETY EVALUATION REPORT

FOR

LICENSE RENEWAL

PRAIRIE ISLAND NUCLEAR GENERATING PLANT INDEPENDENT SPENT FUEL STORAGE INSTALLATION

DOCKET NO. 72-10

LICENSE NO. SNM-2506

Office of Nuclear Material Safety and Safeguards
United States Nuclear Regulatory Commission
September 2014

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TABLES

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INTRODUCTION

By letter dated October 20, 2011, as supplemented February 29, 2012; April 26, 2012; July 26, 2013; July 31, 2014 and August xx, 2014 Northern States Power Company–Minnesota (NSPM), thereafter the licensee, submitted an application to the U.S. Nuclear Regulatory Commission (NRC) for renewal of the operating license for the independent spent fuel storage installation (ISFSI) at the Prairie Island Nuclear Generating Plant (PINGP), Special Nuclear Material License No. SNM-2506, for a period of 40 years beyond the current license. The licensee submitted the license renewal application (LRA) in accordance with the regulatory requirements of 10 CFR 72.42. Pursuant to 10 CFR 72.42(b), this application constitutes a timely renewal. In its LRA, the licensee documents the technical bases for renewal of the license and commitments to actions for managing the potential aging effects of the systems, structures, and components (SSCs) of the ISFSI to ensure that these SSCs will maintain their intended functions during the period of extended operation.

On March 30, 2012, the NRC notified NSPM that the application contained sufficient information for the NRC staff to conduct a detailed technical review and commenced its technical review thereafter.

The PINGP site encompasses about 578 acres and is located within the city limits of Red Wing, Minnesota, in Goodhue County (NSPM, 2011a). NSPM owns and operates two nuclear generating units, Units 1 and 2, on the PINGP site. The ISFSI is located outside the protected area of Units 1 and 2 (i.e., the area encompassed by a physical barrier and to which access is controlled), but within the PINGP controlled area consistent with the definiation of 10 CFR 72.3 (i.e., the area outside the protected area of Units 1 and 2 but within the site boundary of PINGP) (NSPM; 2011b, 2010b).

The PINGP ISFSI employs two dry cask spent storage designs, the TN-40 and TN-40HT; both metal-based casks are designed and manufactured by Transnuclear Inc. (AREVA Group). Each cask can hold up to 40 pressurized water reactor (PWR) fuel assemblies with burnup limits up to 45 GWd/MTU for the TN-40 and up to 60 GWd/MTU for the TN-40HT cask (NSPM, 2010a). The ISFSI can hold up to 48 casks when fully loaded. There are presently xx casks on the ISFSI pads.

The PINGP ISFSI relies upon an earthen berm to shield the public from direct radiation emitted from the ~~surface of~~ the casks. The radiation sources of the effluents from the cask surface contamination are conservatively estimated ~~with~~ assuming maximum allowable values as specified in the Technical Specifications (TS) of the cask; the casks must be decontaminated to the surface contamination limits per the requirements of cask design technical specifications before they can be moved on to the ISFSI.

In the LRA, the licensee presented general information about the ISFSI design, a scoping analysis to determine the SSCs that are in-scope of the renewal and subject to an aging management review (AMR). For each in-scope SSC, the licensee proposed either a time-limited aging analysis (TLAA) or aging management program (AMP) to ensure that the SSC will maintain its intended functions during the period of extended operation.

The NRC staff reviewed the licensee's technical bases for safe operation of the ISFSI for an additional 40 years beyond the term of the current operating license. This Safety Evaluation Report (SER) summarizes the results of the staff's review for compliance with Title 10 of the

Comment [AC1]: PM to provide date after receiving revised Appendix C. PM to remind AI to contact the licensee that they need to provide a revised Appendix C, including the missing aging mechanisms/effects for the neutron shield and the High Burnup AMP.

Comment [JN2]: PM to look at LRA and confirm the commitment(s). Initial LRA only has one commitment to incorporate Appendix C in the SAR, not Appendix A. Is this an issue?

Comment [JN3]: PM to verify if this is needed in order to denote the start date of the review. Note that the first line of the first paragraph also states the supplements to the LRA, i.e. OBS, RSI, RAI-1, RAI-2…

Comment [AC4]: PM to provide the number.

Comment [JN5]: Nate to verify that these are in the Tech Specs

Code of Federal Regulation (10 CFR) Part 72.42 "duration of license, renewal." In its review of the LRA and development of the SER, the staff followed the guidance provided in NUREG–1927, "Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance," dated March 2011 (NRC, 2011).

This SER is organized in four sections: Section 1 provides the staff's review of the general information of the ISFSI. Sections 2 and 3 document the staff's evaluation of the application and issues considered during the review of the application. Section 4 provides the staff conclusions of this review.

Appendix A of this SER is a table listing the licensee's committed aging management actions that are parts of the conditions for renewal of the operating licenses. Appendix B is a bibliography of the references in support of the staff's review and technical determinations.

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1 GENERAL INFORMATION

1.1 Specific License Holder Information

Pursuant to Title 10 of the *Code of Federal Regulation*, Part 72, the U.S. Nuclear Regulatory Commission (NRC) issued an operating license for the independent spent fuel storage installation (ISFSI) at Prairie Island Nuclear Generating Plant (PINGP), Special Nuclear Material (SNM) License No. SNM-2506, for 20 years, which expired on October 31, 2013. The current NRC license for the PINGP ISFSI which is in timely renewal per the regulation of 10 CFR 72.42(c), authorizes the construction and operation of 48 vertical dry storage casks (DSCs), which PINGP is building incrementally to meet storage requirements.

The ISFSI was originally licensed with the TN-40 vertical dry storage system (NRC, 1993). The TN-40HT vertical dry storage system was added through amendment of the ISFSI license (NRC, 2010a). The principal components of the PINGP ISFSI are two seismically qualified concrete pads (NRC, 1993) that provide for 2 parallel rows with 12 casks per row on each pad, and the earthen berm. The concrete pads have been categorized as "Important To Safety" The seismic design criteria for the ISFSI are identical to the criteria for Safe Shutdown Earthquake (SSE) of PINGP, with peak accelerations of 0.12g horizontal and 0.08g vertical (NRC, 1993). The TN-40 and TN-40HT ~~containment~~ confinement vessel comprises carbon steel inner and outer shells, bottom, and lid. The confinement boundary components are

- Inner shell
- Lid assembly outer plate, closure bolts and inner metal seal
- Shell flange
- Vent port cover plate, bolts, and seals
- Drain port cover plate, bolts and seals Northern States Power Company-Minnesota (NSPM) (NSPM, 2011b)

The inner shell and bottom inner plate are made of stainless steel and surrounded by a carbon steel gamma shield~~The inner shell and bottom inner plate are surrounded by a carbon steel gamma ray shield~~. Radial neutron shielding is provided by borated polyester resin enclosed in aluminum boxes~~.~~, which are attached to ~~surrounds~~ the exterior of the cask gamma ~~ray~~ shield. ~~Additional~~ Axial shielding to the top end of the cask ~~neutron shielding~~ is provided by a disc of polypropylene encased in carbon steel and bolted to the cask lid. Each cask contains 40 pressurized water reactor (PWR) spent fuel assemblies (SFAs).

1.2 Specific Financial Information

NSPM stated in the license renewal application (LRA) that it~~they~~ will remain financially qualified to carry out the operation and decommissioning of the ISFSI during the period of the renewed material license as required by 10 CFR 72.22(e).

The staff reviewed the NSPM's financial statement. Based on its review, the staff finds that the licensee has complied with the requirements of 10 CFR 50.75(b) and (c) with respect to providing decommissioning funding assurance for the requirements of 10 CFR 72.30(c) with respect to providing decommissioning funding assurance for the PINGP ISFSI license renewal period.

Comment [JN6]: PM to verify all references globally

Comment [AC7]: PM to complete this subsection

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1.3 Specific Environmental Review

10 CFR 72.34 "Environment Report" requires that each application for an ISFSI or Monitored Retreivable Storage (MRS) license under this part must be accompanied by an Environmental Report which meets the requirements of subpart A of part 51 of this chapter. In xxx, the staff developed an Environment Assessment (EA) report for the PINGP ISFSI license renewal. The staff prepared the EA report to document its evaluation of possible environmental impacts associated with ISFSI license renewals.

Comment [AC8]: PM to provide date and reference with ML accession #.

1.4 Specific Safety Review

The objective of this safety review is to determine that there is reasonable assurance that the ISFSI continue to meet the requirements of 10 CFR Part 72 during the period of extended operation. The NRC staff safety review is a detailed and in-depth assessment of the technical aspects of the PINGP ISFSI license renewal application. Pursuant to 10 CFR 72.42(a), an application for ISFSI license renewal must include the following: (i) TLAAs that demonstrate SSCs important to safety (ITS) will continue to perform their intended function for the requested period of extended operation and (ii) a description of the aging management program (AMP) for management of issues associated with aging that could adversely affect SSC ITS. Per the guidance in NUREG–1927 (NRC, 2011), the licensee performed a scoping evaluation and aging management review to identify all SSCs within the scope of the license renewal and pertinent aging mechanisms and effects, respectively. The licensee developed AMPs and time-limited aging analysis (TLAAs) to assure that the identified in-scope SSCs will continue to perform their intended function during the period of extended operation. This review documents the staff's evaluation of the licensee's scoping analysis, aging management review, and supporting AMPs and TLAAs.

1.5 Application Content

The licensee's license renewal application, as supplemented with responses to request for supplemental information (RSIs) (NSPM, 2012a) and request for additional information (RAIs), (NSPM, 2013) contains the following information:

- General Information
- Scoping Evaluations
- Aging Management Reviews
- Time-Limited Aging Analyses
- Aging Management Programs
- Safety Analysis Report Supplement and Changes

In particular, the Safety Analysis Report Supplement and Changes document the changes and additions to the Safety Analysis Report (SAR) that the licensee committed to furnishing.

1.6 Interim Staff Guidance

The staff, industry, and other interested stakeholders gain experience and develop lessons learned with each operating ISFSI and renewed license. The lessons learned address issues

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related to the licensing goals of maintaining safety, improving effectiveness and efficiency, reducing regulatory burden, and increasing public confidence. The staff develops Interim staff guidance (ISG) to clarify or to address issues not discussed in a Standard Review Plan. These ISGs are to be used by the staff, industry, and other interested stakeholders until incorporated into staff guidance documents such as regulatory guides and standard review plans. Table 1-1 lists the ISGs relevant to ISFSI license renewal.

1.7 Safety Review Evaluation Findings

The staff reviewed the descriptions of the ISFSI and DCSS presented in Chapter 1 of the LRA and supplemental documentation and finds that there is sufficient detail to meet the requirements of 10 CFR Part 72. The staff also reviewed the information provided by the application, representation, and responses to the RAIs. Based on its review, the staff determined that the licensee has provided sufficient information with adequate details to support the license renewal application with the follow findings:

F1.1 The information presented in the renewal application satisfies the requirements of 10 CFR 72.2, 72.22, 72.34, and 72.42.

F1.2 A tabulation of all supporting information and docketed material incorporated by reference has been provided in accordance with 10 CFR 72.42.

The staff followed the guidance provided in NUREG–1927, “Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance,” (NRC, 2011) during its review.

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Table 1-1. Existing Interim Staff Guidance Relevant to ISFSI License Renewal	
Interim Staff Guidance Number	**Interim Staff Guidance Title**
SFST-ISG-1, Rev. 2	Damaged Fuel
SFST-ISG-2, Rev. 1	Fuel Retrievability
SFST-ISG-3	Post Accident Recovery and Compliance with 10 CFR 72.122(l)
SFST-ISG-4	Revision 1 Cask Closure Weld Inspections
SFST-ISG-5	Revision 1 Confinement Evaluation
SFST-ISG-9, Rev. 1	Storage of Components Associated with Fuel Assemblies
SFST-ISG-10, Rev. 1	Alternatives to the ASME Code
SFST-ISG-11, Rev. 3	Cladding Considerations for the Transportation and Storage of Spent Fuel
SFST-ISG-12, Rev. 1	Buckling of Irradiated Fuel Under Bottom End Drop Conditions
SFST-ISG-13	Real Individual
SFST-ISG-14	Supplemental Shielding
SFST-ISG-15	Materials Evaluation
SFST-ISG-16	Emergency Planning
SFST-ISG-17	Interim Storage of Greater Than Class C Waste
SFST-ISG-18, Rev. 1	The Design and Testing of Lid Welds on Austenitic Stainless Steel Canisters as the Confinement Boundary for Spent Fuel Storage
SFST-ISG-19	Moderator Exclusion Under Hypothetical Accident Conditions and Demonstrating Subcriticality of Spent Fuel Under the Requirements of 10 CFR 71.55(e)
SFST-ISG-20	Transportation Package Design Changes Authorized Under 10 CFR Part 71 Without Prior NRC Approval
SFST-ISG-21	Use of Computational Modeling Software
SFST-ISG-22	Potential Rod Splitting Due to Exposure to an Oxidizing Atmosphere During Short-Term Cask Loading Operations in LWR or Other Uranium Oxide Based Fuel
SFST-ISG-24	The Use of a Demonstration Program as a Surveillance Tool for Confirmation of Integrity for Continued Storage of High Burnup Fuel Beyond 20 Years

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2 SCOPING EVALUATION

Title 10 of the *Codes of Federal Regulations* (10 CFR) 72.24 defines the required content to be included in a license application. Furthermore, 10 CFR 72.42 requires each license renewal application (LRA) to include time-limited aging analysis (TLAAs) that demonstrate systems, structures, and components (SSCs) important to safety (ITS) will continue to perform their intended function for the requested period of extended operation; and a description of aging management programs (AMPs) for management of issues associated with aging that could adversely affect SSCs ITS. In addition, 10 CFR 72.122(l) requires that storage systems be designed to allow ready retrieval of spent fuel, high-level radioactive waste and reactor-related Greater Than Class C Waste (GTCC) for further processing or disposal.

A scoping evaluation is necessary to identify the SSCs requiring an aging management review (AMR). The objective of this scoping evaluation is to identify those SSCs meeting the following criteria:

1. ITS

2. Not safety significant but their failure could prevent an ITS SSC to perform its intended functions.

3. Provide reasonable assurance that spent fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public

The staff reviewed the scoping process and the scoping results provided in the LRA (NSPM, 2011a). ~~Per the review guidance in NUREG–1927 (NRC, 2011),~~ In the LAR, the licensee states that it ~~the licensee~~ performed a scoping evaluation that provided the following information:

- A description of the scoping process and methodology for the inclusion of SSCs in the renewal scope.
- A list of the SSCs (and appropriate subcomponents) that are identified as within the scope of renewal and subject to an AMR, including their intended function, and safety classification or basis for inclusion in the renewal scope.
- A list of sources of information used.
- A discussion needed to clarify the process, SSC designations, or sources of information used.

The following section discusses the staff's review and review findings on the licensee's scoping study.

2.1 Scoping and Screening Methodology

LRA Section 2.0, Scoping Evaluations, describes the methodology for identifying those SSCs of the Prairie Island Nuclear Generating Plant (PINGP) Independent Spent Fuel Storage Installation (ISFSI) that are within the scope of license renewal and those SSCs that are subject to an AMR. ~~The staff reviewed the scoping and screening methodology of Northern States~~

~~Power Company Minnesota (NSPM) to determine whether the results meet the requirements of 10 CFR 72.24, 72.42, 72.120, and 72.122.~~

The licensee followed the guidance contained in Section 2, Scoping Evaluation, of NUREG–1927 (NRC, 2011) for the scoping process and screening methodology for the Prairie Island ISFSI LRA (NSPM, 2011a). The licensee's ~~is~~ scoping process and screening methodology considered the (i) current licensing basis (CLB) and (ii) that the CLB documents identified SSCs and their safety functions. The licensee identified the following documents that provide the technical basis for the Prairie Island ISFSI LRA and scoping evaluation.

- Prairie Island ISFSI Safety Analysis Report (SAR) (NSPM, 2011b)
- Prairie Island ISFSI Safety Evaluation Report (SER) (NRC, 1993)
- Prairie Island ISFSI SERs Associated with Subsequent License Amendments
- Prairie Island Updated Safety Analysis Report (PINGP USAR) (NSPM, 2010b)
- Materials License No. SNM-2506
- Technical Specifications (NSPM, 2010a)
- Docketed Licensing Correspondence

Comment [AC9]: PM to provide reference and date.

The Prairie Island ISFSI SAR (NSPM, 2011b) provided two types of broad definitions for SSC classification: (i) "Safety Related" or "Non-Safety Related" for Prairie Island ISFSI SSCs with TN-40 as the only dry storage cask in the ISFSI and (ii) "Important to Safety" or "Not Important to Safety" for the major components of TN-40HT dry storage cask. Since both TN-40 and TN-40HT are currently licensed to be used as dry storage casks for Prairie Island ISFSI and NUREG–1927 (NRC, 2011) classifies SSCs as only "Important to Safety" or "Not Important to Safety," the licensee used the following expanded scoping criteria in its LRA (NSPM, 2011a).

- Criterion 1, the SSC is classified as important to safety (or safety related) as it is relied on to do one of the following:
  - Maintain the conditions required by the regulations and license to store spent fuel safely
  - Prevent damage to the spent fuel cask during handling and storage
  - Provide reasonable assurance that spent fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public
- Criterion 2, the SSC is classified as not ITS (or nonsafety related) but, according to the licensing basis, its failure could prevent fulfillment of a function that is ITS, or its failure as a support SSC could prevent fulfillment of a function that is ITS.

The staff reviewed the scoping and screening methodology of Northern States Power Company-Minnesota (NSPM) to determine whether the results meet the requirements of 10 CFR 72.24,

72.42, 72.120, and 72.122. The following sections document the staff's review and evlaution of the licensee's scoping analyses. ~~Staff reviewed the general information on the scoping and screening methodology provided by the licensee, including a list of the source for CLB information and definitions of scoping criteria. Staff finds the licensee's scoping and screening methodology acceptable.~~

2.1.1 Scoping Process

The licensee identified the ISFSI SSCs within renewal scope subject to an AMR. In order to accomplish this scoping evaluation, the licensee reviewed the Prairie Island ISFSI SAR (NSPM, 2011b), which contains design bases information used to determine those SSCs with safety functions meeting either Scoping Criterions 1 or 2, as defined earlier. The classification of the ISFSI SSCs, including the TN-40 design, is provided in Table 4.5-1 of the Prairie Island ISFSI SAR (NSPM, 2011b) and presented in Table 2.1-1. The ISFSI SAR classifies SSCs in terms of three broad categories: (i) safety related, (ii) augmented quality, and (iii) commercial material. According to these definitions, safety related implies any SSC that prevents or mitigates the consequences of postulated nuclear accidents that could cause undue risk to the health and safety of the public. Augmented classification is for SSCs or services that do not perform a safety related function, but are subject to special licensee requirements or NRC imposed regulatory requirements.

The classification of TN-40HT major components is provided in Table A4.5-1 of Prairie Island ISFSI SAR (NSPM, 2011b) and presented in Table 2.1-2. This classification of TN-40HT SSCs, was made in accordance with NRC (1996, NUREG/CR–6407).

The licensee further reviewed the Prairie Island ISFSI SER (NRC, 1993) that summarized the results of the NRC staff safety review of the original licensing of Prairie Island ISFSI, the SERs associated with subsequent license amendments of the PINGP USAR (NSPM, 2010b). The licensee used

Table 2.1-1. Classification of Structures, Systems, and Components*

Safety Related	Augmented Quality	Commercial Material (Standard Quality)
Containment Vessel: Cask Body Shell Cask Body Bottom Lid Lid Bolts Basket Assembly Trunnions Concrete Pads: Concrete Reinforcing Steel	Lid Gaskets Lid Penetration Covers, Bolts, Gaskets Port Covers, Bolts, Gaskets Neutron Shield Body Shielding Lid Shielding Security System	Protective Cover Overpressure System Transport Vehicle ISFSI Buildings Electrical Power: Lighting Receptacles

NSPM. "Prairie Island Independent Spent Fuel Storage Installation Safety Analysis Report." Table 4.5-1. Rev. 14. Materials License No. SNM-2506. ML113040131. Minneapolis, Minnesota: Northern States Power Company–Minnesota. September 2011.

Table 2.1-2. Classification of TN-40HT Major Components*

Important to Safety	Not Important to Safety
Containment vessel including lid, flange, inner containment shell & bottom containment plate	Pressure monitoring system, & overpressure cover
Lid bolts	Protective cover, bolts, & seal
Lid vent and drain covers, & bolts	Paint on exterior of cask
Basket assembly including fuel compartments, poison plates, & structural plates	
Trunnions	
Basket rails	
Lid, vent & drain seals	
Radial neutron shield	
Cask body shield shell	
Cask body bottom	
Lid shield plate	
Top neutron shield including bolts	
Outer shell	

*NSPM. "Prairie Island Independent Spent Fuel Storage Installation Safety Analysis Report." Table A4.5-1. Rev. 14. Materials License No. SNM-2506. ML113040131. Minneapolis, Minnesota: Northern States Power Company–Minnesota. September 2011.

the reviews of the CLB documents, its scoping criteria, and the Figure 2-1 Flowchart of Scoping Evaluation contained in NUREG–1927 (NRC, 2011) to identify SSCs and their subcomponents that is within scope of license renewal.

Staff reviewed the licensee's scoping process, including a description of the scoping process and methodology, the CLB information, and the discussion needed to clarify the scoping process. Based on its review, the staff finds the licensee's scoping process acceptable.

2.1.2 Systems, Structures, and Components Within Scope of License Renewal

Based on the scoping process discussed earlier in Section 2.1.1, the licensee identified four main SSCs of the ISFSI that are within the scope of license renewal, and these are tabulated in Prairie Island ISFSI LRA (NSPM, 2011a, Table 2.4-1). Prairie Island ISFSI LAR also identified

SSCs that are not within scope and are not subject to an AMR. The SSCs within and not within scope of license renewal are presented in Table 2.1-3.

Table 2.1-3. Structures, Systems, and Components Within and Not Within Scope of License Renewal*

Structures, Systems and Components	Criterion 1	Criterion 2	In-Scope
Dry Storage Cask	Y	N/A	Y
Spent Fuel Assemblies	Y	N/A	Y
Reinforced Concrete Pads	Y	N/A	Y
Earthen Berm	N	Y	Y
ISFSI Pressure Monitoring System	N	N	N
Lighting	N	N	N
Security Fence and Gates	N	N	N
Transport and Supporting Equipment	N	N	N

*NSPM. "Prairie Island Independent Spent Fuel Storage Installation Application for Renewed ISFSI Site-Specific License." Materials License No. SNM-2506. Table 2.4-1. ML113040123. Minneapolis, Minnesota: Northern States Power Company–Minnesota. October 2011.

The SSCs identified in Table 2.1-3 to be within scope include:

- Dry Storage Casks
- Spent Fuel Assemblies
- Reinforced Concrete Pads
- Earthen Berm

The licensee stated these SSCs meet scoping Criterions 1 or 2 in Section 2.1 of this SER and were subject to an AMR (NSPM, 2011a). The casks, spent fuel assemblies, and reinforced concrete pads were identified as in-scope SSCs based upon Criterion 1. Although Tables 4.5-1 and A4.5-1 of Prairie Island ISFSI SAR (NSPM, 2011b) did not include the earthen berm, Prairie Island ISFSI, Section A7A.7.1 (NSPM, 2011b) takes credit for shielding for the presence of the earthen berm and its failure could prevent fulfillment of a function that is ITS. Because of this credit of earthen berm for shielding, the licensee included the earthen berm within scope of license renewal based upon Criterion 2, not ITS (or nonsafety related) as defined in Section 2.1 of this SER. The licensee stated (NSPM, 2013) that once the earthen berm is determined to be in-scope for license renewal, the AMR process and aging management programs are not dependent on which of the scoping criteria were met.

For the in-scope SSCs (Table 2.1-3), the licensee further identified and described the subcomponents that support the SSC safety function. In Prairie Island ISFSI LRA [NSPM (2011a, Section 2.3)], the licensee provided a description of these subcomponents based on the information available in the CLB documents and the licensee further determined that these subcomponents are subject to an AMR. Those components that were identified as not in-scope are excluded from AMR. These subcomponents of SSCs within scope of license renewal are provided in Table 2.1-4.

The subcomponents of SSCs classified by the licensee as ITS and not ITS but their failure would affect the ITS SSCs to perform their intended functions are provided in Tables 2.1-5 and 2.1-6 in this SER respectively.

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Table 2.1-4. Subcomponents of Structures, Systems and Components Within Scope of License Renewal*		
Dry Storage Casks	**Spent Fuel Assembly**	**Structure**
Shell	Fuel Cladding	Reinforced Concrete Pads
Lid	Fuel Cladding End Plug	Earthen Berm
Inner Containment	Guide Tube	—
Bottom	Grid Assembly, Mid Fuel Assembly	—
Bottom Inner Containment	Grid Assembly, Top & Bottom	—
Upper Trunnion	Bottom Nozzle	—
Lower Trunnion	Upper Nozzle	—
Shield Plate	—	—
Outer Shell	—	—
Top Neutron Shield	—	—
Top Neutron Shield Enclosure	—	—
Top Neutron Shield Bolts	—	—
Radial Neutron Shield	—	—
Radial Neutron Shield Box	—	—
Lid Bolts	—	—
Lid Seal (O-ring)	—	—
Vent Port Covers	—	—
Drain Port Covers	—	—
Drain and Vent Port Cover Bolts	—	—
Drain and Vent Port Cover Seats (O-ring)	—	—
Basket Rails	—	—
Fuel Compartment	—	—
Aluminum Plate	—	—
Poisson Plate	—	—
Containment Flange	—	—
*NSPM. "Prairie Island Independent Spent Fuel Storage Installation Application for Renewed ISFSI Site-Specific License." Materials License No. SNM-2506. Tables 2.4-2, 2.4-3, 2.4-4. ML113040123. Minneapolis, Minnesota: Northern States Power Company–Minnesota. October 2011.		

Staff reviewed the licensee's identification of the SSCs and subcomponents that are within the scope of license renewal, intended SSC safety functions, and safety classification or basis for inclusion in the license renewal scope.

The staff's review of the subcomponents is predicated on the understanding that subcomponents may degrade under different modes or variable rates. This consideration is important since the performance of the subcomponents could impact the performance of in-scope SSC during the period of extended operation. The staff notes that the licensee identified the earthen berm as a SSC within scope of license renewal, although it was not classified as safety-related or ITS in the ISFSI SAR (NSPM, 2011b). Based on its review, the staff finds the licensee's scoping analysis results acceptable.

Table 2.1-5. Subcomponents of Structures, Systems, and Components Classified by the Licensee as Important to Safety*		
Dry Storage Casks	**Spent Fuel Assembly**	**Structure**
Shell	Fuel Cladding	Reinforced Concrete Pads
Lid	Fuel Cladding End Plug	—
Inner Containment	Guide Tube	—
Bottom	Grid Assembly, Mid Fuel Assembly	—
Bottom Inner Containment	Grid Assembly, Top & Bottom	—
Upper Trunnion	Bottom Nozzle	—
Lower Trunnion	Upper Nozzle	—
Shield Plate	—	—
Outer Shell	—	—
Top Neutron Shield	—	—
Top Neutron Shield Enclosure	—	—
Top Neutron Shield Bolts	—	—
Radial Neutron Shield	—	—
Radial Neutron Shield Box	—	—
Lid Bolts	—	—
Lid Seal (O-ring)	—	—
Vent Port Covers	—	—
Drain Port Covers	—	—
Drain and Vent Port Cover Bolts	—	—
Drain and Vent Port Cover Seats (O-ring)	—	—
Basket Rails	—	—
Fuel Compartment	—	—
Aluminum Plate	—	—
Poisson Plate	—	—
Containment Flange	—	—

*NSPM. "Prairie Island Independent Spent Fuel Storage Installation Application for Renewed ISFSI Site-Specific License." Materials License No. SNM-2506. Tables 2.4-2, 2.4-3, 2.4-4. ML113040123. Minneapolis, Minnesota: Northern States Power Company–Minnesota. October 2011.

Table 2.1-6. Subcomponents of Structures, Systems, and Components Classified by the Licensee as NonImportant To Safety but Their Failure Would Affect the Important To Safety Structures, Systems, and Components to Perform Their Intended Functions		
Dry Storage Casks	**Spent Fuel Assembly**	**Structure**
None	None	Earthen Berm

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2.1.3 Systems, Structures, and Components NOT Within Scope of License Renewal

The licensee identified in Tables 2.4-1, 2.4-2, and 2.4-3 (NSPM, 2011a) SSCs and subcomponents of other SSCs that do not support SSC intended function and are not subject to an AMR. Table 2.1-7 provides a summary of these SSCs. This table shows that cask pressure monitoring system and ISFSI lighting, security fence and gates; and transporter and supporting equipment. The licensee stated that lighting, security fence and gates, and transfer and supporting equipment do not meet either of the scoping criteria and are not subject to an AMR. Sections 4.5.4 and A4.5.4 of Prairie Island ISFSI SAR (NSPM, 2011b) stated that neither the protective weather cover and overpressure systems of TN-40 and TN-40HT casks nor the pressure monitoring system serve any safety function. Licensee's analyses in the Prairie Island ISFSI SAR (NSPM, 2011b, Section A7A.8.6) showed that all applicable dose acceptance criteria would be satisfied even if the pressure-monitoring system was not functioning properly. These analyses also showed that in the case of a latent seal failure and the removal of the pressure monitoring system due to an accident, there would be time to recover from the condition prior to exceeding the applicable dose acceptance criteria. Furthermore, an AMR would not be required because the instrumentation in the pressure monitoring system is an active component.

In Tables 2.4-2 and 2.4-3 of the Prairie Island ISFSI LRA (NSPM, 2011a), the licensee identified the subcomponents of dry storage casks and spent fuel assemblies, respectively that are not within scope of license renewal. The subcomponents in these tables are consistent with those presented in the CLB document, Prairie Island ISFSI SAR (NSPM, 2011b) Tables 4.5-1 and A4.5-1.

Staff reviewed the licensee's identification of SSCs and subcomponents that are not within the scope of renewal and basis for exclusion from the renewal scope. Staff finds that the lighting, security fence and gates, and transfer and supporting equipment are not within the scope of license renewal because they do not meet either of the scoping criteria. Staff notes that the licensee demonstrated through analyses that all applicable dose acceptance criteria would be satisfied even if the pressure monitoring system were not functioning properly. The staff reviewed the licensee's analysis and found it acceptable. On this basis, the staff determined that the licensee's scoping of the pressure monitoring system as not-in-scope acceptable because the pressure monitoring system does not serve a direct safety function and its failure would not prevent any ITS from fulfilling its function. Staff finds that the licensee has conducted appropriate analyses of confinement systems in support of the scoping evaluation.

The staff also finds that the licensee has accurately identified the subcomponents of dry storage casks and fuel assemblies that are not within scope of license renewal.

2.2 Evaluation Findings

The staff reviewed the Prairie Island Nuclear Generation Plant ISFSI License Renewal Application and supplemental information as identified in the responses to the staff's Observations, Requests for Supplemental Information, and Requests for Additional Information. Based on its review of this information, representations, and supplements (NSPM, 2010a,b; NSPM, 2011a,b; NSPM, 2012a,b; 2013, 2014) the staff finds:

Table 2.1-7. Subcomponents of Structures, Systems, and Components Identified by the Licensee as Not Within the Scope of License Renewal*			
Dry Storage Casks	**Spent Fuel Assembly**	**Structures**	**Other Structures, Systems, and Components**
Protective Cover	Fuel Assembly Insert	None	Independent Spent Fuel Storage Installation Pressure Monitoring System
Protective Cover Bolt	Fuel Pallet	—	Lighting
Protective Cover Seal (O-ring)	Fuel Rod Spring	—	Security Fence and Gates
Overpressure Port Cover	—	—	Transporter and Supporting Equipment
Overpressure Port Cover Seal (O-ring)	—	—	—
Overpressure Tank, Isolation Valves and Tubing	—	—	—
Vent and Drain Quick Disconnects	—	—	—
Overpressure Port Cover Bolts	—	—	—
Lid Alignment Pins	—		—
*NSPM. "Prairie Island Independent Spent Fuel Storage Installation Application for Renewed ISFSI Site-Specific License." Materials License No. SNM-2506. Tables 2.4-1, 2.4-2, 2.4-3. ML113040123. Minneapolis, Minnesota: Northern States Power Company–Minnesota. October 2011.			

The staff reviewed the general information on the scoping and screening methodology provided by the licensee, including a list of the source for CLB information and definitions of scoping criteria. Based on its review, the staff finds the licensee's scoping and screening methodology acceptable. The staff further concludes:

F2.1 The licensee has identified all SSCs ITS and SSCs whose failure could prevent a SSC from performing its function per the requirements of 10 CFR 72.3, 10 CFR 72.24, 10 CFR 72.42, 10 CFR 72.120, 10 CFR 72.122(l), ~~and~~ 72.126(a), and 72.128(a).

F2.2 The justification for any SSC determined not to be within the scope of the license renewal is adequate and acceptable.

The staff performed its review following the guidance provided in NUREG–1927, "Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance" (NRC, 2011) and ISGs as identified in Table 1-1. The staff also used the information provided in NUREG/CR–6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety" ~~Classification of Transportation Packaging and Dry Spent Fuel Storage~~ (NRC, 1996) for system and component classification in its review of the licensee's scoping analyses.

~~Staff reviewed the general information on the scoping and screening methodology provided by the licensee, including a list of the source for CLB information and definitions of scoping criteria. Staff finds the licensee's scoping and screening methodology acceptable.~~ ~~System Components According to Importance to Safety," issued February 1996, in its review as a reference for~~

Comment [JN10]: Nate/Zhian discuss whether this needed since it is not in 1927.

ZL:
It is the requirements for design basis functions, therefore should be included. I also added 72.128(a) which provides general requirements for spent fuel and GTCC storage system. 72.13 indicates that both articles, 72.126 and and 72.128 apply to site specific ISFSI.

Regarding the question on if these artciels are included in NUREG-1927, I would say we have to correct/improve 1927 given the known defifiencies of the guidance ☺.

~~classification of components as ITS to determine the accuracy and completeness of the licensee's scoping study.~~

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3 AGING MANAGEMENT REVIEW

3.1 Review Objective

The objective of the staff's review of the aging management review (AMR) is to determine if the licensee has adequately performed a review of applicable materials, environment, aging mechanisms and effects~~;~~ and identified appropriate ~~the~~ aging management activities for in-scope structures, systems, and components (SSCs).

3.2 AMR Process

The licensee's AMR identified the aging mechanisms and aging effects applicable to each SSC based on its material of construction and service environment. For each aging mechanism/effect, the licensee further identified either a time-limited aging analysis or an aging management program (AMP) to ensure the intended function of the SSC would be maintained during the period of extended operation.

The staff reviewed the licensee's AMR process, including a description of the review process, the CLB information, and the discussion needed to clarify the AMR. Based on its review, the staff finds that the licensee's AMR process is comprehensive and therefore acceptable because the AMR process provides a reasonable assurance that all plause aging mechanisms/effects are identfied.

3.3 Aging Management Review Results: Materials, Service Environment, Aging Effects, and Aging Management Programs

Based on its AMR, the licensee identified the aging mechanisms and aging effects of applicable SSCs with respect to the materials that they are constructed from and the service environment they reside in. Tables 3-1, 3-2, and 3-3 provide the results of the licensee's AMR and the AMPs it plans to apply to effect aging management of the identified SSCs during the period of extended operation. The data listed in Tables 3-1, 3-2, and 3-3 reflect information in the application as supplemented by the Responses to requests for additional information (RAI).

3.3.1 Cask Body/Subcomponents

The licensee identified the following subcomponents of the TN-40 and TN-40HT casks in LRA Section 2.3.1 as safety-related and within the scope of renewal:

- Inner shell and bottom (DSC-1 through DSC-3, DSC-8, DSC-9)
- Inner containment and bottom inner containment (DSC-6, DSC-7, DSC-10, DSC-11)
- Lid (DSC-4, DSC-5)
- Lid bolts and seals (DSC-31 through DSC-33)
- Upper and lower trunnion (DSC-12, DSC-13)
- Gamma shield plate (DSC-14, DSC-15)
- Outer shell (DSC-16, DSC-17)
- Top and radial neutron shield (DSC-18 through DSC-21, DSC-25 through DSC-28)
- Top neutron shield enclosure and bolts (DSC-22 through DSC-24)
- Aluminum radial neutron shield box (DSC-29, DSC-30)
- Drain and vent port covers (DSC-34 through DSC-37)
- Drain and vent port cover bolts and seals (DSC-38 through DSC-40)

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- Basket rails (DSC-41)
- Fuel compartment (DSC-42)

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Table 3-1. Aging Management Review Results—Dry Storage Cask

Item No.	Component Name	In Scope Classification Criterions 1 or 2	Materials	Environment[1, 2, 3, 4]	Aging Effect/Mechanism	AMR SER Section	AMP SER Section
DSC-1	Shell	1	Carbon Steel	(I) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-2	Shell	1	Carbon Steel	(E) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-3	Shell	1	Carbon Steel	(E) Atmosphere/Weather	Loss of material due to general, crevice, and pitting corrosion	3.3.1	3.5.1.1
DSC-4	Lid	1	Carbon Steel	(I) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-5	Lid	1	Carbon Steel	(E) Atmosphere/Weather	Loss of material due to general, crevice, pitting, and galvanic corrosion	3.3.1	3.5.1.1
DSC-6	Inner Containment	1	Nickel-Based Alloys	(I) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-7	Inner Containment	1	Nickel-Based Alloys	(E) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-8	Bottom	1	Carbon Steel	(I) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-9	Bottom	1	Carbon Steel	(E) Atmosphere/Weather	Loss of material due to general, crevice, and pitting corrosion	3.3.1	3.5.1.1
DSC-10	Bottom Inner Containment	1	Nickel-Based Alloys	(I) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-11	Bottom Inner Containment	1	Nickel-Based Alloys	(E) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-12	Upper Trunnion	1	Carbon Steel	(E) Atmosphere/Weather	Loss of material due to general, crevice, and pitting corrosion	3.3.1	3.5.1.1
DSC-13	Lower Trunnion	1	Carbon Steel	(E) Atmosphere/Weather	Loss of material due to general, crevice, and pitting corrosion	3.3.1	3.5.1.1
DSC-14	Shield Plate	1	Carbon Steel	(I) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-15	Shield Plate	1	Carbon Steel	(E) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-16	Outer Shell	1	Carbon Steel	(I) Air/Gas	None/NA	3.3.1	3.5.1.1

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Table 3-1. Aging Management Review Results—Dry Storage Cask (continued)

Item No.	Component Name	In Scope Classification Criterions 1 or 2	Materials	Environment[1, 2, 3, 4]	Aging Effect/Mechanism	AMR SER Section	AMP SER Section
DSC-17	Outer Shell	1	Carbon Steel	(E) Atmosphere/Weather	Loss of material due to general, crevice, and pitting corrosion	3.3.1	3.5.1.1
DSC-18	Top Neutron Shield	1	Polypropylene	(E) Air/Gas/Heat/Neutron and Gamma Radiation[5]	Cracking due to material property changes ~~from~~caused by heat and radiation exposure	3.3.4	3.5.1.2
DSC-19	Top Neutron Shield	1	Polypropylene	(E) Air/Gas/Heat/Neutron and Gamma Radiation[5]	Embrittlement due to property changes resulting from heat and radiation exposure	3.3.4	3.5.1.2
DSC-20	Top Neutron Shield	1	Polypropylene	(E) Air/Gas/Heat/Neutron and Gamma Radiation[5]	Loss of elasticity due to property changes resulting from heat and radiation exposure	3.3.4	3.5.1.2
DSC-21	Top Neutron Shield	1	Polypropylene	(E) Air/Gas/Heat/Neutron and Gamma Radiation[5]	Radiolytic decomposition due to ~~property changes from~~ radiation exposure	3.3.4	3.5.1.2
DSC-22	Top Neutron Shield Enclosure	1	Carbon Steel	(I) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-23	Top Neutron Shield Enclosure	1	Carbon Steel	(E) Atmosphere/Weather	Loss of material due to general, crevice, and pitting corrosion	3.3.1	3.5.1.1
DSC-24	Top Neutron Shield Bolts	1	Carbon Steel	(E) Atmosphere/Weather	Loss of material due to general, crevice, and pitting corrosion	3.3.1	3.5.1.1
DSC-25	Radial Neutron Shield	1	Borated Polyester	(E) Air/Gas/Heat/Neutron and Gamma Radiation[5]	Cracking due to material property changes ~~from~~ resulting from heat	3.3.4	3.5.1.2

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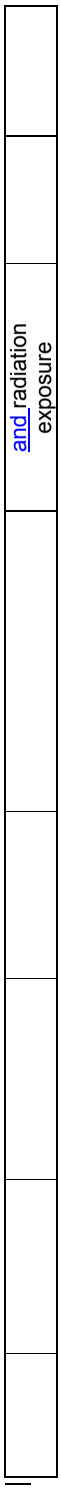

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Table 3-1. Aging Management Review Results—Dry Storage Cask (continued)

Item No.	Component Name	In Scope Classification Criterions 1 or 2	Materials	Environment[1, 2, 3, 4]	Aging Effect/Mechanism	AMR SER Section	AMP SER Section
DSC-26	Radial Neutron Shield	1	Borated Polyester	(E) Air/Gas/Heat/Neutron and Gamma Radiation[5]	Embrittlement due to property changes resulting from heat and radiation exposure	3.3.4	3.5.1.2
DSC-27	Radial Neutron Shield	1	Borated Polyester	(E) Air/Gas/Heat/Neutron and Gamma Radiation[5]	Loss of elasticity due to property changes resulting from and heat radiation exposure	3.3.4	3.5.1.2
DSC-28	Radial Neutron Shield	1	Borated Polyester	(E) Air/Gas/Heat/Neutron and Gamma Radiation[5]	Radiolytic decomposition due to ~~property changes from~~ radiation exposure	3.3.4	3.5.1.2
DSC-29	Radial Neutron Shield Box	1	Aluminum	(I) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-30	Radial Neutron Shield Box	1	Aluminum	(E) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-31	Lid Bolts	1	Carbon Steel	(E) Atmosphere/Weather	Loss of material due to general, crevice, pitting, and galvanic corrosion	3.3.2	3.5.1.1
DSC-32	Lid Seal (O-ring)	1	Aluminum	(I) Air/Gas	None/NA	3.3.3	3.5.1.1
DSC-33	Lid Seal (O-ring)	1	Aluminum	(E) Atmosphere/Weather (outer)	Loss of material due to crevice, pitting, and galvanic corrosion	3.3.3	3.5.1.1
DSC-34	Vent Port Covers	1	Stainless Steel	(I) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-35	Vent Port Covers	1	Stainless Steel	(E) Atmosphere/Weather	Loss of material due to crevice and pitting corrosion	3.3.1	3.5.1.1

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Table 3-1. Aging Management Review Results—Dry Storage Cask (continued)							
Item No.	**Component Name**	**In Scope Classification Criterions 1 or 2**	**Materials**	**Environment[1, 2, 3, 4]**	**Aging Effect/Mechanism**	**AMR SER Section**	**AMP SER Section**
DSC-36	Drain Port Covers	1	Stainless Steel	(I) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-37	Drain Port Covers	1	Stainless Steel	(E) Atmosphere/Weather	Loss of material due to crevice and pitting corrosion	3.3.1	3.5.1.1
DSC-38	Drain and Vent Port Cover Bolts	1	Carbon Steel	(E) Atmosphere/Weather	Loss of material due to general, crevice, pitting, and galvanic corrosion	3.3.2	3.5.1.1
DSC-39	Drain and Vent Port Covert Seals (O-ring)	1	Aluminum	(I) Air/Gas	None/NA	3.3.3	3.5.1.1
DSC-40	Drain and Vent Port Covert Seals (O-ring)	1	Aluminum	(E) Atmosphere/Weather	Loss of material due to crevice, pitting, and galvanic corrosion	3.3.3	3.5.1.1
DSC-41	Basket Rails	1	Aluminum	(E) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-42	Fuel Compartment	1	Stainless Steel	(E) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-43	Aluminum Plate	1	Aluminum	(I) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-44	Aluminum Plate	1	Aluminum	(E) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-45	Poisson Plate	1	Borated Compounds	(E) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-46	Containment Flange	1	Carbon Steel	(I) Air/Gas	None/NA	3.3.1	3.5.1.1
DSC-47	Containment Flange	1	Carbon Steel	(E) Air/Gas	None/NA	3.3.1	3.5.1.1

Comment [ZL11]: Heat transfer function only.

Comment [ZL12]: Poison plates do not serve as structural functions.

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Table 3-1. Aging Management Review Results—Dry Storage Cask (continued)

Item No.	Component Name	In Scope Classification Criterions 1 or 2	Materials	Environment[1, 2, 3, 4]	Aging Effect/Mechanism	AMR SER Section	AMP SER Section
DSC-48	Containment Flange	1	Carbon Steel	(E) Atmosphere/Weather	Loss of material due to general, crevice, pitting, and galvanic corrosion	3.3.1	3.5.1.1
DSC-49[6]	Containment Flange	1	Stainless Steel	(E) Atmosphere/Weather	Loss of material due to crevice and pitting corrosion	3.3.1	3.5.1.1

[1]Some of the subcomponents may be exposed to both (I) internal and (E) environments.

[2]The licensee stated that the (I) Air/Gas environment refers to the initial helium fill gas and trace amounts of other gases, such as Nitrogen, Oxygen, Argon, and fission product gases.

[3]The licensee stated that the (E) Air/Gas environment includes potential off-gases of the enclosed neutron shields.
[4]The licensee stated that the (E) Atmosphere/Weather environment refers to an outdoor environment including humidity, precipitation, ultraviolet radiation, ozone, and wind. The air temperature was stated to range from -35F to 100F.

[5]The staff has modified the environment of the top and radial neutron shield to include heat, and neutron and gamma radiation, per responses included in the supplemented LRA (NSPM, 2014).

[6]DSC-49 refers to an overlay of subcomponent DSC-48.

Comment [ZL13]: Do you mean these components with note 1?

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Table 3-2. Aging Management Review Results—Spent Fuel Assembly							
Item No.	**Component Name**	**In Scope Classification Criterions 1 or 2**	**Materials**	**Environment[1]**	**Aging Effect/Mechanism**	**AMR SER Section**	**AMP SER Section**
SFA-1	Fuel Cladding	1	Zirconium-Based Alloys	(I) Air/Gas	None/NA	3.3.5	3.5.2
SFA-2	Fuel Cladding	1	Zirconium-Based Alloys	(E) Air/Gas	None/NA	3.3.5	3.5.2
SFA-3	Fuel Cladding End Plug	1	Zirconium-Based Alloys	(E) Air/Gas	None/NA	3.3.5	3.5.2
SFA-4	Guide Tube	1	Zirconium-Based Alloys	(I) Air/Gas	None/NA	3.3.5	3.5.2
SFA-5	Guide Tube	1	Zirconium-Based Alloys	(E) Air/Gas	None/NA	3.3.5	3.5.2
SFA-6	Grid Assembly, Mid Fuel Assembly	1	Zirconium-Based Alloys	(E) Air/Gas	None/NA	3.3.5	3.5.2
SFA-7	Grid Assembly, Top & Bottom	1	Nickel-Based Alloys	(E) Air/Gas	None/NA	3.3.5	3.5.2
SFA-8	Bottom Nozzle	1	Stainless Steel	(E) Air/Gas	None/NA	3.3.5	3.5.2
SFA-9	Upper Nozzle	1	Stainless Steel	(E) Air/Gas	None/NA	3.3.5	3.5.2
[1]Section 3.3.5.1 provides the licensee's definition of the environments of the spent fuel assemblies.							

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Table 3-3. Aging Management Review Results—Concrete Pads and Earthen Berm

Item No.	Component Name	In Scope Classification Criterions 1 or 2	Materials	Environment[1, 2]	Aging Effect/Mechanism	AMR SER Section	AMP SER Section
STR-1	Reinforced Concrete Pads	1	Reinforced Concrete	(E) Atmosphere/Weather	Change in material properties due to leaching of $Ca(OH)_2$	3.3.6	3.5.1.3
STR-2	Reinforced Concrete Pads	1	Reinforced Concrete	(E) Atmosphere/Weather	Cracking due to freeze-thaw	3.3.6	3.5.1.3
STR-3	Reinforced Concrete Pads	1	Reinforced Concrete	(E) Atmosphere/Weather	Cracking due to reaction with aggregates	3.3.6	3.5.1.3
STR-4	Reinforced Concrete Pads	1	Reinforced Concrete	(E) Atmosphere/Weather	Loss of material due to freeze-thaw	3.3.6	3.5.1.3
STR-5	Reinforced Concrete Pads	1	Reinforced Concrete	(E) Soil (Buried)	Change in material properties due to leaching of $Ca(OH)_2$	3.3.6	3.5.1.3
STR-6	Reinforced Concrete Pads	1	Reinforced Concrete	(E) Soil (Buried)	Cracking due to reaction with aggregates	3.3.6	3.5.1.3
STR-7	Reinforced Concrete Pads	1	Reinforced Concrete	(E) Soil (Buried)	Cracking due to settlement	3.3.6	3.5.1.3
STR-8	Reinforced Concrete Pads	1	Reinforced Concrete	(E) Atmosphere/Weather	Cracking and loss of material due to chemical attack	3.3.6	3.5.1.3
STR-9	Reinforced Concrete Pads	1	Reinforced Concrete	(E) Soil (Buried)	Cracking and loss of material due to chemical attack	3.3.6	3.5.1.3
STR-10	Reinforced Concrete Pads	1	Reinforced Concrete	(E) Atmosphere/Weather	Cracking, loss of material, and loss of bond due to corrosion of embedded steel	3.3.6	3.5.1.3
STR-11	Reinforced Concrete Pads	1	Reinforced Concrete	(E) Soil (Buried)	Cracking, loss of material, and loss of bond due to corrosion of embedded steel	3.3.6	3.5.1.3
STR-12	Earthen Berm	2	Soil	(E) Atmosphere/Weather	Change in material properties due to desiccation	3.3.7	3.5.1.4

Comment [JN14]: Ricardo to ensure AMR addresses loss of material.

Official Use Only—Pre-decisional

Official Use Only—Predecisional

Table 3-3. Aging Management Review Results—Concrete Pads and Earthen Berm (continued)

Item No.	Component Name	In Scope Classification Criterions 1 or 2	Materials	Environment[1, 2]	Aging Effect/Mechanism	AMR SER Section	AMP SER Section
STR-13	Earthen Berm	2	Soil	(E) Atmosphere/Weather	Loss of form due to settlement	3.3.7	3.5.1.4
STR-14	Earthen Berm	2	Soil	(E) Atmosphere/Weather	Loss of form due to frost action	3.3.7	3.5.1.4
STR-15	Earthen Berm	2	Soil	(E) Atmosphere/Weather	Loss of material due to erosion (wind/rain impact)	3.3.7	3.5.1.4

[1]The licensee stated that the (E) Atmosphere/Weather environment refers to an outdoor environment including humidity, precipitation, ultraviolet radiation, ozone, and wind. The air temperature was stated to range from −35F to 100F.

[2]The licensee stated that (E) Soil (Buried) environment as the below-grade section of the concrete.

DRAFT

Official Use Only—Predecisional

- Aluminum and poison plates (DSC-43 through DSC-45)
- Containment flange (DSC-46 through DSC-49)

Comment [ZL15]: Why are these two items listed here rather than in one of the Tables?

The licensee summarized the AMR results for the cask subcomponents in LRA Table 3.2-1. The staff's evaluation of the AMR results for the cask body and associated subcomponents is provided in this section. The reviews of the AMR results for the closure bolts, cask seals, and neutron shield subcomponents are documented in Sections 3.3.2, 3.3.3, and 3.3.4 of this SER, respectively.

3.3.1.1 **Materials and Environments**

The licensee identified the materials of construction for individual cask subcomponents that were subject to AMR in LRA Table 3.2-1 (NSPM, 2011a). The staff reviewed the ISFSI design bases and confirmed that the licensee adequately identified the materials of construction of the cask body and associated subcomponents.

The licensee described the environments experienced by the cask body and associated subcomponents as either external or internal environments. The licensee noted the climatological data in Figure 2.3-1A of the PINGP USAR (NSPM, 2010b), which states that the external environment of the casks is bounded by the air temperature range of −37 to 38 °C [−35 to 100 °F]. The licensee defined the external environment of the casks as the outdoor atmosphere and weather environment that includes humidity, precipitation, ultraviolet radiation, ozone, and wind conditions. In LRA Table 3.2-1 (NSPM, 2011a), the external air and gas environment is stated to include the potential off gases from the enclosed neutron shields.

The internal environment of the casks refers to the air and gas environment. The casks were filled with helium gas and sealed prior to being trasnfered to the ISFSI during loading operations. The licensee assumed the internal air and gas environment to be the original helium fill gas and trace amounts of other gases, such as nitrogen, oxygen, argon, and fission product gases. The licensee stated that the maximum internal pressure and average gas temperature for the TN-40HT casks were 1.2×10^5 Pa [17.5 psig] and 235 °C [456 °F], respectively. The licensee further stated that these values bound those for the TN-40 casks. The gas temperature and corresponding pressure would decrease over time. The licensee also stated that the fast neutron fluence inside a TN-40HT cask is on the order of 10^{14} n/cm^2 after 25 years of storage, which is below the neutron embrittlement threshold value of 10^{17} n/cm^2.

The staff reviewed the licensee's description of the environments for the cask body and associated subcomponents. The staff reviewed Figures (2.3-1a,b,c) in Section 2.3 of the PINGP USAR (NSPM, 2010b) and confirmed that the licensee adequately defined the climatic characteristics of the site region. The staff also reviewed the PINGP ISFSI SAR (NSPM, 2011b) and confirmed the values reported for the internal cask pressure and temperature (Section A3.3.2.2.6), as well as the value for the fast neutron fluence (Section A4.2.3.5). Based on its review, the staff finds the licensee's identification of the environments for the cask body and associated subcomponents acceptable.

3.3.1.2 Aging Mechanisms/Effects on the Cask Body/Subcomponents During the Period of Extended Storage

The licensee identified loss of material due to various corrosion mechanisms as the aging effects of the cask body and associated subcomponents exposed to outdoor atmosphere and weather environment.

NRC requested the licensee to define the ~~aging effect meant by the phrase~~term "measureable loss of material" used in the supplemented LRA (NSPM, 2014). The staff accepts the licensee's definition of this phrase to mean that inspectors do not observe any depth to the corrosion and corrosion product stains. Staff expectations are that the licensee will include this definition into their AMP and SAR.

Comment [ZL16]: Condition or just expectation?

The aging effects/mechanisms identified include the following:

1. Loss of material due to crevice corrosion for external aluminum, carbon steel, or stainless steel surfaces of the casks.

2. Loss of material due to galvanic corrosion for external carbon steel or aluminum surfaces of the casks in contact with stainless steel.

3. Loss of material due to general corrosion for external carbon steel surfaces of the casks.

4. Loss of material due to pitting corrosion for external aluminum, carbon steel, or stainless steel surfaces of the casks.

The licensee stated that no aging mechanisms and effects were identified for the cask body and associated subcomponents exposed to the air/gas environments.

Comment [ZL17]: Why discuss it here? Is this a special case that needs to be singled out?

The staff reviewed the licensee's identification of aging mechanisms and effects for the cask body and associated subcomponents. Based on its review of the credible aging effects listed in NUREG–1801 (NRC, 2010b) and the operating experience provided in Section 2.0 of Appendix A to the LRA Rev. 1 (NSPM, 2014), the staff determined that the licensee performed a comprehensive AMR for the material and environment combinations. The staff finds the licensee's identification of aging effects for the cask body and associated subcomponents acceptable.

3.3.1.3 Evaluation of Proposed Aging Management Activities

The licensee credited the ISFSI Inspection and Monitoring Program to manage the identified aging effects for the cask body and associated subcomponents during the extended period of operation. The staff reviewed the license renewal application and references therein, including design bases and operating experience reports. Based on its review of the application and other publically available literatures, ~~and~~ the staff concluded that an AMP is an acceptable way for ensuring that the identified aging effects will not result in a loss of intended function.

3.3.2 Closure Bolts

The licensee identified two types of closure bolts, the lid bolts (DSC-31) and the drain and vent port cover bolts (DSC-38). The licensee stated that the closure bolts secure the lid, and that the

drain and vent port covers are bolted to the lid. The closure lid bolts to the cask body to ensure that the intended functions of confinement and structural integrity are maintained.

3.3.2.1 **Materials and Environments**

The licensee identified the material of construction for the closure bolts as carbon steel. The licensee described the environment experienced by the closure bolts as the outdoor atmosphere and weather environment that includes humidity, precipitation, ultraviolet radiation, ozone, and wind conditions.

The staff reviewed the licensee's description of material and environment for the closure bolts. The staff reviewed the ISFSI design bases and confirmed that the licensee adequately identified the material of construction of the cask bolts. The staff reviewed the pertinent sections of the PINGP USAR (NSPM, 2010b) and PINGP ISFSI SAR (NSPM, 2011b) and confirmed that the licensee has adequately identified the material of construction and the service environment for the closure bolts. Based on its review, the staff finds the licensee's identification of material and environment for the closure bolts acceptable.

3.3.2.2 **Aging Mechanisms/Effects on the Closure Bolts**

The licensee identified that the closure bolts exposed to outdoor atmosphere and weather environment are subject to loss of material due to general, crevice, pitting, or galvanic corrosion. The licensee further stated that these aging effects may lead to loss of the intended function of the closure bolts during the period of extended operation.

The staff reviewed the licensee's identification of aging effects for the closure bolts. Based on its review of the credible aging effects listed in NUREG–1801 (NRC, 2010b) and the operating experience provided in Section 2.0 of Appendix A to the LRA Rev. 1, the staff determined that the licensee performed a comprehensive AMR for the material and environment combinations. The staff finds the licensee's identification of aging effects for the closure bolts acceptable.

3.3.2.3 **Evaluation of Proposed Aging Management Activities**

The licensee credited the ISFSI Inspection and Monitoring Program to manage the loss of material aging effects due to general, crevice, pitting, and galvanic corrosion for the closure bolts during the renewal license period. The staff reviewed the license renewal application and references therein, including design bases and operating experience reports, and concluded that an AMP is an acceptable way for ensuring the identified aging effects will not result in a loss of intended function.

3.3.3 Cask Seals

The licensee stated that there are three access ports in the cask lid equipped with Helicoflex metallic O-ring seals. The vent and drain port covers have two O-ring seals (DSC-39, DSC-40), while the overpressure port cover has one O-ring seal (DSC-32, DSC-33). The licensee also stated that the metallic O-ring seals possess long-term stability and high corrosion resistance to ensure tight and permanent containment.

3.3.3.1 **Materials and Environments**

The licensee identified the material of construction for the metallic O-ring seals of the cask lid as aluminum. The licensee differentiated the environments experienced by the cask seals as either external or internal environments. The licensee stated that the external environment of the cask seals is the outdoor atmosphere and weather environment, which were defined to include humidity, precipitation, ultraviolet radiation, ozone, and wind conditions. The licensee also stated that the internal air and gas environment of the cask seals is assumed to be the original helium fill gas and trace amounts of other gases, such as nitrogen, oxygen, argon, and fission product gases.

The staff reviewed the licensee's description of material and environments for the cask seals. The staff reviewed the ISFSI design bases and confirmed that the licensee adequately identified the materials of construction of the cask seals. The staff reviewed the pertinent sections of the PINGP USAR (NSPM, 2010b) and PINGP ISFSI SAR (NSPM, 2011b) and confirmed that the licensee adequately identified the material of construction and the service environments for the cask seals because the shells are exposed to inner air/gas on its surface as part of confinement boundary and the outer surface of the seals are facing abinet environment. Based on its review, the staff finds the licensee's identification of material and environments for the cask seals acceptable.

3.3.3.2 **Aging Mechanisms/Effects on the Cask Seals**

The licensee identified that the cask seals are exposed to outdoor atmosphere and weather environments, and are subject to loss of material due to crevice, pitting, or galvanic corrosion. The licensee further stated that these aging effects may lead to loss of the intended function of the cask seals during the period of extended operation.

The licensee stated that no aging mechanisms and effects were identified for the cask seals exposed to the air/gas environments.

The staff reviewed the licensee's identification of aging effects for the cask seals. Based on its review of the credible aging effects listed in NUREG–1801 (NRC, 2010b) and the operating experience provided in Section 2.0 of Appendix A to the LRA Rev. 1, the staff determined that the licensee performed a comprehensive AMR for the material and environment combinations. The staff finds the licensee's identification of aging effects for the cask seals acceptable.

3.3.3.3 **Evaluation of Proposed Aging Management Activities**

The licensee credited the ISFSI Inspection and Monitoring Program to manage the loss of material due to crevice, pitting, and galvanic corrosion for the cask seals during the renewal license period. The staff reviewed the license renewal application and references therein, including design bases and operating experience reports, and concluded that an AMP is acceptable for ensuring the identified aging effects will not lead to a loss of intended function.

3.3.4 Neutron Shield

Both TN-40 and TN-40HT casks use polymer-based neutron shields to reduce neutron radiation to assure that the ISFSI continue to meet the dose limits prescribed by 10 CFR 72.104 and the exposure control requirements of 10 CFR 72.126 (a), as well as design basis radiation

protection features that the licensee credited in Section A7.3 of the PINGP USAR (NSPM, 2010b).

3.3.4.1 **Materials and Environments**

Both TN-40 and TN-40HT have a top neutron shield and a radial neutron shield. The top neutron shield is a polypropylene disk encased in a carbon steel enclosure. The radial neutron shield uses borated polyester resin cast into slender aluminum tubes.

The licensee performed an AMR on the neutron shields and identified the applicable materials and service environments. Table 3-1 of this Safety Evaluation Report (SER) documents the licensee's final AMR results with a detailed breakdown into subcomponents. These subcomponents included in Table 3-1 (with item ID in parenthesis) are the top neutron shield (DSC-18 through DSC-21), the top neutron shield enclosure (DSC-22, DSC-23), top neutron shield bolts (DSC-24), radial neutron shield (DSC-25 through DSC-28), and radial neutron shield box (DSC-29, DSC-30).

The neutron shield is exposed to both high-energy radiation and heat that is generated by the spent fuel. The heat is primarily from the decay heat of the radioactive materials within the fuel. In addition, the licensee identified that the various subcomponents of the neutron shields are also exposed to the external air/gas environments. The licensee stated that the air/gas environment, defined as "(E) Air/Gas," in Table 3-1, was assumed to be the original helium fill gas and potential off-gases from the enclosed neutron shields.

The staff reviewed the design of the TN-40 and TN-40HT casks and the AMR results for the materials and service environment of the neutron shields. Based on its review, the staff finds that the licensee has adequately identified the materials and the service environments of the neutron shields and hence the results are acceptable.

3.3.4.2 **Aging Mechanisms/Effects on the Neutron Shield**

The licensee identified the following aging effects/mechanisms that could lead to a loss of design safety function of the neutron shield:

1. Cracking due to material property changes resulting from heat and radiation exposure
2. Embrittlement due to property changes resulting from heat and ~~from~~ radiation
3. Loss of elasticity due to property changes resulting from heat and ~~from~~ radiation exposure
4. Radiolytic decomposition due to ~~property changes from radiation~~ exposure to radiation

The licensee identified embrittlement, loss of elasticity, cracking, and radiolytic decomposition as possible aging effects of the polymer materials that could impede the neutron shield from fulfilling its design basis function due to the following three mechanisms:

1. Loss of neutron moderation capability because of material thinning as a result of radiolytic decomposition of the polymer material.

2. Loss of neutron moderation capability because of the streaming paths formed by the cracks.

Comment [JN18]: This is not in Appendix C of the LRA. Need to ensure applicant includes in revised Appendix C (see Introduction comment).

ZL:

This is included in the response to the second round RAI #10.

3. Loss of B-10 due to material redistribution as a result of polymer material shrinking or to a lesser degree, loss of B-10 due to depletion.

The net results of these aging effects are an increase in the number of neutrons coming out of the cask surface and an increase in neutron energy (i.e., an upward shifting of neutron spectrum).

Based on literature review, research results, and operating experience (NRC, 2010b; Liu, et al., 2013; McManus and Chamis, 1996; Fu, et al., 1988; Cota, et al., 2007), when exposed to high-energy radiations and heat, polymer materials will degrade and the major aging effects of such degradations includes loss of materials due to shrink and development of cracks are the two primary aging effects. Loss of B-10 due to depletion caused by $^{10}B(n, \alpha)$ reactions is a plausible but has a much less significant aging effect because of the amount of ^{10}B loaded in the neutron shield is much more than needed for the cask's shielding need. The licensee identified that exposure of the polymer-based neutron shield to the air/gas environments has no aging effects.

The licensee also identified loss of material due to various corrosions on the carbon steel top neutron shield enclosure and bolts exposed to outdoor atmosphere and weather environment. The licensee identified that the aluminum radial neutron shield boxes holding the borated polyester neutron exposed to the air/gas environments has no aging effect. The staff's review of the AMR results on the carbon steel neutron shield enclosure and bolts are documented in Sections 3.3.1 and 3.3.2 of this SER, respectively.

The staff reviewed the licensee's AMR process and results on the neutron shield. Based on its review and the referenced publications, the staff determined that the licensee has adequately identified the aging mechanisms and aging effects that may result in loss of the intended safety functions of the neutron shields and hence the licensee AMR results are acceptable.

3.3.4.3 Evaluation of Proposed Aging Management Activities

The licensee credited the ISFSI Inspection and Monitoring Activities Program to manage the aging effects of the neutron shields. This program has a component in each element of the AMP for monitoring the performance of the neutron shields to assure that the neutron shield will maintain its intended function during the period of extended operation.

The staff reviewed the AMR process and the AMR results for the neutron shields. Based on its review of the information and representation from the licensee and publicly available technical publications (NRC, 2010b; Liu, et al., 2013; McManus and Chamis, 1996; Fu, et al., 1988; Cota, et al., 2007), the staff finds that the licensee has adequately identified the materials, environment, aging mechanisms and aging effects. Based on its review, the staff determined that the AMR performed by the licensee is correct and acceptable.

3.3.5 Spent Fuel Assemblies

The licensee stated that each cask at the ISFSI contains 40 pressurized water reactor (PWR) spent fuel assemblies which, at the time of loading, had a maximum heat generation limit of less than 0.675 kilowatt per assembly for fuel stored in a TN-40 cask, and 0.800 kilowatts per assembly for fuel stored in a TN-40HT cask. The maximum average burnup is

45 Gigawatt-Days per Metric Ton Uranium (GWd/MTU) for fuel stored in a TN-40 cask and 60 GWd/MTU for fuel stored in a TN-40HT cask.

The licensee identified the following subcomponents of the spent fuel assemblies for both the TN-40 and TN-40HT casks as within scope of renewal:

1. Fuel cladding and end plugs (SFA-1 through SFA-3)
2. Guide Tubes (SFA-4 and SFA-5)
3. Grid Assemblies (Middle) (SFA-6)
4. Grid Assemblies (Top, Bottom) (SFA-7)
5. Bottom Nozzle (SFA-8)
6. Upper Nozzle (SFA-9)

The staff reviewed the accuracy of the description with the ISFSI design bases in the referenced SAR. Based on its review, the staff concludes that the description of the spent fuel assemblies is adequate.

3.3.5.1 **Materials and Environments**

External Air/Gas Environment

The licensee identified the external environment ~~seen by~~ the spent fuel assemblies expose to as the same internal environment of the cask. More specifically, the licensee stated that in addition to the helium within the cask, trace amounts of other gases such as nitrogen, oxygen, argon and fission product gasses may be present. The licensee further stated that these gases have collectively been grouped in the "(E) Air/Gas" environment used in Table 3-2.

The licensee recognized that residual boric acid may coat the SFAs surfaces since they were exposed to a borated water environment in the spent fuel pool prior to storage. However, the licensee stated that any boric acid residue remaining on the SFAs will have no deleterious effects/mechanisms due to the absence of water and the materials of construction for the SFAs.

The licensee also stated that following initial cask loading, the maximum fuel cladding temperature was calculated to be 339 °C [642 °F] for fuel in a TN-40 cask and 360 °C [680 °F] for fuel in a TN-40HT cask. Fuel cladding temperature will then decrease over time while in storage because decay heat decreases as fuel's radioactivity decreases over time.

Internal Air/Gas Environment

The licensee identified the fuel cladding and guide tubes as the only two fuel assembly subcomponents to have internal environments. The licensee stated that the fuel rods were initially pressurized with helium during manufacturing. The licensee further clarified that the fuel rod internal environment, defined as "(I) Air/Gas" in Table 3-2, was assumed to be a combination of the original helium fill gas and fission products produced during reactor operation.

The licensee provided additional details on the materials of construction and service environments for the following subcomponents:

1. Fuel Cladding and End Plugs (SFA-1 through SFA-3)

The licensee stated that the fuel cladding and end-plugs are made of zirconium-based alloys. The licensee further identified the environment as either internal (SFA-1) or external (SFA-2, SFA-3). The NRC staff considers the end plugs as integral part of the fuel assembly and not part of the fuel rod, as defined in Section 2.3.2 of the LRA.

Comment [LZ19]: Remove the page breaker after this paragraph.

DRAFT

2. Guide Tubes (SFA-4 and SFA-5)

The licensee identified the materials of construction of the guide tubes as zirconium-based alloys. The licensee further identified the guide tubes as open on the end and to have the same internal (SFA-4) and external (SFA-5) environment.

3. Grid Assemblies (Middle, Top and Bottom) (SFA-6 and SFA-7)

The licensee identified the mid and the top/bottom grid assemblies, which are attached to the guide tubes, as made of zirconium-based alloys or nickel-based alloys, respectively. The licensee further identified the environment of the grid assemblies to be external, as defined above.

4. Bottom Nozzle (SFA-8)

The licensee identified the bottom nozzle as made of stainless steel. The licensee further identified the environment of the bottom nozzle to be external, as defined above.

5. Upper Nozzle (SFA-9)

The licensee identified the upper nozzle as made of stainless steel. The licensee further identified the environment of the bottom nozzle to be external, as defined above.

The staff reviewed the accuracy of the materials of construction and service environments of the spent fuel assemblies with the ISFSI design bases referenced in the LRA. Based on its review, the staff concludes that the licensee adequately identified the materials of construction and service environment of the spent fuel assemblies.

3.3.5.2 Aging Mechanisms/Effects on the Spent Fuel Assemblies

The licensee stated that spent fuel assemblies with burnup of less than 45 GWd/MTU are not impacted by radial hydride formation, per guidance in ISG-11, Rev. 3. The licensee further stated that results of the Dry Cask Storage Characterization Project in Idaho support the conclusion that the condition of the spent fuel assemblies will not degrade under extended storage. The maximum assembly average burnup for a spent fuel assembly stored in a TN-40 cask is 45 GWd/MTU, as specified in the ISFSI Technical Specifications Functional and Operating Limit 2.2 (NSPM, 2010a). Thus, the licensee stated that spent fuel assemblies in the TN-40 casks are not impacted by radial hydride formation.

The licensee also determined that for SFAs with burnup greater than 45 GWd/MTU, the likelihood of this degradation mechanism occurring is minimized by limiting peak cladding temperature to less than 400 °C [752 °F]. The maximum assembly average burnup for a SFA stored in a TN-40HT cask is 60 GWd/MTU, as specified in the ISFSI Technical Specification Functional and Operating Limit 2.3 (NSPM, 2010a). Table A3.3-3 of the ISFSI SAR (NSPM, 2011b) shows that the maximum calculated cladding temperature for storage conditions for SFAs to be stored in a TN-40HT cask is 360 °C [680 °F]. This value is below the 400 °C [752 °F] limit, as defined in ISG-11, Rev.3. As a result, the licensee recognized that ISG-11, Rev. 3 is considered to adequately bound conditions associated with the higher burnup limit of 60 GWd/MTU for the TN-40HT casks. Thus, the licensee further concluded that spent fuel assemblies in the TN-40HT casks are not impacted by radial hydride formation.

Based on the above assessment, the licensee determined there are no aging effects/mechanisms that require management for spent fuel assemblies stored in the inert environment in a cask.

The staff reviewed the identified aging mechanisms and effects for the spent fuel assemblies. The staff determined the aging management review (AMR) to be comprehensive and complete based on the ISFSI design bases referenced in the LRA. Based on its review, the staff finds the licensee's identification of aging mechanisms and effects for the ~~earthen berm~~ fuel assemblies acceptable.

Comment [LZ20]: This must be a typo.

3.3.5.3 **Evaluation of Proposed Aging Management Activities**

Per 10 CFR 72.122 (l), storage systems must be designed for ready retrieval of the spent fuel. The NRC staff has indicated in ISG-2 Rev 1 that "a fuel assembly is "ready retrievable" if it remains structurally sound (i.e., no gross degradation) and could be handled by normal means (i.e., does not pose operational safety problems during removal)." The NRC staff further indicated in ISG-11 Rev 3 that if the maximum fuel temperature was maintained below 400 °C [752 °F] and the fuel was stored in a dry inert atmosphere that it is expected that the fuel would stay structurally sound during normal and off-normal operations. Unless the fuel assemblies are canned or handled by other appropriate means, they must maintain structural soundness in order to meet the regulations and perform their intended function to provide reasonable assurance that the fuel can be retrieved without undue risk. Thus, the fuel assemblies are in the scope of this renewal.

The Technical Specifications 3.1.1, "Cask Cavity Vacuum Drying," and 3.1.2, "Cask Helium Backfill Pressure," for the loading of both the TN-40 and TN-40HT (NSPM, 2010a) require that the fuel be dried to the specifications of NUREG–1526 (the cask cavity is dry by maintaining a cavity absolute pressure less than or equal to 10 mbar for a 30 minute period with the cask isolated from the vacuum pump) and backfilled with an atmosphere of inert gas. Per ISG-11 Rev 3, the NRC staff indicated that these conditions ensure that cladding creep, which is considered to be the potential mechanism of gross degradation of the fuel will not occur during storage.

The PINGP will store only low burnup fuel in the TN-40 system and both high and low burnup fuel in the TN-40HT system. The NRC staff determined through the fuel testing in Idaho where low burnup fuel was stored for 15 years in a dry inert atmosphere and showed no signs of degradation, that no degradation will occur during additional storage periods up to 100 years. Therefore the staff finds that no TLAA or AMP is necessary to store the low burnup fuel for up to a total of 60 years as requested.

In addition to the storage of low burnup fuel, PINGP began storing high burnup fuel in April 2013. Some differences exists between low and high burnup fuel which include: (i) additional cladding oxidation which causes higher hydrogen content in high burnup Zircaloy-4 and Zirlo cladding and (ii) higher cladding stress due to potentially greater fission gas release. NRC staff established ISG-11 Rev 3 with models that extrapolate the expected performance of low and high burnup fuel during storage. The models in ISG-11 Rev 3 indicate acceptable expected fuel performance during the initial 20 years period of operation (2013–2033) for normal and off-normal operation. Nevertheless, NRC staff requests further confirmation of the model extrapolations during the extended period of operation to ensure the models remain conservative and maintain acceptable fuel performance. PINGP identified a confirmation

Comment [LZ21]: Not sure what this meant. Please clarify what is "acceptable expected". Iis it acceptable or expected?

Comment [LZ22]: Does this mean "the staff asked this anyway"?

method through a surrogate high burnup fuel surveillance program as established in AMP Section 3.0 of the LRA Appendix A entitled "High Burnup Fuel Monitoring Program" in conformance to ISG-24. This surveillance program will be used to confirm that the high burnup fuel performance continues as expected and support the conclusions drawn in ISG-11 Rev 3 prior to moving into the period of extended operation beyond the initial 20 years period. Thus, the NRC staff requires this high burnup fuel surveillance AMP to provide this confirmatory information.

3.3.6 Concrete Pads

The ISFSI has two seismically qualified concrete pads (STR-1 through STR-11), each supporting two parallel rows of 12 casks per row. The design safety function of the concrete pads is to provide structural support and a uniform level surface for the casks. Each pad is 36 inches thick and designed to a nominal compressive strength of 3,000 psi at 28 days. The licensee identified the pads as safety-related and within the scope of renewal.

The staff reviewed the accuracy of the description with the ISFSI design bases referenced in the application (NSPM, 2010a, Section 4.5.5). Based on its review, the staff concludes that the description of the pad is correct and acceptable.

3.3.6.1 Materials and Environments

The licensee identified the concrete pads as made of steel reinforced concrete. The licensee noted the climatological data in Figure 2.3-1A of the PINGP USAR (NSPM, 2010b), which states that the external environment of the pads is bounded by the air temperature range of −37 to 38 °C [−35 to 100 °F]. The licensee further identified the service environment of the above-grade section of the concrete pad to be "Atmosphere/Weather," which was defined to include humidity, precipitation, ultraviolet radiation, ozone, and wind. The licensee also specified the below-grade (buried) section of the concrete is being exposed to soil.

The staff reviewed and confirmed that the initial license design bases states that the pads were designed and constructed in accordance with ACI 318-89 (ACI, 2002), including criteria set therein for the detailing and fabrication of the reinforcing steel. More specifically, the design bases states that all reinforcing steel meet the specifications per ASTM A615. The staff reviewed Figures (2.3-1a,b,c) in Section 2.3 of the PINGP USAR (NSPM, 2010b) and confirmed that the licensee has adequately provided the climatic characteristics of the site region. The staff concludes that the licensee adequately identified the materials of construction and service environment of the concrete pads.

3.3.6.2 Aging Mechanisms/Effects on the Concrete Pad

The licensee identified the following aging effects/mechanisms that could lead to a loss of design safety function of the concrete pads:

1. Change in material properties due to leaching of calcium hydroxide (above-grade/below-grade).

2. Cracking or loss of material due to freeze-thaw degradation (above-grade).

3. Cracking due to reaction with aggregates (above-grade/below-grade).

4. Cracking due to settlement (below-grade).

The licensee further defined the aging effect 'change in material properties' of the concrete to include increased porosity and permeability, reduction in strength and reduction in pH. The licensee excluded the applicability of chemical attack of the concrete and corrosion of the steel rebar as possible aging mechanisms, for both above-grade and below-grade environments. However, the licensee stated that it would include a groundwater chemistry program to ensure the absence of aggressive chemical environments for the ISFSI pads.

The staff reviewed the ISFSI design bases, applicable industry-wide operating experience and guidance provided in consensus codes and standards [ACI 349.3R (ACI, 2002) and ASCE 11-99 (ASCE, 2000)]. The staff has determined that the aging mechanisms of chemical attack of the concrete and corrosion of the steel rebar are applicable to the concrete pads. However, the staff has determined that the licensee's inclusion of a groundwater chemistry program in the AMP will serve to ensure that an aggressive chemical environment will be identified and appropriate action will be taken before there is a loss of intended function. Based on its review, the staff finds the licensee's identification of aging mechanisms and effects for the concrete pads acceptable.

3.3.6.3 Evaluation of Proposed Aging Management Activities

The licensee proposed an AMP, "ISFSI Inspection and Monitoring Program," to manage the identified aging effects or mechanisms for the concrete pads. The licensee further stated in the application that no calculations or analyses that have all attributes of a TLAA were identified for the concrete pads. The staff reviewed the license renewal application and references therein, including design bases and operating experience reports, and concluded that an AMP is acceptable means for ensuring the identified aging effects will not lead to a loss of intended function.

3.3.7 Earthen Berm

The ISFSI is surrounded by a 17 ft high earthen berm (STR-12 through STR-15), except for the ISFSI access road opening. The licensee stated that the earthen berm has a slope of one horizontal to one vertical. The design safety function of the earthen berm is to provide radiation shielding for the public. The licensee identified the earthen berm as within the scope of license renewal.

The staff reviewed the accuracy of the description with the ISFSI design bases referenced in the application (NSPM, 2010a, Section 4.5.5). Based on its review, the staff concludes that the description of the earthen berm is correct and acceptable.

3.3.7.1 Materials and Environments

The licensee identified the earthen berm as made of geo-fabric reinforced earth fill material. The licensee further identified the service environment as "Atmosphere/Weather," which was defined to include humidity, precipitation, ultraviolet radiation, ozone, and wind.

The staff reviewed the accuracy of the materials of construction and service environment of the earthen berm with the ISFSI design bases referenced in the application (NSPM, 2010a,

Section 4.5.5). Based on its review, the staff concludes that the licensee adequately identified the materials of construction and service environment of the earthen berm.

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3.3.7.2 Aging Mechanisms/Effects on the Earthen Berm

The licensee identified the following aging effects/mechanisms that could compromise the design safety function of the earthen berm

1. Change in material properties due to desiccation
2. Loss of form due to settlement and frost action
3. Loss of material due to erosion

In the supplemental LRA amendment (NSPM, 2014) , the licensee provided further clarification on the aging effect "change in material properties" due to desiccation and included "surface erosion" as a visible sign of change in material properties due to desiccation that could be detected by visual inspection.

The staff reviewed the identified aging mechanisms and effects for the earthen berm. The staff determined the aging management review (AMR) to be comprehensive and complete based on the ISFSI design bases and the PINGP Site Structures Monitoring Program. Based on its review, the staff finds the licensee's identification of aging mechanisms and effects for the earthen berm acceptable.

3.3.7.3 Evaluation of Proposed Aging Management Activities

The licensee credited the ISFSI Inspection and Monitoring Program to manage the identified aging effects or mechanisms for the earthen berm. The licensee further stated in the LRA that no calculations or analyses that have all attributes of a TLAA were identified for the earthen berm. The staff reviewed the license renewal application and references therein and concluded that an AMP is an acceptable means for ensuring the identified aging effects will not lead to a loss of intended function.

3.3.8 Evaluation Findings

The staff reviewed the AMR for the PINGP ISFSI to verify that the application adequately identified the materials, environments, and aging effects of the in-scope SSCs. Based on its review of the LRA, ~~and~~ the licensee's responses to the staff's ~~Observations,~~ requests for supplemental information (RSIs) and observations, and requests for additional information's (RAIs), the staff finds:

F3.1 The licensee's AMR process to be ~~comprehensive~~ acceptable in identifying the materials of construction and associated operating environmental conditions for those SSCs within the scope of renewal. ~~and has provided a summary of the information in the application and SAR supplement~~.

F3.2 The licensee's review process to be comprehensive in identifying all pertinent aging mechanisms and effects applicable to the in-scope SSCs and the ~~provided a summary of the~~ AMR results are correct, and the AMR results are provided in a summary in the LRA and SAR supplement~~information in the LRA~~ with a commitment to incorporate Appendix C of the LRA, Safety Analysis Report (SAR) Supplement and Changes, into the FSAR.

3.4 Time-Limited Aging Analysis Evaluation

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TLAAs are calculations or analyses that are used to demonstrate that in-scope SSCs will maintain their intended design function throughout an explicitly stated period of extended operation (e.g., 40 years). These calculations ~~or analyses may be~~are typically used to assess fatigue life (number of cycles to predicted failure), or time-limited life (operating timeframe until expected loss of intended design function). ~~TLAAs should account for environment effects.~~

Pursuant to 10 CFR 72.3, TLAAs must meet all six of the following criteria~~-~~:

1. Involve SSCs important to safety (ITS) within the scope of the license or certificate renewal, as delineated in Subpart F of 10 CFR Part 72, or within the scope of the spent fuel storage certificate renewal, as delineated in Subpart L of 10 CFR Part 72, respectively.

2. Consider the effects of aging.

3. Involve time-limited assumptions defined by the current operating term, for example 40 year.

4. Were determined to be relevant by the licensee or certificate holder in making a safety determination.

5. Involve conclusions or provide the basis of conclusions related to the capability of SSCs to perform their intended safety functions.

6. Are contained or incorporated by reference in the design bases.

The licensee identified only two TLAAs meeting all six criteria per 10 CFR 72.3:

1. Basket Aluminum Components for Long Term Storage Deadweight
2. Neutron Damage of the Cask Metallic Components

The staff reviewed the licensee's TLAAs. Based on its review of the design bases, the staff concludes that the licensee's ~~adequately identified all~~ TLAAs are correct and the results are acceptable for demonstration that the associated components are able to maintain their intended function during the period of extended operation. The following two sections provide the staff's review of the above two TLAAs performed by the licensee.

3.4.1 Basket Aluminum Components for Long-Term Storage Deadweight

The licensee evaluated the basket's aluminum components (Aluminum Plates, Table 2.1-5) for long-term storage loading (i.e., deadweight). The compressive stresses, due to deadweight, were compared to allowable stress values, which would limit the amount of creep in the aluminum components to within acceptable levels. The licensee estimated the design allowable stress based upon the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME, 1998, Section II, Part D, Appendix 1).

Comment [ZL23]: The phrase "limit something to within acceptable levels" sounds award.

Comment [ZL24]: This is confusing. I am sure I can understand the logics here. Please consider to revise.

The licensee documented the evaluation of basket aluminum components for long-term storage deadweight in the PINGP ISFSI SAR. The ~~SAR~~ licensee identifies that the maximum compressive stress in the aluminum inserts was conservatively calculated ~~as~~ because it assumed the entire length of the basket were supported by itself at the bottom without taking

credit of the bolts. Based on its calculation the licensee determined that the maximum stress the aluminum components is 15.68 psi. The SAR compared this maximum stress value ~~(15.68 psi)~~ to an allowable stress limit~~. The allowable stress limit of~~ of 758 psi calculated at 243°C [470°F], which represents the stress in 1100 Aluminum to produce a strain of 0.01 in 550,000 hours, which is longer than the 60 year period of operation and show~~. The SAR states~~ that the calculated maximum stress of 15.68 psi is much lower than the allowable of 758 psi.

The licensee stated that the TLAA confirmed that the original evaluation of the aluminum basket components for long-term storage deadweight was projected through the end of the period of extended operation. The licensee further concluded that the TLAA demonstrated that creep would not prevent the aluminum components from performing their intended functions during the period of extended operation.

Staff reviewed the thermal analysis of the TN-40HT cask in the PINGP ISFSI SAR (NSPM, 2011b), which bounds the TN-40 cask because the latter has much lower decay heat load limit. The analysis showed that the maximum temperature of the basket aluminum rails would not exceed 237°C [459 °F]. This temperature is below that assumed for the allowable stress value, i.e., 243°C [470°F] in the TLAA. The~~S~~ staff reviewed the licensee's TLAA, assumptions, and creep calculations. Based on its review that staff ~~and~~ determined that the TLAAs and accociated results~~y~~ are valid. Therefore, the staff finds the licensee's TLAA for the cask basket aluminum components acceptable.

3.4.2 Neutron Damage of the Cask Metallic Components

The licensee identified the effect of neutron damage of cask metallic components for the TN-40HT casks as a TLAA in NSPM (2011a, Appendix B). In order to assess the TLAA for this effect, the licensee calculated a projected value for the integrated fast neutron flux at the end of 60 years. For the calculation, the integrated fast neutron flux inside a TN-40HT cask was assumed to be on the order of 10^{14} n/cm^2 over the period of 25 years based upon the assessment documented in the PINGP ISFSI SAR (NSPM, 2011b, Section A4.2.3.5). The licensee concluded that the integrated fast neutron flux was less than the NRC (1988) threshold value of 10^{17} n/cm^2 for neutron damage and extrapolation of the data available down to the 10^{14} n/cm^2 range confirmed there would be virtually no neutron damage to any of the TN-40HT cask metallic components after 25 years. For the TLAA, the integrated neutron flux value of 10^{14} n/cm^2 after 25 years was used to calculate the value for the integrated fast neutron flux at the end of 60 years (35/25 = 1.4) by a linear extrapolation, resulting in a total of 2.4×10^{14} n/cm^2 after 60 years ($10^{14} \times (1+1.4) = 2.4 \times 10^{14}$). The licensee stated that since this value is less than the threshold ~~value~~ of 10^{17} n/cm^2 ~~assumed~~ for neutron ~~damage~~embrittlement, and concluded that there would be virtually no neutron ~~damage~~ embrittlement to any of the TN-40HT cask for the period of extended operation. Further, the licensee concluded that the TLAA demonstrates that neutron damage is so small that it will not prevent the metallic components of the TN-40HT casks from performing their intended functions during the period of extended operation.

The staff verified the ~~order of magnitude~~total estimated neutron flux value provided for the integrated fast neutron flux at 25 years in NSPM (2011b, Section A4.2.3.5) and the projected value for integrated fast neutron flux at 60 years and found these estimates are conservative. The staff also notes that the TN-40HT calculation bounds the TN-40 casks because the fuel in the TN-40HT contain much higher neutron sources than the TN-40 casks. Based on its review,

the staff finds the licensee's TLAA evaluation for neutron damage of the cask metallic components acceptable.

3.4.3 Evaluation Findings

The staff reviewed the TLAAs presented in the PING ISFSI LRA (NSPM, 2011a) against the regulatory requirements of 10 CFR 72.42. The staff verified that the TLAAs assumptions, calculations, and analyses were adequate and bounded the environments and aging mechanisms for the pertinent SSCs. Based on its review of the information and representations, the staff finds:

F3.3 The licensee identified all pertinent aging mechanisms and effects applicable to the in-scope SSCs that involve TLAAs. The methods and values of the input parameters for the licensee's TLAAs for the identified SSCs are adequate. Therefore, the licensee's TLAAs provide reasonable assurance that the SSCs will maintain their intended function(s) for the term of the period of extended operation, require no further aging management activities, and meet the requirements for renewal.

3.5 Aging Management Program

Pursuant to 10 CFR 72.42(a)(2) ~~requirements~~, the licensee must provide a description of AMPs for management of issues associated with aging that could adversely affect ITS SSCs ~~ITS~~. The licensee provided two AMPs in Appendix A to LRA Rev. 1 [Supplement to License Renewal Application—Response to Second Request for Additional Information dated July 31, 2014, (NSPM, 2014)]:

Comment [ZL25]: Or SSCs that are importatnt to safety.

- ISFSI Inspection and Monitoring Program
- High Burnup Fuel Monitoring Program

3.5.1 ISFSI Inspection and Monitoring Program

The licensee proposed a general AMP, "ISFSI Inspection and Monitoring Program," in Appendix A to the LRA Rev. 1 (NSPM, 2014). The AMP detailed the activities to be performed to ensure the following in-scope SSCs will maintain their intended design safety functions per 10 CFR 72.42(a)(2). The sections hereafter detail the staff's review of the adequacy of this AMP to address the identified aging mechanisms and effects of the following in-scope SSCs and subcomponents:

- In-scope SSCs
  - Dry Storage (In-service) Casks
  - Reinforced Concrete pads
  - Earthen Berm
- In-scope Subcomponent of the Dry Storage (In-service) Casks
  - Polymer Neutron Shield

3.5.1.1 Dry Storage (In-service) Casks

The ISFSI Inspection and Monitoring Program includes periodic inspection activities to manage the aging effects of the dry storage casks. The licensee identified "Dry Storage Casks" as an SSC within scope of the license renewal in Table 2.4-1 of the LRA. The licensee also used the

term “In-service Casks” in the ISFSI Inspection and Monitoring Program AMP in Appendix A to the LRA Rev.1 (NSPM, 2014). For the purposes of the staff review, the terms “Dry Storage Casks” and “In-service Casks” are considered equivalent. For clarity, the staff expects the licensee to adopt a single term for the incorporation into the next revised FSAR. The staff reviewed the AMP against the criteria provided in Section 3.6.1 of NUREG–1927 (NRC, 2011). The staff’s evaluation of each of the program elements is as follows:

1. Scope of the Program

Comment [ZL26]: See NUREG-1927, page 23 on AMP element.

The licensee defined the scope of the program to include visual inspections to monitor the conditions and performance of the casks. The licensee references applicable aging mechanisms and effects in Table A2.1-1 (NSPM, 2014) that are within the scope of this AMP. The aging effect managed by this program for the dry storage (in-service) casks is loss of material due to various corrosion mechanisms. The scope of the visual inspections includes:

- Visual inspection of the exterior of the dry storage (in-service) casks.
- Monitoring of the inter-seal pressure of the dry storage (in-service) casks.
- Visual inspection of a dry storage (in-service) cask bottom prior to the end of the initial license period.
- Visual inspection under a dry storage (in-service) cask protective cover prior to the end of the initial license period.
- Visual inspection of the cask bottom in the event that a dry storage (in-service) cask is lifted in preparation for movement.
- Visual inspection under the protective cover of a dry storage (in-service) cask in the event the cover is removed for maintenance.
- Visual inspection of the bottom and the protective cover of the lead cask at least every 20 years.

Comment [ZL27]: The pressure monitoring system is scoped out. How would the licensee do this if the pressure monitoring is malfunctioning?

How would licensee detect if the pressure moniroing system functions correctly?

If the pressure monitoing system is identified as broken, would the licensee fix or replace the system?

The staff reviewed the licensee’s Scope of the Program and determined that the licensee has correctly identified the aging mechanisms and effects of the dry storage (in-service) casks to be managed by the program. ~~The staff finds the Scope of Program provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the dry storage (in-service) casks.~~

Comment [ZL28]: I suggest deleting this statement because “scope of the program” cannot provide reasonable assurance that the program will be able to manage the identified aging mechanisms/aging effects.

2. Preventive Actions

The licensee defined the visual inspection of the dry storage (in-service) casks as a condition-monitoring program, which does not require any preventive actions. ~~The staff finds that the condition-monitoring program provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the dry storage (in-service) casks.~~ The staff finds the definition of this program elemement correct and acceptable.

3. Parameters Monitored or Inspected

The licensee stated that the dry storage (in-service) casks are visually inspected to ensure the intended functions of the casks are maintained during the period of extended operation. The licensee stated that the casks are visually inspected for signs of corrosion, damage, and/or debris accumulation on the cask exterior surfaces. The lead cask inspections were performed in June 2011 to look for signs of deterioration in the inaccessible areas of the cask bottom and underneath the protective cover. The licensee stated that loss of material due to corrosion is the applicable aging effect. The licensee also stated that the pressure of the inter-seal helium gas is monitored to verify the integrity of the seals of the cask lid and that the intended function of the casks is not compromised.

The staff reviewed the licensee's Parameters Monitored or Inspected for the visual inspections of the casks and inter-seal pressure monitoring. Pursuant to Control of Special Processes in 10 CFR 72.158, the licensee shall establish measures to ensure that special processes, including nondestructive testing (such as visual inspections), is controlled and accomplished by qualified personnel using qualified procedures (with identified parameters to be inspected or monitored) in accordance with applicable codes, standards, specifications, criteria, and other special requirements. The staff finds that the Parameters Monitored or Inspected provide reasonable assurance for ~~managing the aging mechanisms and effects, and~~ ensuring the intended function of the dry storage (in-service) casks will be maintained during the period of extended operation.

Comment [LZ29]: Can the inspection activities be considered as managing agiong effects?

4. Detection of Aging Effects

The licensee stated that quarterly visual inspections of the physical condition of the exterior surfaces of all casks provide a means to detect degradation of these casks due to potential loss of material and ensure that the intended functions are not compromised. The licensee also stated that visual inspections of both the cask bottom and the area underneath the cask protective cover as an opportunistic inspection and, as a minimum, at 20-year intervals for the lead cask, provide a means to detect degradation due to potential loss of material and ensure that the intended functions are not compromised.

The licensee stated that pressure monitoring of all casks is performed as a continuous process and checked daily for alarms. This provides a means to detect metallic O-ring seal degradation due to potential loss of material and ensure that the intended function is not compromised.

The staff reviewed the licensee's Detection of Aging Effects and determined that quarterly visual inspections of the casks and continuous inter-seal pressure monitoring provide acceptable means to effectively detect the aging effects of loss of material so that the dry storage (in-service) casks will maintain their intended functions for the period of extended operation. Pursuant to Control of Special Processes in 10 CFR 72.158, the licensee shall establish measures to ensure that special processes, including nondestructive testing (such as visual inspections), is controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements. The licensee is relying upon the use of applicable industry codes and standards for the visual inspection, which is a type of nondestructive testing method. The staff ~~expects~~ considers that the licensee's choice and use of applicable codes and standards will provide reasonable assurance that the visual inspections will satisfy the requirements of 10 CFR 72.158. The staff finds that the Detection of Aging Effects provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the dry storage (in-service) casks.

Comment [LZ30]: The pressure monitoring system is not scoped in. So, can we credit this system as a reliable means for monitoring the seals? What if the monitoring system fails?

Comment [LZ31]: Doesn't the staff have confidence on the licensee's choice of codes will provide a reasonable assurance?

5. Monitoring and Trending

The licensee stated that quarterly visual inspections will be performed to determine the potential existence of loss of material for the cask exterior surfaces and accumulation of debris. The licensee stated that pressure monitoring of each cask to detect potential loss of material is provided as a continuous process and checked daily for alarms. The licensee also stated that the AMP requires monitoring the condition of SSCs using current and historical operating experience along with industry operating experience to detect, evaluate, and trend degraded conditions. More specifically, the licensee clarified that when degraded conditions are detected and associated corrective actions are completed, the SSCs will continue to be monitored against performance goals.

The licensee further stated in the supplemented LRA (NSPM, 2014) that the ISFSI Inspection and Monitoring Program, as a subset of the PINGP Structures Monitoring Program, requires that the program coordinator evaluates the results of the inspections for adverse trends including an evaluation of whether the frequency of the inspections should be increased. More specifically, the periodic structures inspection procedure contains requirements to generate an inspection report that includes a section on historical information and trends. The licensee clarified that this section is to contain relevant maintenance information on the structure collected while preparing for the inspection. At a minimum, the section will identify the status of Work Requests and Actions Requests issues during the previous inspection of the structure. The section will also include a discussion of the significance of past and present inspection findings. In particular, the licensee stated that this section addresses whether the findings represent an adverse trend or random deficiency indicative of normal structural aging.

The staff reviewed the ~~licensee's~~ Monitoring and Trending Element of this AMP and determined that the licensee's monitoring and trending methods provide acceptable means to effectively predict the extent of the aging effects of loss of material and timely corrective actions. The staff finds that the Monitoring and Trending provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the dry storage (in-service) casks.

6. Acceptance Criteria

The licensee stated that the program includes acceptance criteria to evaluate the extent of a degraded condition and the need for corrective action before the loss of intended function. The licensee stated that the acceptance criteria for visual inspections of the casks are the absence of any of the aging effects (i.e., no observable indications of corrosion). The licensee also stated that if the inspector observes any indication of corrosion, the condition would be entered into its Corrective Action Program. The licensee stated that the acceptance criterion for inter-seal pressure monitoring is the absence of an alarmed condition, and the alarm setpoint is higher than the inter-seal pressure specified in the Prairie Island ISFSI Technical Specification 3.1.5.

The staff reviewed the licensee's Acceptance Criteria and determined that the acceptance criteria acceptable because corrective actions will be taken if any indication of loss of material due to ~~various~~ any corrosion mechanisms is detected by the inspector or an alarmed condition exists. The staff finds that the Acceptance Criteria provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the dry storage (in-service) casks.

Comment [LZ32]: Do we have a definition for this trerm yet?

7. Corrective Actions

The licensee stated that its Corrective Actions Program requirements are established in accordance with the requirements of 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants" and NSPM Quality Assurance Topical Report. The licensee stated that a single Corrective Action Program is applied regardless of the safety classification of the structure or component.

The licensee further stated that the Corrective Action Program procedures require the initiation of an Action Request for actual or potential problems including failures, malfunctions, discrepancies, deviations, defective material and equipment, nonconformances, and administrative control discrepancies, to ensure that conditions adverse to quality, operability, functionality, and reportability issues are promptly identified, evaluated if necessary, and corrected as appropriate. Guidance on establishing priority and timely resolution of issues is contained within the Corrective Action Program procedure. All corrective actions for deviating conditions that are adverse to quality are performed in accordance with the requirements of the Quality Assurance Program which complies with the requirements of 10 CFR 50, Appendix B. Any resultant maintenance, repair/replacement activities, or special handling requirements are performed in accordance with approved procedures.

The licensee clarified that corrective actions provide reasonable assurance that deficiencies adverse to quality are either promptly corrected or evaluated to be acceptable. For evaluations that do not result in repair or replacement, engineering analysis is used to reasonably assure that the intended function is maintained consistent with the current licensing basis. If ~~the~~ deviating condition is assessed to be significantly adverse to quality, the cause of the condition is determined and an action plan is developed to preclude recurrence. Corrective actions identify recurring discrepancies and initiate additional corrective actions including root cause analysis to preclude recurrence. The licensee stated that degraded conditions identified by the AMP inspections will be entered into the Corrective Action Program. Actions required to resolving inspection findings will be tracked to completion and trended within the Corrective Action Program.

The licensee further clarified in the supplemented LRA (NSPM, 2014) that Corrective Action Program also contains provisions to:

- Determine if the condition is reportable to the NRC (e.g., results in the loss of intended function).
- Perform equipment evaluations, apparent cause evaluations, and root cause evaluations.
- Perform functionality assessments.
- Address the extent of condition.
- Determine actions to prevent recurrence.
- Identity operating experience actions.
- Trend conditions.

The licensee further clarified that it is thorough ~~through~~ evaluations conducted as part of the Corrective Action Program that the determination would be made if an AMP, Monitoring Program, or inspection procedure would be revised.

The staff reviewed the details ~~provided for~~of the Corrective Action Program as part of the existing PINGP Quality Assurance Program. Per the requirements of 10 CFR 72.172, the staff expects that if an unanalyzed degraded condition is identified by the AMP inspections, the licensee will enter the finding into the Corrective Action Program and resolve the finding. The staff finds that the licensee's correction action program per the quality assurance requirements in 10 CFR 50 Appendix B provides reasonable assurance that corrective actions will be adequate for managing the aging mechanisms and effects identified in the AMR of the dry storage (in-service) casks

8. Confirmation Process

The licensee stated that the confirmation process is part of the NSPM Corrective Action Program to ensure that the corrective actions taken are adequate and appropriate, have been completed, and are effective. The licensee further stated that the focus of the confirmation process is on the follow-up actions that must be taken to verify effective implementation of corrective actions. More specifically, the measure of effectiveness is in terms of correcting the adverse condition and precluding repetition of significant conditions adverse to quality. The licensee clarified that the Corrective Action Program procedures include provisions for timely evaluation of adverse conditions and implementation of any corrective actions required, including root cause evaluations and prevention of recurrence where appropriate. More specifically, these procedures provide for tracking, coordinating, monitoring, reviewing, verifying, validating, and approving corrective actions, to ensure effective corrective actions are taken.

The licensee further stated the Corrective Action Program is monitored for potentially adverse trends. More specifically, the existence of an adverse trend due to recurring or repetitive adverse conditions will result in the initiation of an Action Request. The licensee confirmed that the AMP will also uncover unsatisfactory conditions resulting from ineffective corrective action.

The staff reviewed the details provided for the licensee's Confirmation Process, as part of the existing Quality Assurance Program, to ensure that appropriate corrective actions are completed and are effective. The staff considers the licensee's Corrective Action Program per the quality assurance requirements in 10 CFR 50 Appendix B provides reasonable assurance that the Confirmation Process is adequate for managing the aging mechanisms and effects identified in the AMR of the dry storage (in-service) casks.

9. Administrative Controls

The licensee stated that the NSPM's Quality Assurance Program, associated formal review and approval processes, and administrative controls applicable to the AMP are implemented in accordance with the requirements of the NSPM Quality Assurance Topical Report and 10 CFR Part 50, Appendix B. The licensee further stated that the administrative controls that govern aging management activities at PINGP are established in accordance with the PINGP Administrative Control Program and associated Fleet Procedures.

The staff reviewed the details provided for the licensee's Administrative Controls, as part of the existing Quality Assurance Program, to ensure that the administrative controls will be adequate

Comment [LZ33]: Through evaluation or thorough evaluation?

Comment [LZ34]: Would this be entered as a condition or part of the AMP?

to provide a formal review and approval process. The staff concludes that the NSPM Quality Assurance Program, per the quality assurance requirements in 10 CFR 50 Appendix B, provides a reasonable assurance that the Administrative Controls are adequate for managing the aging mechanisms and effects identified in the AMR of the dry storage (in-service) casks.

10. Operating Experience

The licensee stated that a review of ISFSI operating history provided evidence that any potential aging effects were identified, evaluated, and managed effectively, assuring that structures and components remained capable of performing their intended functions. The licensee concluded that the dry storage (in-service) casks will continue to perform their intended functions during the period of extended operation.

The licensee stated that the visual inspections of the dry storage (in-service) casks to date, including lead cask inspections, identified only minor cases of coating degradation which were corrected by touching-up of the existing coating material, and there was no observable loss of material on the base metal under the degraded coating. The licensee provided an assessment of potential impacts on the shield plate's intended functions assuming loss of 2.54-cm [1-in] thickness after100 years due to a postulated bounding corrosion rate of 0.254 mm/year [10 mils/year] on the cask bottom. The licensee cited three sources of literature data to support the bounding corrosion rate of 0.254 mm/year [10 mils/year]. The licensee stated that the bottom shield plates of the TN-40 and TN-40HT casks are still able to perform their intended functions with an assumed loss of 2.54 cm [1 in] of material. The licensee also stated that an inspection frequency of at least one inspection every 20 years for the bottom shield plate is sufficient to ensure that detection of the loss of material aging effect occurs before there is a loss of the shield plate's intended functions.

Comment [LZ35]: We maight be challenged with this number because the TN-40 casks are certified for transportation, which was evaluated based on the design basis material thickness.

The licensee stated that operating experience at the Surry ISFSI involving five TN-32 casks, a system similar to the TN-40 and TN-40HT [TN, 2001]. This Surry ISFSI operating experience identified corrosion of the lid bolts and the outer metallic lid seals resulting from external water intrusion. The licensee stated that the root cause of the corrosion was leaking due to improper installation of the Conax connector seals for the electrical connector in the cask protective cover. The licensee further identified the issue as a design and installation issue and not age-related and not subject to this AMP.

The licensee identified additional operating experience, also referenced in the 2001 TN Bulletin. This operating experience referred to five casks at the Surry ISFSI and one cask in the North Anna ISFSI that did not retain the original torque value at initial cask placement on the concrete pads. Lid bolts could be removed by hand on two of these casks. The licensee stated that in all cases there was no evidence that the lid metallic O-rings lost their seal due to the reduced torque. Further evaluation by TN confirmed that the lid seals would remain compressed and containment maintained. TN did not identify areas in the design of the bolted flange/seal that would cause the bolt preload to decrease with time. The licensee stated that a change in the bolt torquing sequence methodology should be implemented to mitigate against the possibility of thermal expansion causing this bolting issue. TN further recommended that lubricant should be applied to the bolts and special attention be paid to the calibration of the bolt torquing equipment. The licensee stated that these recommendations were incorporated in the applicable existing PINGP maintenance procedures.

The licensee further stated that recent operating experience at the Peach Bottom ISFSI identified corrosion of the lid bolts and outer-metallic seals due to loss of bolt-preload stress. The operating experience evaluation report (QF-0447, Rev 0, 2011) identified that the corrosion was caused by leakage of moisture past the protective cover. The report further stated that the corrective actions included replacing the cover seal, improving the bolt torquing process, and resealing the protective cover. The report identified thermal transients for the cask, such as during cask draining, as the root cause for the bolt loosening. As such, the operating experience has not demonstrated the loss of bolting preload as an age-related mechanism, hence, not subject to license renewal review.

The licensee stated that the dry storage (in-service) cask inter-seal helium pressures has revealed no issues with the seals or age related issues with the pressure monitoring system leak-tight integrity on all casks. The licensee also stated that there have been instances during extreme cold weather conditions when a low-pressure alarm was received requiring the pressure monitoring system to be recharged and the fittings tightened. However, these event-driven issues were identified as a function of extreme temperature conditions and not age-related. The licensee further stated that trending of periodic radiation surveys results shows no evidence that the shielding is degrading.

The staff reviewed the licensee's Operating Experience and found the licensee's evaluation of relevant operating experience demonstrates that the program will effectively manage aging effects of the dry storage (in-service) casks during the period of extended operation. The staff further confirmed that the loss of bolting preload identified by the licensee is not an age-related degradation mechanism, and hence not subject to the aging management review of the cask. The staff also determined the assessment of potential impacts of corrosion on the shield plate's intended functions acceptable because the bottom shield plate will maintain its intended functions during the license renewal period. The staff finds that the Operating Experience stated and referenced in the LRA provides reasonable assurance that this AMP will be adequate for managing the aging mechanisms and effects identified in the AMR of the dry storage (in-service) casks.

3.5.1.2 **Cask Polymer Neutron Shield**

~~The TN-40 and TN-40HT casks use polymer-based neutron shields to reduce neutron radiation from the spent fuel in the dry storage (in-service) casks. The ISFSI Inspection and Monitoring Program details the activities to manage the aging mechanisms and effects of the polymer materials in the neutron shields. The AMP also ensures that the ISFSI continues to meet the dose requirements per 10 CFR 72.104 during the period of extended operation. The licensee credits this program for ensuring that both the design basis "Radiation Protection Design Features," as described in Section A7.3 of the PINGP USAR (NSPM, 2010b) and ALARA considerations remain valid during the period of extended operation. The staff reviewed the AMP against the criteria provided in NUREG–1927 (NRC, 2011, Section 3.6.1). The staff's evaluation of each of the program elements is as follows:~~

Zhian's version below:

Both TN-40 and TN-40HT casks use polymer-based neutron shields to reduce neutron radiation coming from the spent fuel in the casks. One way to manage the aging effects of the neutron shields is to monitor the ~~their~~ performance of the neutron shields and take corrective actions when the dose rate outside the cask exceeds predetermined acceptance criteria.

Comment [JN36]: Zhian to decide which sections to keep in the specific elements. More specifically, decide what to keep/delete from the writing preceeded by "Zhian's version below"

ZL:

I took both parts.

Comment [JN37]: Is this referring to the cask or the shield performance here? Nate to speak to Zhian about this comment.

~~The licensee created a general AMP, "ISFSI Inspection and Monitoring Program."~~ The licensee credits this program for ensuring that both the design basis "Radiation Protection Design Features," as described in Section A7.3 of the PINGP USAR (NSPM, 2010b) and ALARA considerations remain valid during the period of extended operation. The staff reviewed the AMP against the criteria provided in NUREG–1927 (NRC, 2011, Section 3.6.1). The staff's evaluation of each of the program elements is as follows:~~This AMP includes the licensee's committed actions to manage the aging of the polymer-based neutron shields. For clarity, the staff reviewed the aging management actions that are related to managing the aging effects of the neutron shield.~~

1. Scope of Program

~~The licensee defined the scope of the program to include radiation monitoring and associated surveillance activities of the dry storage (in-service) casks. The licensee references applicable aging mechanisms and effects in Table A2.1-1 that are within the scope of this AMP. The aging effect managed by this program for the polymers (polypropylene, borated polyester) includes cracking due to material property changes from radiation exposure.~~

~~The staff reviewed the licensee's Scope of Program and determined that the licensee has identified the aging mechanisms and effects of the neutron shield polymers to be managed by the program. The staff finds the Scope of Program provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the neutron shield polymers.~~

Zhian's version below:

~~The neutron shield achieves its designed safety functions (i.e., reducing neutron radiations from the casks) by (i) reducing the neutron energy through moderations by the hydrogen and carbon atoms in the polymer and (ii) absorbing neutrons that have been slowed down by the boron in the shield.~~

The licensee defined the scope of the program as to monitor the performance of the neutron shield to assure that the ISFSI meets the dose requirements of 10 CFR 72.104 during the period of extended operation. The licensee also credits this program for ensuring that the design basis "Radiation Protection Design Features," as described in Section A7.3 of the PINGP USAR (NSPM, 2010b) and ALARA considerations, which was designed based on the physical conditions of the initial neutron shield, remain valid during the period of extended operation. The scope of the general AMP includes in its line item 3, radiation monitoring and associated surveillance activities of the dry storage (in-service) cask."

The neutron shield achieves its designed safety functions (i.e., reducing neutron radiations from the casks) by (i) reducing the neutron energy through moderations by the hydrogen and carbon atoms in the polymer and (ii) absorbing neutrons that have been slowed down by the boron in the shield. As such, monitoring the dose rates outside of the cask can be way to monitor the performance of the neutron shields.

The staff reviewed the definition of the scope of this program and finds that the licensee accurately defined the scope of the program. The components to be managed are clearly defined and the scope element is acceptable.

Comment [JN38]: Could probably get by with simply stating that " designed safety functions by reducing the amount of neutron radiation being emitted from the cask . Nate to speak to Zhian about this comment.

ZL:
Saying that the design basis safety function fo the neutron shielding is to reduce the amound of neutron radiation is conceptually in accurate. It is to reduce the dose rate which includes both reduction in number of neutron coming out from the cask surface and the energy these neutrons.

Comment [JN39]: I would suggest we think about whether we should supply so much detail here especially if the details about the polymer are considered to be proprietary. Nate to speak to Zhian about this comment.

2. Preventive Actions

~~The licensee defined the program as condition monitoring, which does not require any preventive actions.~~

~~The staff finds that the condition-monitoring program provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the polymer-based neutron shield.~~

Zhian's version below:

The licensee determined that this is a condition monitoring program and no preventive actions are required. The staff finds this element is adequately defined and hence acceptable.

3. Parameters Monitored or Inspected

The licensee identified the measured neutron dose rate as the parameters to be monitored. The licensee demonstrated that it is adequate to use quarterly neutron dose rate measurements as a means to detect loss of intended functions of the neutron shield.

The licensee has been performing and has committed to continuing to perform neutron dose rate measurements on a quarterly basis for each cask. The licensee states that the dose rate measurements will use neutron detectors that are capable of detecting increase in cask surface neutron intensity and shift of neutron spectrum.

The staff reviewed the entire AMP and finds that the neutron dose rate can be used as a means to detect loss of the intended function of the neutron shield because the intended function of the neutron shield is reduce neutron radiations so that the radiation exposure requirements of 10 CFR 72.104(a) and 72.140(b) are met. The dose rate is the essential parameter to monitor. Based on this basic physics principle, the staff finds that neutron dose rate is a direct and effective means to monitor the neutron shield performance.

Based on its review, the staff notes~~determined~~ that the measurement equipment, personnel qualification, and actual measurements should be inspected to en~~a~~ssure the measured data are suitable and reliable for this purpose.

4. Detection of Aging Effects

The base material of the neutron shield is polyrene that is made primarily of oxygen, carbon, hydrogen, and aluminum. Boron is added in the polymer to absorb neutrons that have been slowed down to lower energies and zinc is added to retard fire damage.

Based on research results and operating experience (NRC, 2010b; Chopra, et al., 2013; McManus and Chamis, 1996; Fu, et al., 1988; Cota, et al., 2007), when exposed to high-energy radiations and heat, polymer materials will degrade to shrink and further develop cracks. These aging effects will hinder the neutron shield to fulfil its design basis function with three mechanisms:

(1) Loss of neutron moderation capability because of thinning.

Comment [JN40]: Zhian to confirm that all these references were properly copied in the reference section.

ZL:
Looks good.

(2) Loss of neutron moderation capability because of the streaming paths formed due to cracks.

(3) Loss of neutron absorption capability because of B-10 redistribution or to a lesser degree, loss of B-10 due to depletion.

The net results of these aging effects are increase in number of neutrons coming out of the cask surface and increase in neutron energy (i.e., upward shifting of neutron spectrum). The licensee identified that an upshift of the neutron spectrum and increase in neutron flux are indicators of loss of the intended functions of the neutron shield.

The staff reviewed this conclusion and finds the licensee has identified all the aging effects of neutron shield. Based on its review, the staff finds that the licensee has adequately identified all major aging mechanisms and aging effects of the neutron shield. Therefore, the measurement of neutron dose rates outside the surface of each individual cask is an acceptable way for detecting aging of the polymer-based neutron shield.

DRAFT

5. Monitoring and Trending

The licensee stated that the measured neutron dose rate data will be trended and monitored to detect a loss of neutron shielding capacity. The licensee further stated that the AMP requires monitoring the condition of SSCs using current and historical operating experience along with industry operating experience to detect, evaluate, and trend degraded conditions. More specifically, the licensee clarified that when degraded conditions are detected and all associated corrective actions are complete, the SSCs will be monitored once again against performance goals.

The licensee further stated in the supplemented LRA (NSPM, 2014) that the "ISFSI Inspection and Monitoring Program," as a subset of the PINGP Structures Monitoring Program, requires that the program coordinator evaluate the results of the inspections for adverse trends including an evaluation of whether the frequency of the inspections should be increased. More specifically, the periodic structures inspection procedure contains requirements to generate an inspection report that includes a section on historical information and trends. The licensee clarified that this section is to contain relevant maintenance information on the structure collected while preparing for the inspection. At a minimum, the section will identify the status of Work Requests and Actions Requests issues during the previous inspection of the structure. The section will also include a discussion of the significance of past and present inspection findings. In particular, the licensee stated that this section addresses whether the findings represent an adverse trend or random deficiency indicative of normal structural aging.

The staff reviewed the licensee's Monitoring and Trending and determined that the licensee's monitoring and trending methods provide acceptable means to effectively predict the extent of the aging effects and timely corrective actions. The staff recognized that because licensee is using dose rate rather than neutron fluence as the parameter to be monitored, any neutron spectrum shift to higher energy will also be detected in the dose rate measurements. The staff further recognized that the dose rate is an integrated measurement that accounts for both the number of neutrons reaching the detector and a dose rate conversion factor, which is a function of neutron energy. The staff finds that the Monitoring and Trending provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the polymer-based neutron shield.

~~Zhian's version below:~~

~~The licensee will trend the measured neutron dose rate data to monitor progression, if any, of detected loss of neutron shielding capacity.~~

~~The staff reviewed the licensee proposed monitoring and trending methods. The staff recognized that because licensee is using dose rate rather than neutron fluence measurement as the parameter to be monitored, any neutron spectrum shift to higher energy will also be detected in the dose rate measurements. The dose rate is an integrated effect of number of neutrons getting into the detector and dose rate conversion factor, which is a function of neutron energy. Based on these facts, the staff finds the proposed monitoring and trending methods acceptable.~~

6. Acceptance Criteria

The following criteria will be used to determine if no loss of intended function has occurred

- No unexpected increase in neutron radiation intensity.
- No apparent neutron spectrum shift.
- No change in the neutron axial radiation profile.
- Neutron radiation measurement locations must be comprehensive to ensue any neutron shield degradation is detected.
- Neutron detector(s) must be appropriate for detecting the neutrons at all energy levels.
- Neutron detector(s) must be calibrated following appropriate quality assurance program.

The licensee license recognized the difficulties in performing neutron dose rate measurement and commits to using personnel who are qualified for measurement, operation monitoring and trending analyses in their respect areas of specialties. To that effect, the staff recommends thatThe the guidance on selecting and calibrating neutron dose rate measurement equipment monitoring should be commensurate with the recommendations of Jordan et al. (2005) and Johnson (2009).

Comment [JN41]: Zhian to clarify if this is what the licensee stated or what the NRC staff wants the licensee to do. Zhian to also verify these two references were properly incorporated in reference list.

The staff reviewed the proposed acceptance criteria. Based on its review, the staff finds these acceptance criteria acceptable because increase in dose rate indicates either a loss of materials or cracking of the neutron shield. Therefore, these acceptance criteria for the neutron shield monitoring are acceptable.

7. Corrective Actions

The licensee stated that immediate corrective actions would be taken if the acceptance criteria is not met. The licensee further clarified that these actions may include use of additional temporary shielding to limit the direct neutron radiations or sky shine to the side boundary. The licensee stated that a permanent solution will be taken after the root cause is determined.

The licensee stated that its Corrective Action Program requirements are established in accordance with the requirements of 10 CFR 50, Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants” and NSPM Quality Assurance Topical Report. The licensee stated that a single Corrective Action Program is applied regardless of the safety classification of the structure or component.

The licensee further stated that the Corrective Action Program procedures require the initiation of an Action Request for actual or potential problems including failures, malfunctions, discrepancies, deviations, defective material and equipment, nonconformances, and administrative control discrepancies, to ensure that conditions adverse to quality, operability, functionality, and reportability issues are promptly identified, evaluated if necessary, and corrected as appropriate. Guidance on establishing priority and timely resolution of issues is contained within the Corrective Action Program procedure. All corrective actions for deviating conditions that are adverse to quality are performed in accordance with the requirements of the

Quality Assurance Program which complies with the requirements of 10 CFR 50, Appendix B. Any resultant maintenance, repair/replacement activities, or special handling requirements are performed in accordance with approved procedures.

The licensee clarified that corrective actions provide reasonable assurance that deficiencies adverse to quality are either promptly corrected or evaluated to be acceptable. For evaluations that do not result in repair or replacement, engineering analysis is used to reasonably assure that the intended function is maintained consistent with the current licensing basis. If the deviating condition is assessed to be significantly adverse to quality, the cause of the condition is determined and an action plan is developed to preclude recurrence. Corrective actions identify recurring discrepancies and initiate additional corrective actions including root cause analysis to preclude recurrence. The licensee stated that degraded conditions identified by the AMP inspections will be entered into the Corrective Action Program. Actions required to resolve inspection findings will be tracked to completion and trended within the Corrective Action Program.

The licensee further clarified in the supplemented LRA (NSPM, 2014) that Corrective Action also contains provisions to:

- Determine if the condition is reportable to the NRC (e.g., results in the loss of intended function).
- Perform equipment evaluations, apparent cause evaluations, and root cause evaluations.
- Perform functionality assessments.
- Address the extent of condition.
- Determine actions to prevent recurrence.
- Identity operating experience actions.
- Trend conditions.

The licensee further clarified that it is through evaluations conducted as part of the Corrective Action Program that the determination would be made if an AMP, Monitoring Program, or inspection procedure would be revised.

The staff reviewed the licensee's commitments and finds them acceptable. Based on these statement, the staff considers that a timely action to reduce neutron radiations exceeding the acceptance criteria is practical and executable. The staff further considers that a permanent corrective action will be sufficient to assure that the dose limits of 10 CFR 72.104 and 72.126 are satisfied.

The staff further reviewed the details provided for the Corrective Action Program as part of the existing PINGP Quality Assurance Program. Per the requirements of 10 CFR 72.172, the staff expects that if an unanalyzed degraded condition is identified by the AMP inspections, the licensee will enter the finding into the Corrective Action Program and resolve the finding. The staff finds that the licensee's correction action program per the quality assurance requirements

in 10 CFR 50 Appendix B provides reasonable assurance that corrective actions will be adequate for managing the aging mechanisms and effects identified in the AMR of the polymer-based neutron shield.

~~Zhian's version:~~

~~The licensee commits to taking immediate corrective actions. These actions include use of temporary additional shielding to limit the direct neutron radiations or sky shine to the side boundary. A permanent solution will be taken after the root cause is determined.~~

~~The staff reviewed these commitments and finds them acceptable. A timely action to reduce neutron radiations is practical and executable. A permanent correction action is sufficient to assure the dose limits of 10 CFR 72.104 and 72.126.~~

8. Confirmation Process

The licensee credits its continuing monitoring of the dose rates at each cask as a means for confirmation of the effectiveness of the corrective actions. If further dose rate measurements show that new dose rates are higher than expected, further corrective actions, including use of additional neutron shield and root-cause analysis of the failed corrective actions, will be taken.

The staff reviewed the licensee proposed confirmation process and determined it acceptable. Measuring the dose rates or neutron fluence are the only means for confirmation of meeting the 10 CFR 72.104 and 72.126 dose limits.

9. Administrative Controls

The licensee will use the existing plant Quality Assurance Program consistent with the requirements of Appendix B of 10 CFR 50 to control the quality of the AMP. Since these programs have been reviewed and approved by the staff in the initial licensing process, the staff has a reasonable assurance that the site Quality Assurance Program remain acceptable and the staff hence did not perform further review of this part.

10. Operating Experience

The licensee discussed in general term regarding site specific and industry-wide operating experience. The licensee provided in its response to the staff's RAIs, historical gamma and neutron dose rate measurement data. From these data, there is no obvious increase in dose rate. Based on these results, the staff finds that there is no indication of loss of safety function of the neutron shield in the history of the PINGP ISFSI.

The staff reviewed the neutron shield AMP with respect the 10 elements as outlined in NUREG–1927 (NRC, 2011). The staff reviewed the method and the technical bases for the neutron shield monitoring program. Based on its review, the staff determined that the technical bases of this AMP are valid and the procedures implemented are reliable and accurate. On the bases of these assessments, the staff determined that the neutron shield monitoring AMP is adequate for managing the identified aging effects on the polymer-based neutron shield that is used in the TN-40 and TN-40 HT casks at the PINGP ISFSI.

3.5.1.3 Concrete Pads

The ISFSI Inspection and Monitoring Program details the activities to manage the aging mechanisms and effects of the reinforced concrete pads. The staff reviewed the AMP against the criteria provided in NUREG–1927 (NRC,2011, Section 3.6.1). The staff's evaluation of each of the program elements is as follows:

1. Scope of the Program

The licensee defined the scope of the program to include visual inspection of the concrete pads and monitoring of groundwater chemistry. The licensee references applicable aging mechanisms and effects in Table A2.1-1 that are within the scope of this AMP. The aging effects managed by this program for the concrete pads include:

- Change in material properties due to leaching of calcium hydroxide (above-grade/below-grade).
- Cracking or loss of material due to freeze-thaw degradation (above-grade).
- Cracking due to reaction with aggregates (above-grade/below-grade).
- Cracking due to settlement (below-grade).

The staff reviewed the licensee's Scope of the Program and determined that the licensee has identified the aging mechanisms and effects of concrete pads to be managed by the program. The staff finds the Scope of Program provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the concrete pads.

2. Preventive Actions

The licensee defined the visual inspection of the concrete pads as a condition monitoring program, which does not require any preventive actions. The licensee further defined the groundwater chemistry monitoring as a mitigation program to prevent aging effects from exposure to an aggressive chemical environment.

The staff finds that the condition monitoring and mitigation programs provide reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the concrete pads.

3. Parameters Monitored or Inspected

The licensee stated that the parameters to be monitored and inspected during the visual inspection of the concrete pads are consistent with those in industry codes and standards, including ACI 349.3R, "Evaluation of Existing Nuclear Safety-Related Concrete Structures." The aging effects that are monitored for the concrete pads are change in materials properties, cracking, and loss of material. The licensee further clarified that the aging management for change in materials properties (increased in porosity and permeability, reduced strength, lower pH) will be accomplished by managing the aging mechanism (i.e., by inspecting for evidence of leaching and deposits of calcium products).

The licensee stated that monitoring of the ground water chemistry for chloride, sulfate and pH will be used to verify that the concrete pads are not exposed to an aggressive chemical environment. The licensee stated that this AMP will ensure that parameters inspected focus on conditions identified during industry and plant specific operating experience reviews.

The staff reviewed the licensee's Parameters Monitored or Inspected for the visual inspections of the concrete pads and monitoring of the groundwater chemistry. Pursuant to Control of Special Processes in 10 CFR 72.158, the licensee shall establish measures to ensure that special processes, including nondestructive testing (such as visual inspections), is controlled and accomplished by qualified personnel using qualified procedures (with identified parameters to be inspected or monitored) in accordance with applicable codes, standards, specifications, criteria, and other special requirements. The staff finds that the Parameters Monitored or Inspected provides reasonable assurance for managing the aging mechanisms and effects, and ensuring the intended function of the concrete pads will be maintained during the period of extended operation.

4. Detection of Aging Effects

The detection of aging effects relies on visual inspection of the concrete pads. The licensee stated that accessible areas will be inspected at intervals not to exceed 5 years. The licensee further stated that opportunistic inspections will be used for inaccessible areas (e.g., inspection of the area underneath a cask if the cask is moved, or inspections of below-grade portions of the pad if excavated, exposed or modified for any reason).

The licensee stated that monitoring of groundwater chemistry will include sampling of well water and river water every 6 months. The licensee further stated in the supplemented LRA (NSPM, 2013) that water samples are obtained from the vicinity of the PINGP site. The samples will be characterized for chloride, sulfate and pH to periodically confirm that the concrete pads are not exposed to an aggressive chemical environment.

The staff reviewed the licensee's Detection of Aging Effects and determined that inspection methods and frequencies for the concrete pads provide acceptable means to effectively detect the aging mechanisms and effects so that the concrete pads will maintain their intended functions for the period of extended operation. Pursuant to Control of Special Processes in 10 CFR 72.158, the licensee shall establish measures to ensure that special processes, including nondestructive testing (such as visual inspections), is controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements. The licensee is relying upon the use of applicable industry codes and standards for the visual inspection, which is a type of nondestructive testing method. The staff expects that the licensee's choice and use of applicable codes and standards will provide reasonable assurance that the visual inspections will satisfy the requirements of 10 CFR 72.158. The staff finds that the Detection of Aging Effects provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the concrete pads.

5. Monitoring and Trending

The licensee stated that the AMP requires monitoring the condition of SSCs using current and historical operating experience along with industry operating experience to detect, evaluate, and trend degraded conditions. More specifically, the licensee clarified that when degraded

conditions are detected and all associated corrective actions are complete, the SSCs will be monitored once again against performance goals.

The licensee further stated in the supplemented LRA (NSPM, 2014) that the ISFSI Inspection and Monitoring Program, as a subset of the PINGP Structures Monitoring Program, requires that the program coordinator evaluates the results of the inspections for adverse trends including an evaluation of whether the frequency of the inspections should be increased. More specifically, the periodic structures inspection procedure contains requirements to generate an inspection report that includes a section on historical information and trends. The licensee clarified that this section is to contain relevant maintenance information on the structure collected while preparing for the inspection. At a minimum, the section will identify the status of Work Requests and Actions Requests issues during the previous inspection of the structure. The section will also include a discussion of the significance of past and present inspection findings. In particular, the licensee stated that this section addresses whether the findings represent an adverse trend or random deficiency indicative of normal structural aging.

The staff reviewed the licensee's Monitoring and Trending and determined that the licensee's monitoring and trending methods provide acceptable means to effectively predict the extent of the aging effects and timely corrective actions. The staff finds that the Monitoring and Trending provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the concrete pads.

6. Acceptance Criteria

The licensee stated the acceptance criteria for all visual inspections of the concrete pads are consistent with, or more restrictive than, those contained in Section 5.2.1 of ACI 349.3R (ACI, 2002) (i.e., the second-tier criteria). The licensee further clarified in the supplemented LRA (NSPM, 2014) some of the specific criteria that would lead to an Action Request for cracks, calcium streaks and deposits, surface scaling, spalling, rust stains and failure of old concrete patched. The licensee clarified that exceeding the parameters in such specific acceptance criteria would require entering the condition into the Corrective Action Program and evaluating if the condition is acceptable or if repair is required. The licensee also stated that the acceptance criteria for the groundwater chemistry monitoring are concentrations of chlorides ≤500 ppm, sulfates ≤1,500 ppm, and pH ≥5.5.

The staff reviewed the acceptance criteria in the consensus standard ACI 349.3R and determined that the second-tier criteria was adequate for determining a loss of intended function in the concrete pads. The NRC notes that the groundwater chemistry monitoring criteria was also found to be commensurate with ASME B&PV Code Section XI, Subsection IWL (ASME, 2013). The staff finds that the Acceptance Criteria provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the concrete pads.

7. Corrective Actions

The licensee stated that its Corrective Actions Program requirements are established in accordance with the requirements of 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants" and NSPM Quality Assurance Topical Report. The licensee stated that a single Corrective Action Program is applied regardless of the safety classification of the structure or component.

The licensee further stated that the Corrective Action Program procedures require the initiation of an Action Request for actual or potential problems including failures, malfunctions, discrepancies, deviations, defective material and equipment, nonconformances, and administrative control discrepancies, to ensure that conditions adverse to quality, operability, functionality, and reportability issues are promptly identified, evaluated if necessary, and corrected as appropriate. Guidance on establishing priority and timely resolution of issues is contained within the Corrective Action Program procedure. All corrective actions for deviating conditions that are adverse to quality are performed in accordance with the requirements of the Quality Assurance Program which complies with the requirements of 10 CFR 50, Appendix B. Any resultant maintenance, repair/replacement activities, or special handling requirements are performed in accordance with approved procedures.

The licensee clarified that corrective actions provide reasonable assurance that deficiencies adverse to quality are either promptly corrected or evaluated to be acceptable. For evaluations that do not result in repair or replacement, engineering analysis is used to reasonably assure that the intended function is maintained consistent with the current licensing basis. If the deviating condition is assessed to be significantly adverse to quality, the cause of the condition is determined and an action plan is developed to preclude recurrence. Corrective actions identify recurring discrepancies and initiate additional corrective actions including root cause analysis to preclude recurrence. The licensee stated that degraded conditions identified by the AMP inspections will be entered into the Corrective Action Program. Actions required to resolve inspection findings will be tracked to completion and trended within the Corrective Action Program.

The licensee further clarified in the supplemented LRA (NSPM, 2014) that Corrective Action also contains provisions to

- Determine if the condition is reportable to the NRC (e.g., results in the loss of intended function).
- Perform equipment evaluations, apparent cause evaluations, and root cause evaluations.
- Perform functionality assessments.
- Address the extent of condition.
- Determine actions to prevent recurrence.
- Identity operating experience actions.
- Trend conditions.

The licensee further clarified that it is through evaluations conducted as part of the Corrective Action Program that the determination would be made if an AMP, Monitoring Program, or inspection procedure would be revised.

The staff reviewed the details provided for the Corrective Action Program as part of the existing PINGP Quality Assurance Program. Per the requirements of 10 CFR 72.172, the staff expects that if an unanalyzed degraded condition is identified by the AMP inspections, the licensee will

enter the finding into the Corrective Action Program and resolve the finding. The staff finds that the licensee's correction action program per the quality assurance requirements in 10 CFR 50 Appendix B provides reasonable assurance that corrective actions will be adequate for managing the aging mechanisms and effects identified in the AMR of the concrete pads

8. Confirmation Process

The licensee stated that the confirmation process is part of the NSPM Corrective Action Program to ensure that the corrective actions taken are adequate and appropriate, have been completed, and are effective. The licensee further stated that the focus of the confirmation process is on the follow-up actions that must be taken to verify effective implementation of corrective actions. More specifically, the measure of effectiveness is in terms of correcting the adverse condition and precluding repetition of significant conditions adverse to quality. The licensee clarified that the Corrective Action Program procedures include provisions for timely evaluation of adverse conditions and implementation of any corrective actions required, including root cause evaluations and prevention of recurrence where appropriate. More specifically, these procedures provide for tracking, coordinating, monitoring, reviewing, verifying, validating, and approving corrective actions, to ensure effective corrective actions are taken.

The licensee further stated the Corrective Action Program is monitored for potentially adverse trends. More specifically, the existence of an adverse trend due to recurring or repetitive adverse conditions will result in the initiation of an Action Request. The licensee confirmed that the AMP will also uncover unsatisfactory conditions resulting from ineffective corrective action.

The staff reviewed the details provided for the licensee's Confirmation Process, as part of the existing Quality Assurance Program, to ensure that appropriate corrective actions are completed and are effective. The staff considers the licensee's Corrective Action Program per the quality assurance requirements in 10 CFR 50 Appendix B provides reasonable assurance that the Confirmation Process is adequate for managing the aging mechanisms and effects identified in the AMR of the concrete pads.

9. Administrative Controls

The licensee stated that the NSPM Quality Assurance Program, associated formal review and approval processes, and administrative controls applicable to the AMP are implemented in accordance with the requirements of the NSPM Quality Assurance Topical Report and 10 CFR Part 50, Appendix B. The licensee further stated that the administrative controls that govern aging management activities at PINGP are established in accordance with the PINGP Administrative Control Program and associated Fleet Procedures.

The staff reviewed the details provided for the licensee's Administrative Controls, as part of the existing Quality Assurance Program, to ensure that the administrative controls will be adequate to provide a formal review and approval process. The staff concludes that the NSPM Quality Assurance Program, per the quality assurance requirements in 10 CFR 50 Appendix B, provides reasonable assurance that the Administrative Controls are adequate for managing the aging mechanisms and effects identified in the AMR of the concrete pads.

10. Operating Experience

The licensee stated that visual inspections of the concrete pads were performed during the initial license period in accordance with existing PINGP procedures. The licensee further performed a review of ISFSI operating history during the initial license period. More specifically, the licensee provided a summary of the last two inspection reports including ISFSI structures.

During a quarterly inspection report in the third quarter of 2001, the licensee stated that shallow surface spalls around the base plates of three of the monitor stands adjacent to the casks. The licensee further stated that the Corrective Action Program evaluation determined these spalls acceptable, with a recommendation for inspections at a 7-year interval. The inspection also revealed four shrinkage cracks on the floor slab of the Equipment Storage Building (not within the scope of renewal). The licensee found the condition acceptable with a recommendation for periodic inspections every 7 years.

During the last inspection report including ISFSI structures, in the second quarter of 2008, the licensee initiated a work request to excavate to sound material the spalled concrete identified in the above referenced inspection of 2001. The licensee patched the excavated areas to prevent further degradation in these areas. The licensee stated that significant holes were also found along the foundation of the Alarm Monitoring Building (not within scope of renewal). The licensee corrected these deficiencies by filling these holes and compacting the affected soil.

As a result of the operating experience issues in the 2001 and 2008 inspections, the licensee decreased the inspection frequency interval from 7 years to 5 years. The licensee further stated that there have not been any Licensee Event Reports associated with the Prairie Island ISFSI. Moreover, the licensee stated that no any age-related degradation issues or findings for the concrete pads were identified after reviewing the ISFSI Corrective Action Program database.

The licensee conducted a review of precedent ISFSI license renewal application to evaluate any relevant operating experience, including Calvert Cliffs Nuclear Power Plant, H. B. Robinson Steam Electric Station, and Surry Power Station. The licensee did not identify any specific OE related to concrete structures from the conclusions of this review.

The licensee also performed a lead canister inspection, per NUREG–1927 (NRC, 2011, Appendix E, Rev. 0). Inspection of the concrete under the lifted cask did not exhibit visual signs of degradation.

The staff reviewed the licensee's Operating Experience and found no operating experience to indicate that the program would not be effective in managing the aging effects of the concrete pads during the period of extended operation. The staff finds that the operating experience stated and referenced in the LRA provides reasonable assurance that this AMP will be adequate for managing the aging mechanisms and effects identified in the AMR of the concrete pads.

3.5.1.4 **Earthen Berm**

The ISFSI Inspection and Monitoring Program details the activities to manage the aging mechanisms and effects of the earthen berm. The staff reviewed the AMP against the criteria provided in NUREG–1927 (NRC, 2011, Section 3.6.1). The staff's evaluation of each of the program elements is as follows:

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1. Scope of Program

The licensee defined the scope of the program to include visual inspection of the conditions and performance of the earthen berm. The licensee references applicable aging mechanisms and effects in Table A2.1-1 that are within the scope of this AMP. The aging effects managed by this program for the earthen berm include:

- Change in material properties due to desiccation.
- Loss of form due to settlement and frost action.
- Loss of material due to erosion.

The staff reviewed the licensee's Scope of Program and determined that the licensee has identified the aging mechanisms and effects of earthen berm to be managed by the program. The staff finds the Scope of Program provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the earthen berm.

2. Preventive Actions

The licensee defined the visual inspection of the earthen berm as a condition monitoring program, which does not require any preventive actions.

The staff finds that the condition monitoring program provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the earthen berm.

3. Parameters Monitored or Inspected

The licensee stated that the parameters to be monitored and inspected during the visual inspection of the earthen berm are consistent with those in industry codes and standards. The aging effects that are monitored for the earthen berm are change in material properties, loss of form, and loss of material.

The licensee stated that this AMP will ensure that parameters inspected focus on conditions identified during industry and plant specific operating experience reviews.

The staff reviewed the licensee's Parameters Monitored or Inspected for the visual inspections of the earthen berm. Pursuant to Control of Special Processes in 10 CFR 72.158, the licensee shall establish measures to ensure that special processes, including nondestructive testing (such as visual inspections), is controlled and accomplished by qualified personnel using qualified procedures (with identified parameters to be inspected or monitored) in accordance with applicable codes, standards, specifications, criteria, and other special requirements. The staff finds that the Parameters Monitored or Inspected provides reasonable assurance for managing the aging mechanisms and effects, and ensuring the intended function of the earthen berm will be maintained during the period of extended operation.

4. Detection of Aging Effects

The detection of aging effects relies on visual inspection of the earthen berm. The licensee stated that the earthen berm will be inspected at least once every 5 years.

The staff reviewed the licensee's Detection of Aging Effects and determined that inspection methods and frequencies for the earthen berm provide acceptable means to effectively detect the aging mechanisms and effects so that the concrete pads will maintain their intended functions for the period of extended operation. Pursuant to Control of Special Processes in 10 CFR 72.158, the licensee shall establish measures to ensure that special processes, including nondestructive testing (such as visual inspections), is controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements. The licensee is relying upon the use of applicable industry codes and standards for the visual inspection, which is a type of nondestructive testing method. The staff expects that the licensee's choice and use of applicable codes and standards will provide reasonable assurance that the visual inspections will satisfy the requirements of 10 CFR 72.158. The staff finds that the Detection of Aging Effects provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the earthen berm.

5. Monitoring and Trending

The licensee stated that the AMP requires monitoring the condition of SSCs using current and historical operating experience along with industry operating experience to detect, evaluate, and trend degraded conditions. More specifically, the licensee clarified that when degraded conditions are detected and all associated corrective actions are complete, the SSCs will be monitored once again against performance goals.

The licensee further stated in the supplemented LRA (NSPM, 2014) that the ISFSI Inspection and Monitoring Program, as a subset of the PINGP Structures Monitoring Program, requires that the program coordinator evaluates the results of the inspections for adverse trends including an evaluation of whether the frequency of the inspections should be increased. More specifically, the periodic structures inspection procedure contains requirements to generate an inspection report that includes a section on historical information and trends. The licensee clarified that this section is to contain relevant maintenance information on the structure collected while preparing for the inspection. At a minimum, the section will identify the status of Work Requests and Actions Requests issues during the previous inspection of the structure. The section will also include a discussion of the significance of past and present inspection findings. In particular, the licensee stated that this section addresses whether the findings represent an adverse trend or random deficiency indicative of normal structural aging.

The staff reviewed the licensee's Monitoring and Trending and determined that the licensee's monitoring and trending methods provide acceptable means to effectively predict the extent of the aging effects and timely corrective actions. The staff finds that the Monitoring and Trending provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the earthen berm.

6. Acceptance Criteria

The licensee stated that the acceptance criteria for all visual inspections of the earthen berm are the absence of any aging effects listed in Table A2.1-1 of the Appendix A to the LRA Rev. 1 (NSPM, 2014). More specifically, the licensee stated that the inspector will look for indications of:

- Slope instability (indication of loss of form aging effect): The licensee stated that the inspection procedure calls for the inspector to look for indications of sand boils, seepage, slippage of the embankment toe, and dropping of the embankment crown due to more than surface erosion.

- Settlement (indication of loss of form aging effect): The licensee stated that the inspection procedure relies upon the training and qualification of the inspectors (i.e., civil or structural degree and one or more years of structural inspection experience) to make the determination if settlement has occurred.

- Surface erosion (indication of loss of material and change in material properties aging effects): The licensee stated that the inspection procedure calls for the inspector to look for indications of rutting, raveling, loss of riprap, and other irregularities which over time have the potential to change embankment height and slope.

The licensee further stated in the supplemented LRA (NSPM, 2014) that a wide range of conditions may be observed during inspections of the berm, which are appropriately addressed in the inspection procedure, consistent with other earthen structures included in the Structures Monitoring Program for the PINGP site.

The staff reviewed the licensee's Acceptance Criteria in the supplemented LRA and Appendix A to the LRA Rev. 1 (NSPM, 2014), and determined that the criteria were adequate for determining a loss of intended function in the earthen berm. The staff finds that the Acceptance Criteria provides reasonable assurance for managing the aging mechanisms and effects identified in the AMR of the earthen berm.

7. Corrective Actions

The licensee stated that its Corrective Action Program requirements are established in accordance with the requirements of 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants" and NSPM Quality Assurance Topical Report. The licensee stated that a single Corrective Action Program is applied regardless of the safety classification of the structure or component.

The licensee further stated that the Corrective Action Program procedures require the initiation of an Action Request for actual or potential problems including failures, malfunctions, discrepancies, deviations, defective material and equipment, nonconformances, and administrative control discrepancies, to ensure that conditions adverse to quality, operability, functionality, and reportability issues are promptly identified, evaluated if necessary, and corrected as appropriate. Guidance on establishing priority and timely resolution of issues is contained within the Corrective Action Program procedure. All corrective actions for deviating conditions that are adverse to quality are performed in accordance with the requirements of the Quality Assurance Program which complies with the requirements of 10 CFR 50, Appendix B. Any resultant maintenance, repair/replacement activities, or special handling requirements are performed in accordance with approved procedures.

The licensee clarified that corrective actions provide reasonable assurance that deficiencies adverse to quality are either promptly corrected or evaluated to be acceptable. For evaluations that do not result in repair or replacement, engineering analysis is used to reasonably assure that the intended function is maintained consistent with the current licensing basis. If the

deviating condition is assessed to be significantly adverse to quality, the cause of the condition is determined and an action plan is developed to preclude recurrence. Corrective actions identify recurring discrepancies and initiate additional corrective actions including root cause analysis to preclude recurrence. The licensee stated that degraded conditions identified by the AMP inspections will be entered into the Corrective Action Program. Actions required to resolve inspection findings will be tracked to completion and trended within the Corrective Action Program.

The licensee further clarified in the supplemented LRA (NSPM, 2014) that Corrective Action also contains provisions to:

- Determine if the condition is reportable to the NRC (e.g., results in the loss of intended function).
- Perform equipment evaluations, apparent cause evaluations, and root cause evaluations.
- Perform functionality assessments.
- Address the extent of condition.
- Determine actions to prevent recurrence.
- Identity operating experience actions.
- Trend conditions.

The licensee further clarified that it is through evaluations conducted as part of the Corrective Action Program that the determination would be made if an AMP, Monitoring Program, or inspection procedure would be revised.

The staff reviewed the details provided for the Corrective Action Program as part of the existing PINGP Quality Assurance Program. Per the requirements of 10 CFR 72.172, the staff expects that if an unanalyzed degraded condition is identified by the AMP inspections, the licensee will enter the finding into the Corrective Action Program and resolve the finding. The staff finds that the licensee's correction action program per the quality assurance requirements in 10 CFR 50 Appendix B provides reasonable assurance that corrective actions will be adequate for managing the aging mechanisms and effects identified in the AMR of the earthen berm.

8. Confirmation Process

The licensee stated that the confirmation process is part of the NSPM Corrective Action Program to ensure that the corrective actions taken are adequate and appropriate, have been completed, and are effective. The licensee further stated that the focus of the confirmation process is on the follow-up actions that must be taken to verify effective implementation of corrective actions. More specifically, the measure of effectiveness is in terms of correcting the adverse condition and precluding repetition of significant conditions adverse to quality. The licensee clarified that the Corrective Action Program procedures include provisions for timely evaluation of adverse conditions and implementation of any corrective actions required, including root cause evaluations and prevention of recurrence where appropriate. More

specifically, these procedures provide for tracking, coordinating, monitoring, reviewing, verifying, validating, and approving corrective actions, to ensure effective corrective actions are taken.

The licensee further stated the Corrective Action Program is monitored for potentially adverse trends. More specifically, the existence of an adverse trend due to recurring or repetitive adverse conditions will result in the initiation of an Action Request. The licensee confirmed that the AMP will also uncover unsatisfactory conditions resulting from ineffective corrective action.

The staff reviewed the details provided for the licensee's Confirmation Process, as part of the existing Quality Assurance Program, to ensure that appropriate corrective actions are completed and are effective. The staff considers the licensee's Corrective Action Program per the quality assurance requirements in 10 CFR 50 Appendix B provides reasonable assurance that the Confirmation Process is adequate for managing the aging mechanisms and effects identified in the AMR of the earthen berm.

9. Administrative Controls

The licensee stated that the NSPM Quality Assurance Program, associated formal review and approval processes, and administrative controls applicable to the AMP are implemented in accordance with the requirements of the NSPM Quality Assurance Topical Report and 10 CFR Part 50, Appendix B. The licensee further stated that the administrative controls that govern aging management activities at PINGP are established in accordance with the PINGP Administrative Control Program and associated Fleet Procedures.

The staff reviewed the details provided for the licensee's Administrative Controls, as part of the existing Quality Assurance Program, to ensure that the administrative controls will be adequate to provide a formal review and approval process. The staff concludes that the NSPM Quality Assurance Program, per the quality assurance requirements in 10 CFR 50 Appendix B, provides reasonable assurance that the Administrative Controls are adequate for managing the aging mechanisms and effects identified in the AMR of the earthen berm.

10. Operating Experience

The licensee stated that visual inspections of the earthen berm were performed during the initial license period in accordance with existing PINGP procedures. The licensee further performed a review of ISFSI operating history during the initial license period. More specifically, the licensee provided a summary of the last two inspection reports including ISFSI structures.

The licensee stated no anomalies have been identified for the earthen berm.

The staff reviewed the licensee's Operating Experience and found no operating experience to indicate that the program would not be effective in managing the aging effects of the earthen berm during the period of extended operation. The staff finds that the operating experience stated and referenced in the LRA provides reasonable assurance that this AMP will be adequate for managing the aging mechanisms and effects identified in the AMR of the earthen berm.

3.5.2 High Burnup Fuel Monitoring Program

The licensee stated that the ISFSI provides for long-term dry fuel interim storage for high burnup spent fuel assemblies (i.e., fuel assemblies with discharge burnups between 45 and 60 GWD/MTU). The licensee's AMR of the high burnup SFAs in a dry inert environment did not identify any aging effects/mechanisms that could lead to a loss of intended function. However, the licensee recognized that there has been relatively little operating experience, to date, with dry storage of high burnup fuel. Therefore, the licensee provided an AMP in Section 3.0 of Appendix A to the LRA Rev. 1, entitled "High Burnup Fuel Monitoring Program." The licensee stated that the purpose of the High Burnup Fuel Monitoring Program is to confirm that the high burnup fuel assemblies' intended function(s) are maintained during the period of extended operations.

The licensee's AMP was submitted in conformance to ISG-24, which identifies an acceptable confirmation method through a surrogate high burnup fuel surveillance program. The AMP is based on the U.S. Department of Energy (DOE) funded high burnup fuel dry storage cask demonstration program (EPRI, 2014) or other high burnup fuel surveillance demonstrations that meet the criteria of ISG-24. ISG-24 entitled "The Use of a Demonstration Program as a Surveillance Tool for Confirmation of Integrity for Continued Storage of High Burnup Fuel Beyond 20 Years" provides the acceptance criteria for the surveillance demonstration. NRC staff also developed ISG-11 Rev 3 with models that extrapolate the expected performance of low and high burnup fuel during storage. The licensee's AMP relies on a surrogate surveillance program to confirm that the high burnup fuel performance continues as expected and support the conclusions drawn in ISG-11 Rev 3 prior to moving into the period of extended operation beyond the initial 20 years period. The NRC staff recognizes that this is a similar approach to that used to provide reasonable assurance for low burnup fuel performance (EPRI, 2002, 2014; Einziger, et al., 2003a & b; Bare, et al., 2001).

1. Scope of Program

The licensee defined the scope of the program to include high burnup spent fuel assemblies with discharge burnups between 45 and 60 GWD/MTU. The licensee stated that the initial fuel assemblies covered under this AMP were placed into dry storage in a TN-40HT cask on April 4, 2013.

The licensee stated that the spent fuel cladding materials are either Zircaloy-4 or Zirlo^{TM} stored in a dry helium environment. The licensee further stated that the aging effects will be determined for material/environment combinations per ISG-24 Rev. 0 or the "High Burnup Dry Storage Cask Research and Development Project" (HDRP).

The licensee stated that the AMP relies upon the joint Electric Power Research Institute (EPRI) and Department of Energy (DOE) "High Burnup Dry Storage Cask Research and Development Project" (HDRP), or an alternative program meeting the guidance in Interim Staff Guidance (ISG) 24 as a surrogate program to monitor the condition of high burnup spent fuel assemblies in dry storage. The licensee further stated that the HDRP is a program designed to collect data from a spent nuclear fuel storage system containing high burnup fuel in a dry helium environment. More specifically, the program entails loading and storing a TN-32 bolted lid cask (the Research Project Cask) at Dominion Virginia Power's North Anna Power Station with intact high burnup spent nuclear fuel (with nominal burnups ranging between 53 GWd/MTU and 58 GWd/MTU). The fuel assemblies to be used in the HDRP include four different kinds of

cladding (Zircaloy-4, low-tin Zircaloy-4, Zirlo™, and M5™). The licensee clarified that the HDRP cask is to be licensed to the temperature limits contained in ISG-11, and loaded such that the fuel cladding temperature is as close to the limit as practicable.

The staff reviewed the licensee's Scope of Program, which is defined by the DOE-funded HDRP or alternative program meeting the criteria in Interim Staff Guidance (ISG) 24. The staff finds that the Scope of Program provides reasonable assurance that the licensee will be informed of any aging mechanisms and effects from such surrogate surveillance program. The staff further finds that such surrogate surveillance program will serve as confirmation that fuel performs as expected per ISG-11 Rev 3, and can be readily retrieved.

2. Preventive Actions

The licensee stated that the AMP is a condition monitoring program to confirm there is no degradation of a high burnup fuel assembly that would result in a loss of intended function(s). The licensee further stated that no preventive or mitigating attributes are associated with this AMP, except initial design limits placed during loading operations. More specifically, the licensee referenced technical specifications that ensure fuel is stored in an inert environment thus preventing cladding degradation due to oxidation. TS 3.1.1, "Cask Cavity Vacuum Drying," demonstrates that the cask cavity is dry by maintaining a cavity absolute pressure less than or equal to 10 mbar for a 30 minute period with the cask isolated from the vacuum pump. In addition, TS 3.1.2, "Cask Helium Backfill Pressure," requires that the cask is backfilled with helium and that the inert environment be established within 34 hours of commencing cask draining. The licensee clarified that this time requirement ensures that the peak cladding temperature remains below 752°F (i.e., the temperature specified in ISG-11), thus mitigating degradation due to cladding creep.

The staff reviewed the licensee's Preventive Actions and finds it provides reasonable assurance that the licensee will be informed of any aging mechanisms and effects by the DOE-funded HDRP or alternative program meeting the criteria in Interim Staff Guidance (ISG) 24. The staff further finds that such surrogate surveillance program will serve as confirmation that fuel performs as expected per ISG-11 Rev 3, and can be readily retrieved.

3. Parameters Monitored or Inspected

The licensee stated that the Parameters Monitored or Inspected are defined by the HDRP or alternative surveillance surrogate program meeting the criteria in ISG-24.

The staff reviewed the licensee's Parameters Monitored or Inspected and find it provides reasonable assurance that the licensee will be informed of any aging mechanisms and effects by the DOE-funded HDRP or alternative program meeting the criteria in Interim Staff Guidance (ISG) 24. The staff further finds that such surrogate surveillance program will serve as confirmation that fuel performs as expected per ISG-11 Rev 3, and can be readily retrieved.

4. Detection of Aging Effects

The licensee stated that the Detection of Aging Effects are defined by the HDRP or alternative surveillance surrogate program meeting the criteria in ISG-24.

The staff reviewed the licensee's Detection of Aging Effects and finds it provides reasonable assurance that the licensee will be informed of any aging mechanisms and effects by the DOE-funded HDRP or alternative program meeting the criteria in Interim Staff Guidance (ISG) 24. The staff further finds that such surrogate surveillance program will serve as confirmation that fuel performs as expected per ISG-11 Rev 3, and can be readily retrieved.

5. Monitoring and Trending

The licensee stated that, as information/data from the surrogate surveillance program becomes available, it will monitor, evaluate, and trend the information via its Operating Experience Program and/or the Corrective Action Program to determine what actions should be taken to manage fuel and cladding performance, if any.

The licensee stated it will use its Operating Experience Program and/or Corrective Action Program to determine what actions should be taken if it receives information/ data from other sources than the demonstration program on fuel performance.

The licensee further stated it will perform formal evaluations of the aggregate feedback from the HDRP and other sources of information at the specific points in time during the period of extended operation. These evaluations will include an assessment of the continued ability of the high burnup fuel assemblies to continue to perform their intended function(s) at each point. The licensee stated that these separate evaluations will occur by April 4 of 2028, 2038 and 2048, respectively.

The NRC staff finds that the schedule for the Monitoring and Trending provided in the AMP, which takes into account operating experience with fuels gained from any other sources, will deliver the requisite reasonable assurance prior to the high burnup fuel entering into the period of extended operation in 2033. The staff further finds that the surrogate surveillance program will serve as confirmation that fuel performs as expected per ISG-11 Rev 3, and can be readily retrieved.

6. Acceptance Criteria

The licensee stated that the Acceptance Criteria are defined by the HDRP or alternative surveillance surrogate program meeting the criteria in ISG-24.

The licensee further clarified that if any of the following fuel performance criteria are exceeded in the HDRP or alternative program, a corrective action will be required:

- Cladding Creep—total creep strain extrapolated to the total approved storage duration based on the best fit to the data, accounting for initial condition uncertainty shall be less than 1 percent.

- Hydrogen—maximum hydrogen content of the cover gas over the approved storage period shall be extrapolated from the gas measurements to be less than 5 percent.

- Drying—The moisture content in the cask , accounting for measurement uncertainty, shall indicate no greater than one liter of residual water after the drying process is complete

- Fuel rod breach—fission gas analysis shall not indicate more than 1 percent of the fuel rod cladding breaches.

The staff reviewed the licensee's Acceptance Criteria and finds it provides reasonable assurance that the licensee will be informed of any aging mechanisms and effects by the DOE-funded HDRP or alternative program meeting the criteria in Interim Staff Guidance (ISG) 24. The staff further finds that such surrogate surveillance program will serve as confirmation that fuel performs as expected per ISG-11 Rev 3, and can be readily retrieved.

7. Corrective Actions

The licensee stated that its Corrective Actions Program requirements are established in accordance with the requirements of 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants" and NSPM Quality Assurance Topical Report. The licensee further stated that a single Corrective Action Program is applied regardless of the safety classification of the structure or component.

The licensee clarified that, at each of the assessments detailed in AMP Section 5, the impact of the aggregate feedback will be assessed and actions taken when warranted. The licensee further clarified that these evaluations will address any lessons learned and take appropriate corrective actions, including:

- Perform repairs or replacements
- Modify this confirmatory program in a timely manner
- Adjust age-related degradation monitoring and inspection programs (e.g., scope, frequency)
- Actions to prevent reoccurrence
- An evaluation of the DCSS to perform it's safety and retrievability functions
- Evaluation of the effect of the corrective actions on this component to other safety components.

The staff reviewed the details provided for the Corrective Action Program as part of the existing PINGP Quality Assurance Program. Per the requirements of 10 CFR 72.172, the staff expects that if an unanalyzed degraded condition is identified by the surrogate surveillance program, the licensee will enter the finding into the Corrective Action Program and resolve the finding. The staff finds that the licensee's correction action program per the quality assurance requirements in 10 CFR 50 Appendix B provides reasonable assurance that corrective actions will be adequate for managing any aging mechanisms and effects identified by the DOE-funded HDRP or alternative program meeting the criteria in Interim Staff Guidance (ISG) 24.

8. Confirmation Process

The licensee stated that the confirmation process is part of the NSPM Corrective Action Program to ensure that the corrective actions taken are adequate and appropriate, have been completed, and are effective. The licensee further stated that the focus of the confirmation

process is on the follow-up actions that must be taken to verify effective implementation of corrective actions. More specifically, the measure of effectiveness is in terms of correcting the adverse condition and precluding repetition of significant conditions adverse to quality. The licensee clarified that the Corrective Action Program procedures include provisions for timely evaluation of adverse conditions and implementation of any corrective actions required, including root cause evaluations and prevention of recurrence where appropriate. More specifically, these procedures provide for tracking, coordinating, monitoring, reviewing, verifying, validating, and approving corrective actions, to ensure effective corrective actions are taken.

The staff reviewed the details provided for the licensee's confirmation process, as part of the existing Quality Assurance Program, to ensure that appropriate corrective actions are completed and are effective. The staff considers the licensee's Correction Action Program per the quality assurance requirements in 10 CFR 50 Appendix B provides reasonable assurance that the confirmation process is adequate for managing any aging mechanisms and effects identified by the DOE-funded HDRP or alternative program meeting the criteria in Interim Staff Guidance (ISG) 24.

9. Administrative Controls

The licensee stated that the NSPM Quality Assurance Program, associated formal review and approval processes, and administrative controls applicable to the AMP are implemented in accordance with the requirements of the NSPM Quality Assurance Topical Report and 10 CFR Part 50, Appendix B. The licensee further stated that the administrative controls that govern aging management activities at PINGP are established in accordance with the PINGP Administrative Control Program and associated Fleet Procedures.

The staff reviewed the details provided for the licensee's administrative controls, as part of the existing Quality Assurance Program, to ensure that the administrative controls will be adequate to provide a formal review and approval process. The staff concludes that the NSPM Quality Assurance Program, per the quality assurance requirements in 10 CFR 50 Appendix B, provides reasonable assurance that the administrative controls are adequate for managing any aging mechanisms and effects identified by the DOE-funded HDRP or alternative program meeting the criteria in Interim Staff Guidance (ISG) 24.

10. Operating Experience

The licensee stated that it intends to rely on the information from the HDRP with similar types of HBU fuel. The licensee further stated that it will evaluate and take any additional data/research to assess fuel performance from both domestic and international sources that are relevant to the fuel in the NSPM casks.

The staff reviewed the licensee's "operating experience" program element and found no operating experience to indicate that the surrogate surveillance program would not be effective in managing any aging mechanisms and effects identified by the DOE-funded HDRP or alternative program meeting the criteria in Interim Staff Guidance (ISG) 24.

3.5.3 Evaluation Findings

The staff reviewed the AMPs presented in the application against the regulatory requirements of 10 CFR 72.42. The staff verified that the AMPs are adequately identified and appropriate for

managing the aging effects identified for the SSCs. The staff also verified that the methods and technical bases of these AMPs are acceptable. Based on its review of the information and representation, the staff finds:

F3.4 The licensee has identified maintenance and surveillance programs that will provide reasonable assurance that aging effects would be managed during the period of extended operation, in accordance with 10 CFR Part 72.

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4 CONCLUSION

Pursuant to 10 CFR 72.42(a), the Commission may issue a renewed license if it finds that actions have been identified and have been or will be taken, such that there is reasonable assurance that the activities authorized by the renewed license will continue to be conducted in accordance with the current licensing basis (CLB).

The staff of the U.S. Nuclear Regulatory Commission (NRC) (the staff) reviewed the license renewal application (LRA) for the Independent Spent Fuel Storage Installation at the Prairie Island Nuclear Generating Plant, in accordance with NRC regulations 10 CFR 72.42(a). The staff followed the guidance provided in NUREG–1927, "Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance" and ISGs as identified in Table 1-1. Based on its review of the LRA, the staff determines that the requirements of 10 CFR 72.42(a) have been met.

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APPENDIX A
PROCEDURE AND ACTIONS OF AGING MANAGEMENT PROGRAMS

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APPENDIX B
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APPENDIX C
TITLE 10 OF CODE OF FEDERAL REGULATIONS