Xcel Energy®

Prairie Island Nuclear Generating Plant
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May 23, 2014

L-PI-14-031
10 CFR 72.56

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

Prairie Island Independent Spent Fuel Storage Installation
Docket No. 72-10
Materials License No. SNM-2506

Prairie Island Independent Spent Fuel Storage Installation - License Amendment Request to Revise Cavity Pressurization Requirements for TN-40 and TN-40HT Spent Fuel Storage Casks

Reference: NSPM letter, M.A. Schimmel to NRC Document Control Desk, "Prairie Island Independent Spent Fuel Storage Installation (ISFSI) License Renewal Application," L-PI-11-074, dated October 20, 2011, ADAMS Accession No. ML11304A068.

Pursuant to 10 CFR 72.56, the Northern States Power Company, a Minnesota Corporation (NSPM), doing business as Xcel Energy, hereby requests approval from the Nuclear Regulatory Commission (NRC) of an amendment to the materials license for the Prairie Island Independent Spent Fuel Storage Installation (ISFSI).

This license amendment request (LAR) proposes to revise the cask cavity pressurization requirements and their technical bases for the Prairie Island ISFSI spent fuel storage casks. The ISFSI Safety Analysis Report (SAR) currently states that cask cavity pressure will be maintained at or above one atmosphere absolute on the coldest day at the end of life. This criterion is met for the initial 20-year storage period. However, during operation beyond the initial 20-year storage period, additional cooling of cask contents will result in a decrease in cavity pressures below ambient.

The evaluation in Enclosure 2 explains that this reduction in cavity pressure does not affect the casks' containment integrity and does not affect the nonreactive helium environment within cask cavities. These barriers against oxidation will continue to effectively protect stored cladding and fuel materials. NSPM proposes that the cask design criteria be revised to accept sub-atmospheric cavity pressures. This LAR includes proposed changes to the ISFSI Technical Specifications (TS), TS Bases, and SAR.

NSPM is requesting approval of this LAR to avoid re-pressurizing casks after long term storage. The casks are provided with connections to allow them to be re-pressurized; however, the process involves cask handling risks and worker radiation exposures that NSPM does not consider to be warranted, as explained in Enclosure 2 to this LAR.

Enclosure 1 to this letter contains the oath or affirmation statement required pursuant to 10 CFR 72.16(b).

Enclosure 2 to this letter contains the technical evaluation and regulatory safety analysis of the proposed changes. Proposed markups of the ISFSI TS, TS Bases are included, along with some applicable SAR markups to illustrate key licensing basis changes.

NSPM has determined that the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(11) and, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared. In addition, pursuant to 10 CFR 51.60(b)(2), no environmental report need be prepared. The proposed changes do not require any changes to the PI ISFSI Environmental Report.

NSPM requests NRC review and approval of this LAR by March 2015 to avoid activities associated with re-pressurizing cask cavities. This LAR does not rely upon any of the technical issues or SAR changes addressed in the referenced License Renewal Application, and NSPM considers that these two requests may be reviewed independently.

If there are any questions or if additional information is needed, please contact Gene Eckholt at 651-267-1742.

Summary of Commitments

This letter contains no new commitments and no revisions to existing commitments.

Kevin Davison
Site Vice President, Prairie Island Nuclear Generating Plant
Northern States Power Company - Minnesota

Enclosures (2)

cc: Administrator, Region III, USNRC (letter only)
SFST Project Manager, Prairie Island ISFSI, USNRC (8 copies with Enclosures)
NRR Project Manager, Prairie Island Nuclear Generating Plant, USNRC (letter only)
Resident Inspector, Prairie Island Nuclear Generating Plant, USNRC (letter only)
State of Minnesota (letter only)

ENCLOSURE 1

Oath or Affirmation Pursuant to 10 CFR 72.16

1 Page Follows

UNITED STATES NUCLEAR REGULATORY COMMISSION

NORTHERN STATES POWER COMPANY - MINNESOTA

PRAIRIE ISLAND INDEPENDENT SPENT FUEL STORAGE INSTALLATION
DOCKET NO. 72-10

REQUEST FOR AMENDMENT TO
MATERIALS LICENSE No. SNM-2506

LICENSE AMENDMENT REQUEST
TO REVISE CAVITY PRESSURIZATION REQUIREMENTS FOR TN-40
AND TN-40HT SPENT FUEL STORAGE CASKS

The Northern States Power Company, a Minnesota corporation, d/b/a Xcel Energy (hereafter "NSPM") requests approval to revise the cavity pressurization requirements for TN-40 and TN-40HT spent fuel storage casks as described in Enclosure 2, which contains the evaluation of the proposed changes.

NORTHERN STATES POWER COMPANY - MINNESOTA

By [signature]
Kevin Davison
Site Vice President - Prairie Island Nuclear Generating Plant
Northern States Power Company - Minnesota

State of Minnesota

County of Hennepin

On this 23 day of May, 2014 before me a notary public acting in said County, personally appeared Kevin Davison, Site Vice President, Prairie Island Nuclear Generating Plant, and being first duly sworn acknowledged that he is authorized to execute this document on behalf of NSPM, that he knows the contents thereof, and that to the best of his knowledge, information, and belief the statements made in it are true.

Sandra Lynn Humenansky

SANDRA LYNN HUMENANSKY
NOTARY PUBLIC-MINNESOTA
My Commission Expires Jan. 31, 2017

ENCLOSURE 2

Evaluation of Proposed Changes

License Amendment Request to Revise Cavity Pressurization Requirements for TN-40 and TN-40HT Spent Fuel Storage Casks

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2. Detailed Description
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ATTACHMENTS:

1. ISFSI Technical Specifications Marked-Up Pages
2. ISFSI Technical Specifications Revised Pages
3. ISFSI Technical Specifications Bases Marked-Up Pages (for information only)
4. ISFSI SAR Marked-Up Pages (for information only)

1. Summary Description

Pursuant to 10 CFR 72.56, the Northern States Power Company, a Minnesota Corporation (NSPM) doing business as Xcel Energy, hereby requests an amendment to the materials license for the Prairie Island Independent Spent Fuel Storage Installation (ISFSI). NSPM requests approval from the Nuclear Regulatory Commission (NRC) to change a design criterion and revise the requirements and bases for helium pressurization of the Prairie Island ISFSI spent fuel storage casks.

Helium pressurization of cask cavities is established as part of the cask loading process. Each cask cavity is evacuated to remove oxidizing gases and is then backfilled with helium. The helium backfill process pressurizes cask cavities to meet a current design criterion in the ISFSI Safety Analysis Report (SAR) that as cask contents cool, the cavity pressure will remain at or above one atmosphere absolute on the coldest day at the end of life. The minimum initial pressurization value is calculated to ensure a pressure of at least one atmosphere with an ambient temperature of -40°F after a storage period of 20 years (TN-40) or 25 years (TN-40HT casks). This analyzed storage period for the "end of life" is consistent with the initial 20-year license period for the ISFSI. However, during operation beyond the initial 20-year storage period, cavity pressures may decrease below ambient.

Cask cavity pressure, whether above or below ambient, does not affect containment integrity or the helium environment within the cask cavities. The helium backfill process initially pressurizes the cask cavity and ensures that the amount of oxidizing gases is less than 0.25% (volume). This ensures that oxidizing gas concentration is below levels where cladding degradation could be expected. Although cavity pressure will decrease over time, the amount of oxidizing gas in the cavity will not increase. Therefore, cavity pressures below atmospheric do not affect the protection of cladding and fuel materials against potential oxidation.

The reduction of oxidizing gases to less than 0.25% (volume) is assured by evacuating the cavity to less than 14 mbar absolute and then backfilling and pressurizing the cavity with helium to at least 1345 mbar absolute. The 1345 mbar pressure is currently verified in TS SR 3.1.2.2. NSPM proposes to add a new Technical Specification (TS) Surveillance Requirement (SR) to verify the 14 mbar absolute evacuation pressure, as shown in the TS markups described later in this Enclosure.

NSPM is requesting approval of this license amendment request (LAR) to avoid re-pressurizing casks after long term storage. The casks are provided with connections to allow them to be re-pressurized; however, the process involves cask handling risks and worker radiation exposures that NSPM does not consider to be warranted, as explained in the Technical Evaluation later in this Enclosure.

The proposed change will be reflected in revisions to TS 3.1.2, *Cask Helium Backfill Pressure,* the TS Bases for TS 3.1.2, and the ISFSI SAR.

2. Detailed Description

2.1 Background

The Prairie Island ISFSI includes dry storage casks manufactured by Transnuclear, Inc., models TN-40 and TN-40HT. Spent fuel is stored in each cask within a robust sealed containment vessel filled with a helium cover gas. Helium provides heat transfer and maintains an inert, non-reactive environment.

An inert environment protects against degradation of fuel cladding and fuel materials due to oxidation. Oxidation of cladding could lead to physical damage and dimensional changes that could affect the retrievability of fuel in the future.

Typically, spent fuel stored in the Prairie Island ISFSI does not contain a cladding breach. However, in the event that a pinhole leak were to develop in the cladding, an inert environment will also protect against oxidation of fuel, which would also present risks of dimensional changes that could affect future retrievability.

An inert environment is established during the cask loading process by evacuating the cask cavity and then backfilling and pressurizing it with helium. Air in-leakage is precluded by maintaining containment integrity.

Containment integrity and an inert, nonreactive helium environment are maintained independent of cask cavity pressure as described in the Technical Evaluation later in this Enclosure.

2.2 Proposed Technical Specification Changes

Attachment 1 to this enclosure includes a markup of the proposed changes to TS 3.1.2 and Attachment 2 includes a clean re-typed version of these revised pages which include the following changes:

- SR 3.1.2.2: Add a new SR to verify that the cask cavity pressure is reduced to ≤ 14 mbar absolute prior to backfilling the cavity with helium. This will remove potentially oxidizing gases from the cavity so that the total amount of residual oxidizing gases will be less than 0.25% (volume) after the refill pressure has been established in accordance with SR 3.1.2.3.

- SR 3.1.2.3: Re-number the existing SR 3.1.2.2. This SR verifies that cask cavity helium pressure is at least 1345 mbar absolute, and no greater than 1445 mbar absolute. This pressure, when combined with the new SR 3.1.2.2 will ensure that the total amount of residual oxidizing gases will be less than

0.25% (volume). No changes are made to this SR other than the change in SR designation.

2.3 Proposed Technical Specification Bases Changes

Attachment 3 to this enclosure includes a markup of changes to the TS Bases, for information only. These changes include:

- TS Bases B 3.1.2, Cask Helium Backfill Pressure, SR 3.1.2.2

  A new Bases discussion is added to explain the cavity evacuation pressure requirement proposed as SR 3.1.2.2. This evacuation is part of the cask loading process as shown in the Sequence of Operations in Figure 5.1.1 of the SAR, but has not previously been included in a TS requirement. The evacuation pressure is proposed to be added as a new TS SR to ensure that the total amount of oxidizing gases in the cask cavity is less than 0.25% (volume), when combined with the helium backfill pressure requirement in TS SR 3.1.2.3 (re-numbered from existing SR 3.1.2.2).

- TS Bases B 3.1.2, Cask Helium Backfill Pressure, SR 3.1.2.3

  SR 3.1.2.3 is a re-numbered version of the current TS SR 3.1.2.2, and identifies the helium backfill pressure requirement of 1345 to 1445 mbar absolute. The Bases for this pressure requirement is changed from precluding in-leakage of air to ensuring that the total amount of oxidizing gases in the cavity is less than 0.25% (volume), when combined with the cavity evacuation required by the new SR 3.1.2.2. This is below the level at which degradation of cladding materials could be expected, as described in an evaluation of cover gas impurities performed by Pacific Northwest Laboratories (Reference 2) and as referenced in NUREG-1536, *Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility,* (Reference 3), Section 9.5.1, *Cask Loading.*

  The SR value of 1345 mbar absolute is acceptable because it provides ample margin to the value (1320 mbar absolute) used in the technical analysis.

2.4 Proposed Safety Analysis Report Changes

The following proposed ISFSI SAR changes are provided for information only:

- Delete statements about maintaining pressure at or above ambient on the coldest day at the end of licensed life.

- Delete discussions about maintaining cask cavity pressure above ambient to preclude air in-leakage.

- Revise the purpose of helium pressurization to explain how reducing the total amount of oxidizing gases to less than 0.25% (volume) will help ensure the integrity of cladding materials.

- Replace SAR Section A3.3.2.2.6.2, Internal Pressure at End of Service Life, with a discussion about how the 0.25% volume limit is met as shown in Attachment 4 to this enclosure.

With the TS Bases and SAR changes proposed in this LAR, the PI ISFSI will continue to operate safely to protect the health and welfare of the public.

3. Technical Evaluation

The Prairie Island ISFSI spent fuel storage casks are initially filled with helium to provide an inert environment and minimize oxidation of cladding and fuel materials. Oxidation of cladding materials could lead to surface changes, physical damage, and dimensional changes in the fuel rods. Oxidation of fuel materials could lead to swelling and dimensional changes. Dimensional or surface changes in stored fuel assemblies could affect their retrievability at some time in the future.

In addition to providing an inert environment, the helium environment also enhances the heat transfer across the gaps within the cask cavity. Within the computer models used for thermal analyses, no credit is taken for a particular helium pressure (e.g., 1 atmosphere) to achieve thermal conductivity across the gaps, and no credit for convection heat transfer is taken. Analysis demonstrates that thermal conductivity across the gaps is independent of helium pressure. Hence, the proposed changes do not affect thermal performance of the casks.

An inert environment is established by evacuating air and oxidizing gases, and then backfilling and pressurizing the cask cavity with helium. The inert environment is assured during cask storage by maintaining confinement integrity.

A positive cask cavity pressure is described in the SAR as a barrier "to prevent in-leakage of air" (Section 3.2.5.3.3/A3.2.5.3.3) and as a "precaution against the in-leakage of air" (Section 3.3.1/A3.3.1). However, in-leakage is prevented by the welded containment vessel and double O-ring seals on all mechanical connections. The seal interspace is pressurized and monitored with a low pressure alarm for each cask, as explained in the Containment Integrity discussion later in this Evaluation.

The current cavity pressurization calculations ensure that as the cask contents cool, the internal pressure will remain above ambient for at least 20 years (TN-40) and 25 years (TN-40HT). These calculations are consistent with the 20 year period of the initial Prairie Island ISFSI materials license.

During operation beyond the initial 20-year service period, cask contents will have cooled significantly and cavity pressure may decrease below ambient. This is illustrated in SAR Figure A7A.8-2. This LAR proposes to address this reduction in cavity pressure as follows:

- Delete the design criterion that cask cavity pressure must remain above ambient at the end of licensed life, and
- Revise the TS and TS Bases for helium backfill pressure requirements to implement a helium backfill process that ensures oxidizing gases are limited to 0.25% (volume).

Justification for these changes is based on the following considerations:

- Containment integrity continues to be maintained, independent of cavity pressure;
- The 0.25% (volume) of oxidizing gases in the cavity is too low to degrade cladding materials and is not affected by cavity pressure; and
- Re-pressurization is not warranted.

These considerations are addressed as follows.

3.1 Containment Integrity

The TN-40 and TN-40HT cask designs provide for containment of spent fuel inside a containment vessel with a welded steel shell, a flanged and bolted lid, two bolted lid penetrations (vent and drain), a double O-ring seal at each mechanical joint, and a seal interspace pressurization system that is monitored and alarmed to detect leakage. Containment vessel integrity prevents leakage of radioactive materials from the cask cavity and prevents leakage of air into the cask cavity. This maintains the inert helium atmosphere within the cask cavity.

The containment vessel body assembly consists of a 1.5 inch thick steel cylindrical shell with an integrally-welded bottom closure. The licensing basis for the containment vessel is that permeation through the vessel body walls is negligible (as identified in ISFSI SAR Sections 3.3.2.1 and A3.3.2.1), and the cavity gas can only escape through the lid closure system (as described in SAR Section 3.3.1 and A3.3.1). The bolted lid closure system employs two systems to ensure cask leak tightness. First, all bolted closures are provided with double O-ring seals. Second, the interspace between the seals is pressurized to provide a positive pressure gradient and monitored to detect leakage.

The overpressure system that pressurizes the seal interspaces includes an overpressure tank that is initially pressurized to at least 5.5 atm. The system also includes a pressure transmitter and alarm which alerts personnel to low pressure in the overpressure system that could be indicative of a leak. The alarm setpoint ensures that pressure decreases in the overpressure monitoring system are identified, and corrective actions taken, well before any potential out-leakage from the cask cavity could occur. The monitored interspace overpressure system, in combination with the robust welded containment vessel, precludes in-leakage of air or out-leakage of cavity gas independent of cavity pressure.

Defense in depth against leakage or permeation through the steel containment vessel walls or welds is provided by the outer steel shield shell. The shield shell is a welded steel shell that surrounds the containment vessel with a close fit. The joint between the outer shell and the containment vessel flange is seal welded. This installation further minimizes the potential for in-leakage through the containment vessel walls or welds.

As discussed further below, the SAR can be used to determine the impacts of positive or negative cavity pressures. If the inner seals were to leak, whether the cavity is above or below ambient, helium would flow from the overpressure system into the cask cavity; radioactive material would not be released and air would not be introduced. If the outer seals were to leak, whether the cavity is above or below ambient, helium would leak from the overpressure system to the exterior; no radioactive material would be released and no air would be introduced. The continuous positive inward and outward pressure gradient of the pressurized seal interspace guards against the admission of air into the cavity due to seal leakage.

Leakage through the walls and welds of the containment vessel is negligible as described above, and any such leakage would be beyond the licensing basis for the casks.

3.2 Limited Oxidizing Gases

The amount of oxidizing gases in the cask cavity is limited during cask loading by the helium backfill process. Cask loading operations are illustrated in SAR Figure 5.1-1, *Sequence of Operations,* and include, in part, the following steps to ensure that oxidizing gases are reduced to < 0.25% (volume):

- After the cask is loaded with spent fuel, the lid is installed, and the internal cavity is drained through the drain port. During the draining process, air is backfilled into the cask.
- Air and residual water are then removed by vacuum drying. A Vacuum Drying System applies a vacuum at the vent port, vaporizing any liquid water present and sweeping the water vapor out of the cask. Vacuum drying is performed in accordance with TS LCO 3.1.1, *Cask Cavity Vacuum Drying.*
- The Vacuum Drying System is then disconnected and the Vacuum Backfill System is connected. During this process the cask vacuum is broken and the cask cavity is exposed to air.
- A Vacuum Backfill System then evacuates the cavity to remove oxidizing gases. The system applies vacuum at the vent port and evacuates the cask cavity to at least 14 mbar absolute. This step (and pressure value) has always

been implemented in site procedures and is included as proposed new TS SR 3.1.2.2.

- After oxidizing gases have been evacuated, the cask cavity is backfilled with dry helium gas. The backfill pressure is established between 1345 and 1445 mbar absolute, in accordance with TS LCO 3.1.2, *Cask Helium Backfill Pressure.* This is verified in accordance with current TS SR 3.1.2.2 (which is proposed to be re-numbered as SR 3.1.2.3 as part of this LAR).

By standards of usage, the proposed new TS can not be retroactively applied to the previously-loaded casks. However, to demonstrate that the physical conditions inside each of the previously-loaded casks conforms with the technical evaluation provided herein, NSPM reviewed work order records as follows:

- Confirmed completion of the procedure step that achieves a cask cavity pressure of at least 14 mbar absolute in each cask prior to helium backfill.
- Confirmed completion of the procedure step that achieves a cask cavity pressure of at least 1320 mbar absolute in each cask during the helium backfill process. (This value satisfies the value of 1320 mbar absolute assumed in the technical evaluation.)

In this manner the previously-loaded casks have been shown to have satisfied the maximum limit on oxidizing gas concentration, and will not require repressurization.

Evacuation to a pressure of less than 14 mbar absolute and pressurization with helium to at least 1345 mbar absolute will ensure that the amount of oxidizing gases remaining in the cavity is less than 0.25% (volume). Considerable research has been performed in the industry to evaluate the effects of air on fuel and cladding materials. NUREG-1536 (Reference 3), Section 9.5.1, *Cask Loading/Draining and Drying,* cites research by the Pacific Northwest Laboratories (PNL). In report PNL-6365, "Evaluation of Cover Gas Impurities and Their Effects on Dry Storage of LWR Spent Fuel," (Reference 2), PNL identifies a concentration of oxidizing gases of 0.25% (volume) as a concentration that is "much too low to degrade the cladding even if all of the gas reacts with the cladding." This concentration of 0.25% (volume) is also cited in NUREG-1536 as corresponding to a quantity of oxidizing gases that is below levels where any cladding degradation is expected.

ISFSI SAR Section A4.2.3.6.5, *Effect of Galvanic Reactions on the Performance of the Cask,* states that the amount of any oxidizing gases remaining after vacuum drying and helium backfill is too small to cause corrosion that could have significant effect on the fuel cladding, neutron absorber integrity, or the basket and cask structural performance.

As long as containment integrity is maintained, the amount of oxidizing gases inside the cask cavity will not increase from the amount that was present when the cask was evacuated during cask loading operations. This is below levels where cladding degradation would be expected. The amount of oxidizing gases will not be affected by changes in cavity pressure due to long term cooling.

3.3 Re-Pressurization Not Warranted

The TN-40 and TN-40HT casks are physically capable of being re-pressurized to maintain pressure above ambient conditions. The cask designs include a vent port which allows for connection of a helium source to the cask cavity. However, replacement of the vent port cover requires a seal leak test and, based on industry operating experience, it is likely that all lid seals would have to be replaced. This would require returning the cask to the spent fuel storage pool and removing all stored fuel. NSPM does not consider that the material handling risks and worker exposures associated with this process are warranted, as explained below.

Access to the vent port requires transfer of the cask from the ISFSI to the Auxiliary Building and removal of the vent port cover that is part of the containment boundary and is sealed with a double O-ring. The seal interspace is pressurized and monitored as part of the overpressure system. Re-pressurization of the cask cavity would breach the confinement boundary and a leak test would be required upon completion. The interspace of the vent port seal is interconnected to the interspaces of the drain port seal and the main lid seal. Therefore, the leak test would involve testing all three seals. Industry operating experience indicates that it is very difficult for seals that have been in service to pass this leak test because of the affinity of the seal areas to retain traces of helium gas (in combination with sensitive test methodology). Thus, a cask re-pressurization would require seal replacement. To replace the cask lid seal in a radiologically prudent manner, NSPM expects that the cask would be returned to the spent fuel storage pool and the fuel removed. Occupational worker exposures would be excessive if the cask sealing surfaces were cleaned and prepared with nuclear fuel in the cask.

It is important to explain that the difficulty in passing the leak test for casks that have been in service is not because the seals actually leak, but rather it is due to the leak test method. The leak test would be performed by first establishing a helium environment on both sides of the double O-ring. The helium in the cask cavity establishes the environment for the inner O-ring and a temporary hood would be placed over the exterior of the lid and filled with helium to provide the environment for the outer O-ring. A vacuum would then be drawn on the interspace and the removed gas would be monitored to detect the presence of helium. The problem with seals that have been in use with the interspaces pressurized with helium, is that helium molecules become trapped or attached to the seal surfaces and any microscopic cracks and crevices. When a vacuum is drawn on the interspace for the leak test, it is very difficult, if not impossible in practice, to evacuate enough of the trapped or attached helium molecules so that the analyzed interspace gas will pass the acceptance criterion.

NSPM has the capability to move casks from the ISFSI storage location back to the spent fuel pool in the Prairie Island Nuclear Generating Plant and to perform all activities associated with re-pressurizing the casks and re-establishing containment integrity. While NSPM is confident that cask movement and re-pressurization can be performed safely, there are risks associated with this activity, as there are in any material handling activity.

In addition to cask handling risks, re-pressurization would involve worker exposures. Activities must be performed around the cask to move it to the Auxiliary Building and return it to the storage pad. Even if the cask lid seal does not have to be replaced as described above, there are worker exposures associated with activities on top of the cask to remove the vent port cover, connect the helium bottle, install a new seal, re-install the vent port cover, and perform the seal leak test.

The previous discussion explains that containment integrity and low levels of oxidizing gases are maintained independent of cavity pressure. Therefore, there is no technical or safety benefit to be derived from re-pressurizing cask cavities to account for long term cooling and pressure reduction. In the absence of any technical or safety benefit, NSPM does not consider that the cask handling risks and worker exposures associated with re-pressurization are warranted.

3.4 Conclusions

The proposed change will allow cask cavity pressure to decrease below ambient conditions without re-pressurization during operation beyond the initial 20-year service period. The integrity of stored fuel and cladding materials will continue to be protected by an inert environment and by containment integrity which are not affected by cavity pressure.

The proposed changes to the TS will ensure that the helium backfill process limits oxidizing gases in the cavity to no more than 0.25% (volume). This low concentration of oxidizing gases is a level at which degradation of cladding or fuel materials is not expected.

Re-pressurizing cask cavities to maintain pressure above ambient would require breaching containment and would also involve worker exposures that are not warranted by an associated technical or safety benefit.

With the changes to the TS, TS Bases, and SAR proposed in this LAR, operation of the Prairie Island ISFSI will continue to protect the health and safety of the public.

4. Regulatory Safety Analysis

4.1 Applicable Regulatory Requirements/Criteria

The applicable regulatory requirements associated with this LAR include the following:

10 CFR Part 72, Subpart F - General Design Criteria

Subpart F of 10 CFR 72 provides general design criteria for storage of high level nuclear wastes of which some apply to independent spent fuel storage facilities. The Prairie Island ISFSI provides for storage of dry spent fuel casks within a licensed storage facility. This LAR addresses Technical Specifications and a design criterion that only apply to individual casks. Therefore, criteria applicable to the facility are not affected by this amendment. Table 4-1 below lists the sections of Part 72 which contain general criteria and identifies if the section is affected by the changes proposed in this amendment request. For those sections which are affected, more detailed discussion is provided.

Table 4-1
ISFSI General Design Criteria Affected by the Proposed LAR

Regulation	Title	Affected by this Amendment
72.120	General consideration	Yes
72.122	Overall requirements	Yes
72.124	Criteria for nuclear criticality safety	No
72.126	Criteria for radiological protection	No
72.128	Criteria for spent fuel, high-level radioactive waste, and other radioactive waste storage and handling	Yes
72.130	Criteria for decommissioning	No

72.120 General Considerations

72.120(d) states, in part: The ISFSI or Monitored Retrievable Storage (MRS) facility must be designed, made of materials, and constructed to ensure that there will be no significant chemical, galvanic, or other reactions between or among the storage system components, spent fuel, reactor-related GTCC waste, and/or high level waste including possible reaction with water during wet loading and unloading operations or during storage in a water-pool type ISFSI or MRS. The behavior of materials under irradiation and thermal conditions must be taken into account.

As demonstrated in Section 3, implementation of the proposed TS will provide an inert environment with a low concentration of oxidizing gases that ensures the proper behavior of fuel cladding and cask cavity materials.

72.122 Overall requirements

This Section defines criteria applicable to dry spent fuel storage casks with respect to quality standards, protection against environmental conditions and natural phenomena, fires and explosions, retrievability, and a number of other considerations including confinement barriers and systems, as follows:

72.122 (h), *Confinement barriers and systems*, states in part: (1) The spent fuel cladding must be protected during storage against degradation that leads to gross ruptures or the fuel must be otherwise confined such that degradation of the fuel during storage will not pose operational safety problems with respect to its removal from storage.

72.122(l), *Retrievability*, states in part: Storage systems must be designed to allow ready retrieval of spent fuel ... for further processing or disposal.

As demonstrated in Section 3, implementation of the proposed TS will provide an inert environment with a low concentration of oxidizing gases that ensures the proper behavior of fuel cladding and cask cavity materials to support confinement and retrievability functions.

72.128 Criteria for spent fuel, high-level radioactive waste, and other radioactive waste storage and handling

72.128(a), *Spent fuel and high-level radioactive waste storage and handling systems*, states in part: Spent fuel storage ... and other systems ... must be designed to ensure adequate safety under normal and accident conditions. These systems must be designed with ... (3) Confinement structures and systems,...

The proposed amendments constitute no physical change to the storage system design and thereby do not affect the confinement function. As demonstrated in Section 3, implementation of the proposed TS will provide an inert environment with a low concentration of oxidizing gases that ensures the proper behavior of cask confinement materials.

10 CFR Part 72, Subpart F, defines design criteria to ensure adequate safety under normal and accident conditions. Based on the technical evaluation provided herein as supported by the proposed SAR changes, the Prairie Island ISFSI, including TN-40 and TN-40HT casks and the established helium backfill process, continues to ensure adequate safety under normal and accident conditions in accordance with the applicable criteria in this Section.

Thus, with the changes proposed in this license amendment request, the requirements of Title 10 CFR Part 72, Subpart F continue to be met.

4.2 Conclusions

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

5. Environmental Consideration

NSPM has determined that the proposed change would involve an amendment to a materials license identified in 10 CFR 51.60(b)(1) which is administrative, organizational, or procedural in nature, or which results in a change in process operations or equipment. However, the proposed amendment does not involve (i) a significant change in the types or significant increase in the amounts of any effluents that may be released offsite, (ii) significant increase in individual or cumulative occupational radiation exposure, (iii) significant construction impact, or (iv) significant increase in the potential for or consequences from radiological accidents. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(11). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

In addition, NSPM has determined that the proposed amendment would not involve (i) a significant expansion of a site, (ii) a significant change in the types of effluents, (iii) a significant increase in the amounts of effluents, (iv) a significant increase in individual or cumulative occupational radiation exposure, (v) a significant increase in the potential for or consequences from radiological accidents, or (vi) a significant increase in spent fuel storage capacity. Therefore, pursuant to 10 CFR 51.60(b)(2), no environmental report need be prepared in conjunction with the proposed amendment. The proposed changes do not require any changes to the PI ISFSI Environmental Report.

6. References

1. Not used.

2. PNL 6365, "Evaluation of Cover Gas Impurities and Their Effects on the Dry Storage of LWR Spent Fuel," R.W. Knoll and E.R. Gilbert, Pacific Northwest Laboratories, November 1987.

3. NUREG-1536, "Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility," US NRC, NMSS, Revision 1, July 2010.

Attachment 1

ISFSI Technical Specifications

Marked-Up Pages

Affected Pages:

3.1.2-1
3.1.2-2

2 Pages Follow

3.1 CASK INTEGRITY

3.1.2 Cask Helium Backfill Pressure

LCO 3.1.2 The cask cavity shall be backfilled with helium to within the limits.

APPLICABILITY: LOADING OPERATIONS.

ACTIONS

-----NOTE-----
Separate Condition entry is allowed for each cask.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Cask initial helium backfill pressure limit not met.	-----NOTE----- Action A.1 applies until a gas other than helium is introduced into the cask for subsequent operations or the helium is removed for the performance of SR 3.1.1.1. -----	
	A.1 Initiate action to establish a helium environment in the cask.	Immediately
	<u>AND</u>	
	A.2 Establish cask cavity backfill pressure within limits.	Prior to leak testing (SR 3.1.3.1)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. Required Action A.1 and associated Completion Time not met.	B.1	Return cask to pool and reflood.	7 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.2.1	----------------------------NOTE---------------------------- Not required to be met prior to the specified Frequency. -- Verify that a helium environment has been established in the cask cavity.	Once within 34 hours after commencing cask draining
Insert 3.1.2.2 → ~~SR 3.1.2.2~~ SR 3.1.2.3	----------------------------NOTE---------------------------- Not required to be met prior to the specified Frequency. -- Verify that the cask cavity helium pressure is ≥ 1345 mbar absolute and ≤ 1445 mbar absolute.	Once prior leak testing (SR 3.1.3.1)

SR 3.1.2.2		
	----------------------------NOTE ---------------------------------- Not required to be met prior to the specified Frequency. -- Verify that the cask cavity pressure is ≤ 14 mbar absolute.	Once prior to pressurization (SR 3.1.2.3)

Attachment 2

ISFSI Technical Specifications

Revised Pages

2 Pages Follow

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Required Action A.1 and associated Completion Time not met.	B.1 Return cask to pool and reflood.	7 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.2.1	-----NOTE----- Not required to be met prior to the specified Frequency. ----- Verify that a helium environment has been established in the cask cavity.	Once within 34 hours after commencing cask draining
SR 3.1.2.2	-----NOTE----- Not required to be met prior to the specified Frequency. ----- Verify that the cask cavity pressure is ≤ 14 mbar absolute.	Once prior to pressurization (SR 3.1.2.3)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.1.2.3	---------------------------NOTE----------------------------- Not required to be met prior to the specified Frequency. -- Verify that the cask cavity helium pressure is ≥ 1345 mbar absolute and ≤ 1445 mbar absolute.	Once prior leak testing (SR 3.1.3.1)

Attachment 3

ISFSI Technical Specifications Bases

Marked-up Pages

(for information only)

Affected Pages:

B3.1.2-4
B3.1.2-5

2 Pages Follow

BASES

ACTIONS (continued)

B.1

If a helium cask environment cannot be achieved and maintained, fuel clad temperatures may increase beyond the analyzed condition. Therefore, the cask will be required to be placed back into the spent fuel pool within 7 days and re-flooded. This time is sufficient time to return the cask to the spent fuel pool and re-flood the cask cavity. Once placed in the spent fuel pool, the fuel is provided adequate decay heat removal to maintain the loaded fuel within limits.

SURVEILLANCE REQUIREMENTS

SR 3.1.2.1

This Surveillance is modified by a Note. The Note clarifies that meeting the Surveillance is not required, and thus there is not a failure to meet the LCO per SR 3.0.1 and SR 3.0.4 does not apply, prior to the specified Frequency.

While, the effective thermal conductivity of the cavity gas is not dependant upon pressure, it is dependant upon the make-up of the gases within the cask cavity. Thermal analyses have shown that maximum fuel cladding temperature limit of 752°F is not exceeded during LOADING OPERATIONS provided a 75% helium environment (based on partial pressure) is established within the cask. Thus, design basis heat removal requirements will be satisfied provided an environment of at least 75% helium has been established, and maintained in the cask cavity within the 34 hour vacuum drying time frame (Reference 3).

Insert SR 3.1.2.2 - see next page

(A)

~~SR 3.1.2.2~~ SR 3.1.2.3

This Surveillance is modified by a Note. The Note clarifies that meeting the Surveillance is not required, and thus there is not a failure to meet the LCO per SR 3.0.1 and SR 3.0.4 does not apply, prior to the specified Frequency.

SR 3.1.2.3

BASES

SURVEILLANCE REQUIREMENTS

~~SR 3.1.2.2~~ (continued)

The long-term integrity of the stored fuel is dependent on storage in a dry, inert environment and maintenance of adequate heat transfer mechanisms. Filling the cask cavity with helium at the initial pressure specified ~~will ensure that there will be no air in-leakage, which could potentially damage the fuel cladding, and that the cask cavity internal pressure will remain within limits for the life of the cask.~~

Insert SR 3.1.2.3

(B)

Backfilling with helium at a specified pressure must be performed successfully on each cask prior to performance of leak testing activities and TRANSPORT and STORAGE OPERATIONS.

REFERENCES

1. SAR Section 8.2.
2. SAR Section A8.2.
3. SAR Section A3.3.

(A) → Insert 3.1.2.2:

SR 3.1.2.2

This Surveillance is modified by a Note. The Note clarifies that meeting the Surveillance is not required, and thus there is not a failure to meet the LCO per SR 3.0.1 and SR 3.0.4 does not apply, prior to the specified Frequency.

-

Evacuating the cask cavity to the specified vacuum prior to pressurization (see SR 3.1.2.3) will ensure that the amount of oxidizing gases remaining in the cavity will be no greater than 0.25% (volume). Below this concentration, degradation of stored cladding and fuel materials is not expected.

(B) → Insert 3.1.2.3:

, following the evacuation in SR 3.1.2.2, will ensure that the amount of oxidizing gases remaining in the cavity will be no greater than 0.25% (volume). At this concentration, degradation of stored cladding and fuel materials is not expected. Also, maintaining pressure below the upper limiting value will ensure that cask cavity internal pressure will remain within limits for the life of the cask.

Attachment 4

ISFSI SAR

Marked-Up Pages

(for information only)

Affected Pages:

A3.3-36
Insert A3.3.2.2.6.2
A3.6-3

3 Pages Follow

Replace with insert A3.3.2.2.6.2

A3.3.2.2.6.2 INTERNAL PRESSURE AT END OF SERVICE LIFE

A minimum helium backfill pressure of 19.5 psia was determined on the basis that a minimum of 1 atm pressure must exist on the coldest day at the end of life.

The full length cask model was run with steady state conditions in the handling building to determine the average cavity gas temperature after completion of the helium backfilling. An ambient temperature of 70 ºF is considered for this run. The average gas cavity temperature of 426 ºF (886 ºR) was retrieved from the model using the methodology described in Section A3.3.2.2.6.1.1. This model did not include the 1.0" gap at each end of the poison and aluminum plates. An evaluation determined that when these gaps are modeled, the cavity gas increased 8ºF. Thus, the determination below used an average gas temperature of 434ºF (426ºF + 8ºF). 01368790

The determination of the end of life cavity pressure was based on the average gas backfill temperature of 434ºF (894ºR) at the time of backfill and an average gas temperature of 216ºF (676ºR) after 25 years of storage an external ambient temperature of -40ºF. 01368790

The initial pressure of 19.5psia assures that at the end of 25 years, on the coldest day (–40 ºF ambient), the internal pressure of the cask is:

$$P_{cavity} = 19.5 \text{ psia} \times (676^{\circ}R/894^{\circ}R) = 14.74 \text{ psi}$$ 01368790

Therefore, the internal pressure of the cask is above the 1 atm minimum.

A3.3.2.2.7 RADIAL HOT GAP BETWEEN THE BASKET RAILS AND THE CASK INNER SHELL

A nominal diametrical cold gap of 0.30 in. is considered between the basket and the cask cavity wall for the TN-40HT cask.

A radial, hot gap of 0.13" at thermal equilibrium is assumed in the ANSYS model for normal storage conditions. To verify this assumption, the hot dimensions of the cask inner diameter and basket outer diameter are calculated at thermal equilibrium as follows.

The outer diameter of the hot basket is:

$$OD_{B,hot} = OD_B + [L_{SS,B} \times \alpha_{SS} (T_{avg,B} - T_{ref}) + L_{Al} \times \alpha_{Al} (T_{avg,Al} - T_{ref})]$$

Where:

$OD_{B,hot}$ = Hot outer diameter of the basket
OD_B = Cold outer diameter of the basket = 72" – 0.30" = 71.70"
$L_{SS,B}$ = Length of basket at 90-270 direction = O_{DB} – 2×0.46" = 70.78"
L_{Al} = Length of aluminum shim = 2×0.46 = 0.92"

Insert A3.3.2.2.6.2

A3.3.2.2.6.2 Oxidizing Gases Within Cask Cavity

To provide an inert environment within the cask cavity, the cask is evacuated and then pressurized with helium such that the residual oxidizing gases within the cavity are no more than 0.25% by volume.

As discussed in SAR Section 5.1, cask cavity vacuum is broken after completion of the vacuum dryness test. Thus, the cask cavity will be exposed to oxidizing gases such as air or water vapor prior to the final helium backfill. This calculation assumes that the entire cask cavity is filled with air after breaking the vacuum to maximize the amount of oxidizing gases within the cask cavity. According to PNL-6365 report (Reference 45), the gases of concern are those that can oxidize exposed UO_2 fuel: O_2, CO_2, and CO. Therefore, assuming dry air with an oxygen content of 21% (covering for both O_2 and CO_2 in air) maximizes the amount of oxidizing gases.

Ideal gas law is used to determine the volume percentage of the oxidizing gases within the cask cavity after completion of the final backfill. Per the ideal gas law, the volume percentage of the gases within a mixture is equal to the ratio of the moles. Thus, the volume percent of oxidizing gases may be determined by the following equation:

$$V_{O2}\% = 21 \times \frac{P_v}{P_b} \times \frac{T_b}{T_v} \ (\%)$$

Where,

$V_{O2}\%$ = the volume percent of oxidizing gases in the cask cavity,

P_v and P_b = evacuation vacuum and backfill pressure, respectively

T_v and T_b = average cavity gas temperature prior and after backfill, respectively

Since helium conductivity is much higher than air, the average cavity gas temperature decreases after the backfilling with helium. Hence, T_b is lower than T_v and their ratio is lower than 1. However, to conservatively increase the volume percentage of oxidizing gases, it is assumed that T_b is equal to T_v and their ratio is 1.0.

Assuming a conservative evacuation pressure (P_v) of 15 mbar prior to final backfill and a conservative pressure of 1320 mbar after final backfill (P_b), the volume percentage of oxidizing gases within the cask cavity is:

$$V_{O2}\% = 21 \times \frac{P_v}{P_b} = 21 \times \frac{15}{1320} = 0.239\%$$

The conservatively calculated volume percentage of the oxidizing gases within the cask is below the limit of 0.25%.

31. Bentz, D. P., "A Computer Model to Predict the Surface Temperature and Time-of-Wetness of Concrete Pavements and Bridge Decks," Report # NISTIR 6551, National Institute of Standards and Technology, 2000.

32. Siegel, Robert, Howell, R. H., "Thermal Radiation Heat Transfer," 4th Edition, 2002.

33. AAR Brooks & Perkins, Advanced Structures Division, "Standard Specification for Boral™ Composite Sheets."

34. Not used.

35. USNRC, SFPO, NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems - Final Report," 1997.

36. ANSYS Computer Code and User's Manuals, Version 8.0.

37. TN Letter to NRC, "Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 1 to the NUHOMS® HD System, Response to Request for Additional Information (Docket No. 72-1030; TAC No. L24153)", Enclosure 2, Response to RAI 4.1, TN Document No. E-27377, December 15, 2008.

38. USNRC, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material," 2004.

39. Gregory, J. J., Mata, R., Keltner, N. R., "Thermal Measurements in a Series of Long Pool Fires," SANDIA Report, SAND 85-0196, TTC-0659, 1987.

40. IAEA Safety Standards, "Regulations for the Safe Transport of Radioactive Material," 1985.

41. USNRC, SFPO, NUREG/CR-0497, "A Handbook of Materials Properties for Use in the Analysis of Light Water Reactor Fuel Rod Behavior," MATPRO - Version II (Revison 2), EG&G Idaho, Inc., TREE-1280, 1981.

42 Letter, Ashok Thadani (NRC) to S. R. Tritch (Westinghouse), "Acceptance for Referencing of Topical Report WCAP-12610 'Vantage+ Fuel Assembly Reference Core Report' (TAC No. 77258)" July 1, 1991.

43. SANDIA Report, SAND90-2406, "A Method for Determining the Spent Fuel Contribution to Transport Cask Containment Requirements," 1992.

44. ANSYS Computer Code and User's Manuals, Version 10.0.

45. Knoll, R.W., et al., "Evaluation of Cover Gas Impurities and Their Effects on the Dry Storage of LWR Spent Fuel," PNL-6365, DE88 003983, PNNL, November 1987.

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