SAFETY EVALUATION REPORT

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U.S. DEPARTMENT OF ENERGY

FORT ST. VRAIN

INDEPENDENT SPENT FUEL STORAGE INSTALLATION

LICENSE NO. SNM-2504

LICENSE RENEWAL

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1.0 SUMMARY

By letters dated November 10, 2009, as supplemented by correspondence dated June 9, July 30, September 7, November 9, November 30, and December 23, 2010 and by correspondence dated July 18, 2011, the Department of Energy (DOE) submitted an application to the Nuclear Regulatory Commission (NRC) for the renewal of the NRC site-specific license No. Special Nuclear Material (SNM) - 2504 for the Fort Saint Vrain (FSV) Independent Spent Fuel Storage Installation (ISFSI) located in Platteville, CO. The application requested license renewal for a 20-year period beyond the end of the current license. The current 20-year license is set to expire on November 30, 2011. The FSV ISFSI uses a Modular Vault Dry Storage (MVDS), which is a contained shield system designed for 40 years of interim storage of the FSV High Temperature Gas Cooled Reactor (HTGR) fuel. The FSV reactor was built and operated during the 1970's and 1980's. It was permanently shut down in 1989 and decommissioned.

The FSV ISFSI is located within the former FSV Nuclear Generating Station (NGS) exclusion area boundary. In 1991, the Public Service Company of Colorado (PSCo) requested an NRC license to construct and operate an ISFSI and the NRC issued a 20-year license to PSCo to receive, possess, store, and transfer FSV spent fuel to the ISFSI in accordance with the requirements in 10 CFR Part 72. Between December of 1991 and June 10, 1992, PSCo loaded 1,458 HTGR fuel elements and six neutron source fuel elements into the ISFSI (DOE, 2009b). In December 1995, the DOE informed the NRC of its intent to procure the FSV ISFSI, take possession of the fuel stored in it and to take transfer of the license. An Agreement in Principle was incorporated by contract modification between DOE and PSCo on February 9, 1996. Although DOE took immediate possession at that time, PSCo continued to manage the spent fuel in accordance with license No. SNM-2504 until June 4, 1999, when the license was transferred to DOE (NRC, 1999). The amendment application contains an aging management review (AMR) to evaluate the effects of aging for an additional 20 years of storage. Based on the statements and analysis provided by the applicant, the staff agrees that the applicant has adequately addressed aging issues, and the FSV ISFSI can be operated safely for an additional 20 years with an aging management plan in accordance with 10 CFR Part 72.

Section 1 of this Safety Evaluation Report (SER) includes general information regarding the FSV facility and its license renewal application. Section 2 of the SER describes the scoping evaluation submitted by the licensee. The aging management reviews of safety-related components and subcomponents of the FSV ISFSI are described in Section 3 of the SER. Section 4 of the SER reviews additional safety-related considerations not directly related to a specific subcomponent in the FSV ISFSI, including retrievability and radiological monitoring. The SER is concluded in Section 5, with references listed in Section 6.

1.1 Facility Description

The High Temperature Gas Cooled Reactor (HTGR) at FSV, which was built and operated as an advanced reactor concept with cooperation between the U.S. Atomic Energy Commission, Gulf General Atomic, and PSCo, was permanently shut down in August 1989. PSCo removed the fuel and other radioactive reactor components from the reactor vessel. Spent nuclear fuel was then transferred to onsite dry storage at the ISFSI. The ISFSI was designed for storage of up to 1,482 fuel elements which are known as standard fuel elements, control fuel elements, and bottom control fuel elements; 1,458 elements of which are stored in the facility. Since there are six spent fuel elements stored in a fuel storage container (FSC), there are 243 FSCs storing standard, control, or bottom control spent fuel elements at the FSV ISFSI.

2.0 SCOPING EVALUATION

During the review of the application, the NRC updated the requirements in 10 CFR 72.42 to allow license periods up to 40 years from the date of issuance. Licenses may be renewed by the Commission at the expiration of the license term upon application by the licensee for a period not to exceed 40 years. In addition an application for ISFSI license renewals must include: time limited aging analyses that demonstrate that structures, systems, and components important to safety will continue to perform their intended function for the requested period of extended operation and a description of the aging management plan for management of issues associated with aging that could adversely affect structures, systems, and components important to safety. In addition, staff issued final guidance in NUREG-1927 “Standard Review Plan for Renewal of Independent Spent Fuel Storage Installations License and Dry Cask Storage Systems” in 2011.

DOE's license renewal process for the FSV ISFSI is generally consistent with the pilot Site-Specific ISFSI license renewal process developed by Dominion (Virginia Electric and Power Company) and approved by the NRC for the Surry Power Station Site-Specific ISFSI, and subsequently followed by Progress Energy for the Robinson Nuclear Plant Site-Specific ISFSI license renewal and Duke Energy for the Oconee Nuclear Station Site-Specific ISFSI license renewal.

2.1 Introduction

DOE submitted an application with a format and content based on the Preliminary Guidance for License Renewal for Site-Specific ISFSI[1] and consistent with draft NUREG-1927.

2.2 Scoping Methodology

In the first step in the license renewal process, DOE identified the in-scope ISFSI Systems Structures and Components (SSCs). This was done by evaluating the SSCs that comprised the ISFSI against the following scoping criteria provided in the Preliminary Guidance for License Renewal for Site-Specific ISFSIs with the comments that were provided by Dominion: *Any SSC that meets either of the criteria shall be evaluated further in the aging management review process described later. The categories of SSCs are those that are:*

1. Important to safety, as they are relied upon to:

- *a) Maintain the conditions required to store spent fuel safely.*
- *b) Prevent damage to the spent fuel during handling and storage.*
- *c) 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, as identified in the current licensing basis.*

These SSCs ensure that these important safety functions are met for (1) criticality, (2) shielding, (3) confinement, (4) heat transfer, and (5) structural integrity.

2. Classified as not important to safety, but, according to the current licensing basis, whose failure could prevent an important to safety function from being fulfilled or whose failure as a support SSC could prevent an important to safety function from being fulfilled.

The function performed by an SSC that causes it to be within the scope of license renewal is its intended function.

Also, SSCs which perform ISFSI support functions are generally not within the scope of license renewal. The fuel in storage is considered to be within the scope of license renewal.

Any ISFSI SSC that met either Scoping Criterion 1 or 2 above was determined by DOE to be within the scope of license renewal (in-scope), and the function(s) it was required to perform during the extended term was identified. The results of the Scoping evaluation are presented in Section 2.3.

2.3 Scoping Results

The SSCs comprising the ISFSI were identified by DOE in Table 2.3-1 of the application, Scoping Results. Those SSCs meeting Scoping Criterion 1 or 2 were identified in the table as being within the scope of license renewal.[2] As indicated in Table 1 below, the FSCs, FSC Support Stools, Standby Storage Wells, Container Handling Machine (CHM) Raise/Lower Mechanism, CHM FSC Grapple, Charge Face Structure (CFS) structural steel, Cask Load/Unload Port (CLUP), Structural Concrete of the MVDS Building, Concrete Fill Inside the CFS, and Fuel in Storage were determined to be within the scope of license renewal and to require further review in the aging management review process. The intended functions performed by the individual subcomponents of these in-scope SSCs were identified in the aging management review summary tables of the application (Tables 3.2-1 through 3.11-1). Table 2.3.1 of the application is reproduced below:

Table 1: Reproduction of Table 2.3.1, SSCs Meeting the Scoping Criterion

System Structure or Component	Criterion 1	Criterion 2	In-Scope?
Fuel Storage Containers (FSC)	YES	NO	YES
FSC Support Stools (SS)	YES	NO	YES
Standby Storage Wells (SSW)	YES	NO	YES
Container Handling Machine (CHM) Raise/Lower Mechanism	YES	NO	YES
CHM FSC Grapple	YES	NO	YES
Charge Face Structure Steel	YES	NO	YES
Cask Load/Unload Port (CLUP)	YES	NO	YES
Structural Concrete of Modular Dry Vault Store (MVDS) Building	NO	YES	YES
Concrete Fill Inside the Charge Face Structure	NO	YES	YES
Fuel in Storage	YES	NO	YES

Based on the staff's review, the scoping evaluation was adequate. Individual subcomponents were described in Tables 3.2-1 through 3.11-1 of the application. To reduce ambiguity, the structural steel of the MVDS building should have been specifically mentioned with the structural concrete of the MVDS building in the scoping review. However, inspection of the structural steel in the MVDS building was included in the engineering reviews of the structural concrete and is adequate for identifying SSCs subject to the aging management review.

3.0 AGING MANAGEMENT REVIEW

3.1 Aging Management Review (AMR) Methodology

The scoping process by DOE identified the ISFSI SSCs within the scope of license renewal which required evaluation for the effects of aging in the AMR process. The purpose of the AMR was to assess the in-scope SSCs with respect to aging effects that could affect the ability of the SSC to perform its intended function during the renewed license period. The AMR process involved the following four major steps:

- Identification of in-scope subcomponents requiring AMR (screening),
- Identification of materials and environments,
- Identification of aging effects requiring management, and
- Determination of the activities/programs required to manage the effects of aging.

Each of these steps was discussed in Subsections 3.1.1 through 3.1.4 of the license renewal application, respectively. The operating experience review by DOE for confirmation of the AMR process and the document sources used in the process were discussed in Subsections 3.1.5 and 3.1.6 of the license renewal application. The results of the aging management review for the subcomponents of the ISFSI SSCs that were in the scope of license renewal were provided in the following sections of the license renewal application:

- Section 3.2, AMR Results – FSCs
- Section 3.3, AMR Results – FSC Support Stools
- Section 3.4, AMR Results – Standby Storage Wells
- Section 3.5, AMR Results – CHM Raise/Lower Mechanism
- Section 3.6, AMR Results – CHM FSC Grapple
- Section 3.7, AMR Results – Charge Face Structure Structural Steel
- Section 3.8, AMR Results – CLUP
- Section 3.9, AMR Results – Structural Concrete of the MVDS Building
- Section 3.10, AMR Results – Concrete Fill Inside the Charge Face Structure
- Section 3.11, AMR Results – Fuel in Storage

The AMRs were documented in referenced Engineering Design Files (EDFs). To the extent the EDFs also included recommendations for enhanced or additional aging management activities, the enhanced activities were addressed in Appendix C to this license application.

3.1.1 Identification of In-Scope Subcomponents Requiring AMR

The scoping process described in Section 2.0 did not identify the specific subcomponents for the in-scope ISFSI SSCs that required AMR. Therefore, during the first step in the AMR process, the in-scope SSCs were further reviewed to identify and describe the subcomponents that supported the intended functions of the SSCs. The staff finds that the description of the SSC subcomponents, as supplemented by additional documentation provided by the licensee was adequate to assess the license renewal application.

3.1.2 Identification of Materials and Environments

The second step of the AMR process by DOE involved the identification of the materials of construction and the environments to which these materials are exposed for the ISFSI subcomponents that required an AMR.

3.1.3 Identification of Aging Effects Requiring Management

The third step in the AMR process by DOE involved the identification of the aging effects requiring management. Aging effects requiring management during the renewed license period were those that could compromise or cause a loss of passive SSC intended function(s). If degradation of a subcomponent would be insufficient to compromise or cause a loss of function, or the relevant conditions do not exist at the FSV ISFSI for the aging effect to occur or propagate, then no aging management was required.

3.1.4 Determination of the Activities Required to Manage the Effects of Aging

The final step in the AMR process by DOE involved the determination of the Aging Management Activities (AMAs) or Aging Management Programs (AMPs) to be credited or developed for managing the effects of aging. The licensee credited existing ISFSI inspection and maintenance programs for the management of aging effects that could compromise or cause a loss of component intended function during the renewed license period.

3.1.5 Operating Experience Review for Process Confirmation

As described in Subsection 3.1.3 of the application and the aging management review documents for the in-scope SSCs, the potential aging effects for the FSV ISFSI material and environment combinations were compiled from common industry and facility operating experience through the use of accepted industry standards and reference materials, including various metallurgical literary references relating specific materials and environments to aging effects and mechanisms. These aging effects/mechanisms were evaluated, as described above, based on the premise that similar materials in similar environments experience similar aging effects and mechanisms.

3.2 Aging Management Review Results

3.2.1 Subcomponents – Fuel Storage Containers (FSCs)

The FSCs are cylindrical carbon steel canisters which are the confinement boundary for the spent fuel. There are a total of 243 FSCs in storage. The licensee specified that six of the FSCs are leak tested on a regular 5-year interval and that leak testing is done in accordance with American National Standards Institute - 14.5 using a gas pressure rise test. The shell of the FSC is 0.5-inch thick; the bottom of each canister is welded to a 2-inch thick base with a full penetration V-groove weld. The container lid is 1.5-inches thick and is attached to the canister with 24 0.5-inch steel bolts. The container is sealed with double metal O-rings. The exterior of each FSC was coated with 6 to 8 mil thick flame-sprayed aluminum described in Engineering Design File 9166, Rev. 1. Remote video inspection of the FSC exteriors was performed in February 2008. The inspection showed no degradation of the FSC exteriors. Small quantities of debris (dust, dirt, etc.) were found on and around the surface of the FSC. The following materials were identified by DOE: aluminum flame-sprayed carbon steel, carbon steel, low alloy steel, and silver-plated Inconel (O-rings). The following environments were identified by DOE: outside cooling air FSCs are shielded from the weather -36 to 49°C (-32°F to 120°F), radiation is 4×10^{11} γ-rads/50 years and 5×10^{14} neutrons/cm^2/50 years, and decay heat is 74°C (165°F). The licensee listed no aging effects which affected the materials of the FSC, and therefore listed no aging management activities.

Based on measurements conducted by Great Lakes Carbon Company, which supplied the graphite for the fuel elements, DOE estimated that a maximum of 0.01% of the weight of each fuel element was entrapped water. As part of the engineering analysis described in Engineering Design File 9166, Rev. 1, the licensee conservatively estimated that the quantity of water in each fuel element was ten times higher. This estimate of entrapped water was used to determine the maximum quantity of corrosion which could occur in the FSC. It was estimated that the thickness of the FSCs could be reduced by as much as 3% by internal corrosion. Design calculations based on an internal pressure of 13 psi (air pressure) and Subsection ND of Division 1 in Section III of the ASME Code showed that the reduced wall thickness of the FSCs would greatly exceed the minimum required 0.0135 inches specified in design calculations. The licensee also calculated the maximum quantity of water (0.046 lbs) expected in ingress into the FSCs over a forty-year period based on a leak rate of 1×10^{-3} cm^3/sec. The quantity of water that could ingress into the FSCs was bounded by the conservative estimate of the water entrapped within the graphite fuel elements in each FSC (0.35 lbs). The staff finds that any potential corrosion caused by ingress of water is not significant and bounded by the estimated corrosion caused by entrapped water in the graphite fuel elements. There is no safety related issue regarding the corrosion on the interior of the FSCs.

The estimated corrosion of the flame sprayed aluminum coating (0.52 mils/y) was based on data taken from qualifying corrosion tests as part of an American Welding Society Study (AWS C2.14-74). It was assumed that the corrosion rate of the flame sprayed aluminum coating on the FSC matched that of the flame sprayed coating in a marine environment. The staff finds that this estimated corrosion rate is exceedingly conservative, as the corrosion of aluminum in a rural environment is at least an order of magnitude lower than in a marine environment. Given a thickness of 6 to 8 mils and a corrosion rate of 0.52 mils/y, the flame-sprayed coating is expected to lose 9% of its thickness over a 40-year period. The results of the February 2008 inspection verified that the aluminum coating on the FSCs adequately protects the FSCs from corrosion. Given the estimated corrosion rates, the coating thickness, environmental conditions and direct observation of the coatings, the staff finds that the flame-sprayed aluminum coatings acceptable for protecting the FSCs during the license renewal period.

Leak testing data collected from six FSCs since 1996 have shown that the leak rate from the FSCs has been maintained below 10^{-3} cm^3/s. Outgassing of moisture from the FSCs due to the use of a higher vacuum (< 1 Torr) resulted in artificially high leakage rates (all below 10^{-3} cm^3/s). Procedural controls are now in place to prevent excessive outgassing. The staff finds that regular radiological monitoring of the facility constitutes compliance with 10 CFR 72.122(h)(4) and is sufficient verification that the remaining 237 FSCs are adequately sealed. The staff finds the decay heat of the spent fuel is insufficient to induce any microstructural changes in the FSCs. Recurrent visual inspections of the main storage vault and FSCs are sufficient to monitor for any signs of degradation.

3.2.2 Subcomponents – Fuel Storage Container (FSC) Support Stools

The FSC Support Stools (SS) support the base of the FSCs on the vault floor, transmit and limit the loads into the building foundations. The SS are grouted to the floor of the vault. The stools are manufactured from carbon steel castings coated with flame-sprayed aluminum. The SS were secured in place with zinc-plated carbon steel drop-in anchors prior to grouting. The materials are: aluminum flame-sprayed carbon steel, zinc plated carbon steel, and carbon steel. The environments are: outside cooling air, FSC SS are shielded from the weather -36 to 49°C (-32°F to 120°F), radiation is < 4 x 10^{11} γ-rads/50 years and < 5 x 10^{14} neutrons/cm^2/50 years, and concrete and grout embedment.

The licensee listed no aging effects which affected the materials of the FSC and SS, and therefore listed no aging management activities related to mitigation. However, inaccessible areas of the vaults that can be remotely inspected will be visually inspected every 10 years to assess the FSC SSs for signs of degradation.

The primary source of corrosion that could affect the FSC and the SS will be humidity in the outside cooling air. The corrosion of aluminum in a rural environment is at least an order of magnitude lower than the conservative corrosion rate 13 μm/y (0.52 mils/y) estimated by the licensee, which was based on the corrosion of the aluminum coating in a marine environment. The corrosion of zinc in a rural environment is approximately 10 μm/y (0.4 mils/y). The carbon steel anchoring bolts are not important to safety, as their function was to hold the FSC SS in place during grouting; therefore no corrosion analysis of the bolts was performed. The staff finds that the corrosion rates of the aluminum coating is sufficiently low to protect the underlying steel over the license extension and that no corrosion analysis of the zinc-plated anchoring bolts is needed. Video inspection of the main storage vault in February 2008 showed no deterioration of visible portions of the FSC SS or of the concrete or grout embedments. Recurrent inspections of the main storage vault are sufficient to monitor for any degradation. The staff finds that no other aging management activities are required for the FSC SSs.

3.2.3 Subcomponents – Standby Storage Wells

The MVDS contains three standby storage wells (SSWs). These wells are intended to act as containment vessels for the isolation of failing FSCs, to permit leak checking of FSCs away from the vault module storage position and provide the ability of moving individual fuel elements if necessary. Each well consists of a carbon steel body, flange and base forging. The exterior of the SSW is coated with flame-sprayed aluminum and is bolted shut with low alloy fasteners. Dual silver plated Inconel O-rings can be installed for a leak-tight (< 10^{-3} std cm^3/sec) configuration. The materials are: aluminum flame-sprayed carbon steel, carbon steel, low alloy steel, and silver plated Inconel O-rings. The environments are: outside cooling air, SSWs are shielded from the weather -36 to 49°C (-32°F to 120°F), and radiation is < 9 x 10^3 γ-rads/50 years and < 5 x 10^{14} neutrons/cm^2/50 years.

The SSWs were not sealed using the dual metal O-rings after the initial license was granted which permitted ambient moisture in the air to initiate corrosion in the SSWs. A video surveillance of the SSWs in February 2008 revealed that the interior walls of the SSWs showed signs of corrosion. Video surveillance was not able to determine the exact extent of corrosion in the SSWs. The licensee assumed a corrosion rate of 25 μm/y (0.985 mil/y) to the SSWs and that the minimum thickness of the SSWs would be reduced to 0.325 inches in 50 years, which far exceeds the required 0.0095 inches specified in design calculations. These design calculations are based on an internal pressure of 13 psi (air pressure) and Subsection ND of Division 1 in Section III of the ASME Code.

The primary source of corrosion which could affect the SSWs is the condensation of moisture on the uncoated interior of the SSWs. This condensation led to moderate corrosion and the buildup of corrosion debris within the SSWs. An inspection of the SSWs in February 2008 detected the corrosion. The corrosion debris was removed from the SSWs. The application of grease to the lid and containment seals was added to the aging management activities, and the SSWs were sealed using dual metallic O-rings. The licensee committed to periodic leak testing of the SSWs starting in 2010. The staff finds these adjustments to the monitoring of the SSWs acceptable, and has determined them to be sufficient to mitigate any significant further degradation of the SSWs. The estimated corrosion rate of the interior steel of the SSWs 25 μm/y (0.985 mil/y) was based on International Standards Organization (ISO) standards 9223:1992 and 9224:1992 which bounded the measured quantities of rust removed from the interior of the SSWs. The staff finds the estimate of material loss in the SSWs reasonable based on the engineering analysis presented in Engineering Design File 9194, Rev. 1. Given the corrosion rate of 25 μm/y (0.985 mil/y) and the expected time of the ISFSI's operation, the staff finds that an expected wall thickness of the SSWs (0.325 inches) adequate. The staff notes, however, that the minimum wall thickness of the SSWs, based on ASME Code with an internal pressure of 13 psi (0.009 inches) may not be adequate for the SSWs. Such a wall thickness assumes a vertical of the fuel blocks into the SSWs where the fuel blocks do not touch the sides of the SSWs during loading (so no extra stresses are applied).

The secondary source of corrosion which could affect the SSWs is corrosion of the flame-sprayed exterior of the SSW due to moisture in the outside air. The corrosion of aluminum in a rural environment is approximately 0.2 microns/y (0.004 mils/y) however, the nominal thickness of the flame-sprayed coating is 150 to 200 microns (6 to 8 mils). Therefore, the staff finds that the performance of the FSV ISFSI will not be significantly affected by operating for a 40-year time frame.

3.2.4 Subcomponents – Container Handling Machine (CHM) Raise/Lower Mechanism

The CHM is the device which is used to move the FSC. The device is designed to be single failure proof so that a failure of any single component will not result in dropping the FSC. The CHM is constructed from alloyed steel (e.g., Society for Automotive Engineers SAE 4140), carbon steel, and copper alloys. The CHM is stored in the Modular Dry Vault Store.

The materials are: carbon steel, alloyed steel, and copper alloy. The environments are (During operation, 660 hours cumulatively): indoor air -36 to 49^{o}C (-32^{o}F to 120^{o}F), radiation is 39.65 γ-rads and 0.03 n-rads and (While not in Operation): inside air is -36 to 49^{o}C (-32^{o}F to 120^{o}F) and maximum Decay Heat is 73^{o}C (164^{o}F).

The licensee listed no aging mechanisms associated with the CHM that required an aging management activity. No aging effects were observed during the two 5-year inspections and most recent inspection of the CHM in August 2009. The CHM undergoes mandatory annual preventative maintenance and monthly examination (as required).

The storage of the CHM in the interior environment of the MVDS significantly restricts the potential for corrosion, and negates the need for additional aging management activities for the CHM. The maximum temperatures reached during loading/unloading of the FSCs were well below that required to make microstructural changes or cause creep in the alloys used in the CHM. The radiation dose to the CHM during loading/unloading of the CHM was orders of magnitude lower than what is required to affect the materials in the CHM. Annual and routine maintenance programs are in place to verify the continued operation of the CHM. Given the conditions of the operation for the CHM, the storage environment of the CHM, and an ongoing maintenance program, the staff finds that the CHM does not require additional aging management activities.

3.2.5 Subcomponents – Container Handling Machine Fuel Storage Container Grapple

The CHM FSC Grapple is an attachment to the CHM for moving of FSCs. The grapple is designed to lift a FSC containing either six spent fuel blocks, neutron source elements, or twelve reflector blocks. The CHM FSC Grapple is constructed entirely of carbon, and alloyed steel. Similar to the CHM, the FSC Grapple is not exposed to an outside environment. The materials are: carbon steel and alloyed steel. The environments are (During operation, 660 hours cumulatively): inside air -36 to 49^{o}C (-32^{o}F to 120^{o}F), radiation is: 12.8 γ-rads and 0.03 n-rads, and maximum decay heat is 73^{o}C (164^{o}F). While not in operation, inside air is -36 to 49^{o}C (-32^{o}F to 120^{o}F).

The licensee listed no aging mechanisms associated with the CHM FSC grapple that required an aging management activity. No aging effects were observed during the two 5-year inspections. A third inspection of the grapple was conducted in 2010. The current inspection plan outlined in EDF-8529 Revision 1 requires a semi-annual inspection of the CHM FSC grapple when in use.

The staff finds that the indoor storage of the CHM FSC grapple in the MVDS significantly restricts the potential for corrosion, and negates the need for an AMP. The staff finds the inspection of the CHM FSC as described in EDF-8529, Revision 1 and TPR-5609 adequate.

3.2.6 Subcomponents – Charge Face Structure (CFS) Structural Steel

The CFS structural steel provides the support for the container handling machine, the isolation valves attached to the container handling machine and charge face steel structure, shield plug at each fuel storage container location, and the containment and support for the concrete fill inside the CFS. The CFS structural steel, in conjunction with the FSC support stools, supports the position of the FSCs in the vault. The CFS also forms the cover of the MVDS system and the operating floor of the charge hall. The material is carbon steel. The environments are: outside cooling air is -36 to 49^{o}C (-32^{o}F to 120^{o}F) with the CFS is shielded from the weather, outer CHM vessel is 134^{o}C (274^{o}F), charge hall is 49^{o}C (120^{o}F), and radiation is 4 x 10^{10} to 4 x 10^{11} rads/50 years and 5 x 10^{14} neutrons/cm^{2}/50 years.

The licensee listed no aging mechanisms associated with the CFS that required an aging management activity. Accessible structural steel in the CFS will be visually inspected on an annual basis. In February 2008 a video camera was used to examine the underside of the CFS. No corrosion was observed on the underside of the CFS. Inaccessible areas of the vaults that can be remotely inspected will be visually inspected every 10 years to assess CFS underside (vault ceiling), and vault wall and floor surfaces for signs of degradation.

The staff finds the structural steel in the CFS, which is accessible to the outside cooling air, may be susceptible to aging by generalized corrosion, although the steel of the CFS was covered with a corrosion resistant primer and a paint coating. Visual observations of the accessible areas of the CFS have not identified any significant corrosion. The remote inspection of the CFS underside in February 2008 showed no degradation of the CFS and continued inspections will be used to ensure no degradation of the CFS. The temperatures to which the CFS is exposed are too low to affect the mechanical properties of the steel in the CFS. The neutron flux to which the steel is exposed is orders of magnitude too low to affect the steel.

Given the environment for the structural steel in the CFS, regular visual inspections, and the inspection results presented to the staff, the staff finds that the structural steel CFS does not require an AMP.

3.2.7 Subcomponents – Cask Load / Unload Port (CLUP)

The Cask Load / Unload Port (CLUP) is a carbon steel seating ring and an adaptor plate complete with shield ring. The seating ring is recessed into the charge face onto which the transfer cask can sit via the flange at the top of its body. The seating ring and charge face are slotted to allow the transfer cask to be placed in position by the MVDS crane with minimum lift. The height of lift of the crane hook when lifting the transfer cask is restricted by the dedicated sling length.

The CLUP allows the transfer cask to be supported at the MVDS charge face level for FSC loading/unloading operations. The port allows the loading port isolation valve to be located and bolted into position over the transfer cask. Within the Transfer Cask Reception Bay and below the port position, cask restraint clamps are used to retrain the cask lower end for the seismic event. The materials are: steel, carbon steel, alloy steel, and cast iron. The environments are (During Operation 460 hours cumulatively): indoor air is -36 to 49^{o}C (-32^{o}F to 120^{o}F), radiation is 42.32 γ-rads and 0.23 n-rads, and maximum decay heat is 54^{o}C (130^{o}F). While not in operation, the environment is indoor air is -36 to 49^{o}C (-32^{o}F to 120^{o}F).

The CLUP shutter, hatch cover and adapter plate are all subjected to periodic inspection in intervals of not more than 12 months for the first three years following construction and at the 5-year intervals thereafter. The CLUP transfer cask supports are inspected on an annual basis. The CLUP spent fuel shipping cask restraints are visually inspected on an annual and prior-to-use basis. The procedure has been implemented eight times since just prior to and after the license transfer. On two occasions (February 1998 and June 2001) the presence of a small amount of corrosion was noted on some restraint components and removed accordingly. The licensee listed no aging mechanisms associated with the CLUP that required an aging management activity.

The staff finds that the indoor storage of the CLUP in the MVDS significantly restricts the potential for corrosion, and negates the need for an AMP of the CHM. The routine inspection of the CLUP as specified by the licensee is sufficient to ensure the operation of the CLUP.

3.2.8 Subcomponents – Structural Concrete and Steel for the Modular Vault Dry Storage (MVDS) Building

The MVDS Building is constructed from steel reinforced concrete which is exposed to decay heat and radiation from the spent fuel and to weathering from the outdoor environment. The materials are: concrete and structural steel. The environments are: outside cooling air is -36 to 49°C (-32°F to 120°F), radiation is 4 x 10^{11} γ-rads/50 years and 500 n-rads/50 years, and decay heat is 165°F (74°C).

The application lists only cracking and loss of material of the concrete as part of the AMP, however corrosion, scaling, spalling, rust staining, pitting, erosion, and loss of mechanical properties from irradiation as the aging effects for both the structural concrete and structural steel of the MVDS building were considered.

Accessible structural concrete and steel of the MVDS is visually examined on a 5-year basis, as stated in Engineering Design File 8672, Rev. 1, using a digital camera with a 3X zoom capability. Elevated, accessible structural concrete and steel is scanned using 7X magnification binoculars and then examined with a 26X magnification scope. The examination method has been performed by qualified personnel. Visual inspection results are evaluated using American Concrete Institute (ACI) 201.1R-92[3] and 349 R3-02[4]. Inspections of the structural concrete and steel were performed in 2006 and repeated in 2009. Several minor aging effects were identified by the licensee as a result of these inspections. These effects included a ten square inch patch of concrete which separated from the MVDS wall, efflorescence/staining below the roof slope on the east inlet side of the facility, the minor corrosion of steel components in a truck bay ceiling and in the chimney canopy. No significant degradation of the MVDS was observed. Crack gauges were installed on the west vault wall centerlines to provide enhanced monitoring of the overall MVDS concrete. Regular inspection of the accessible structural concrete and steel are scheduled on a 5-year basis as recommended in ACI 349 R3-02[4].

The staff finds that the current AMP of the ISFSI structural concrete and steel are acceptable for the following reasons: 1) No significant deterioration of the structural concrete or steel has been observed during the licensing period; 2) The inspection frequency and acceptance criteria of accessible concrete is based on an appropriate industry standard, ACI 349 R3-02; 3) The procedure for visually examining degradation of the concrete at elevated heights is able to identify ACI 349.3R-02 first-tier cracks at a distance of more than 200 ft; 4) Any degradation of the structural concrete or steel requiring maintenance will be repaired prior to the next inspection interval, or immediately if necessary.

3.2.9 Subcomponents – Concrete Fill inside the Charge Face Structure

The concrete fill inside the CFS must have a minimum concrete density of 140 pounds per cubic foot. There are no requirements for the mechanical properties of the concrete fill. The concrete is completely enclosed by structural steel, and is not subject to corrosion unless the structural steel corrodes first. The material is concrete. The environments are: outside air is -36 to 49°C (-32°F to 120°F), radiation is 4 x 10^{11} γ-rads/50 years and 500 n-rads/50 years, and decay heat is 63°C (146°F). The licensee listed no aging effects that require aging management of the concrete fill.

The only requirement for the concrete fill in the CFS is a minimum density of 140 pounds per cubic foot. The concrete fill serves no structural function. Potential spalling of the concrete fill is limited by the placement structural steel. The decay heat is below the recommendations set forth in the American Concrete Institute document, 349-01/349R-01[5]. Therefore, the staff finds that no AMP is required for the concrete fill in the charge face structure.

3.2.10 Subcomponents – Fuel in Storage

The materials are: carbon (graphite, carbonaceous cement, pyrolytic), boron carbide, uranium carbide, and thorium carbide. The environments are: air at < 399°C (< 750°F), decay heat at < 399°C (< 750°F), and radiation at 2.97×10^{14} photons/s, as loaded and 3.31×10^{5} neutrons/s, as loaded. The licensee listed no aging effects that require AMP of fuel in storage.

The staff finds that no AMP is required for the graphite fuel elements. The graphite fuel elements are chemically inert and will not degrade under the conditions of storage. The dual metallic silver-plated Inconel O-rings provide sufficient containment to prevent the significant ingress of water and subsequent corrosion of the FSC, fuel, or radiolysis of water. A gas pressure rise test is performed in accordance with ANSI N14.6 every five years, with a seal leakage acceptance criterion not exceeding 1×10^{-3} std.cm^3/s. Special considerations for the storage of spent graphite fuel: the buildup of Wigner energy in the graphite elements, formation of tritium within the FSCs due to transmutation of lithium-6 impurities in the graphite, and reaction of nitrogen in the air with the neutron flux from the fuel elements, are of no safety concern due to the low-temperatures and fluxes involved with the storage of the graphite fuel elements. Numerical calculations and citations of IAEA TECDOC No. 152, "Characterization, Treatment and Conditioning of Radioactive Graphite from Decommissioning of Nuclear Reactors" were provided by the applicant as justification.

4.0 ADDITIONAL CONSIDERATIONS

4.1 Retrievability

The staff has identified no aging mechanism, which affect the fuel, the FSCs, or devices that are required to retrieve the fuel, which would prohibit the ready retrieval of the spent nuclear fuel. The potential for flammable gas generation was addressed in response to NRC Bulletin 96-04 and six of the FSCs will be sampled for flammable gases prior to shipment to ensure that no flammable gases are present in the FSCs. The staff finds that the license renewal application sufficiently demonstrated that the spent nuclear fuel stored at the FSV ISFSI will be ready retrievable in accordance with 10 CFR 72.122(l).

4.2 Inlet/Outlet Screen Monitoring

Maintaining the cooling inlet and outlet screens free from obstruction is required by Technical Specification (TS) 3.1 to ensure cooling air temperatures are not elevated for prolonged periods, the steel and concrete are not subject to related damage, and overheating of the SSC components inside the ISFSI is prevented. Acceptance limits for maintaining the cooling inlet and outlet screens free from obstruction are described in the Technical Specifications. The licensee indicated that there had never been any violation of the TS in the license renewal application. No changes have been made to the TS for screen monitoring, which were previously approved. Therefore, the staff finds the monitoring of the inlet/outlet screens acceptable.

4.3 Radiological Monitoring

The quarterly monitoring of radiological conditions is performed by DOE in accessible areas of the ISFSI to ensure radiological posting thresholds are not exceeded. If any radiation and contamination levels were to exceed such thresholds, they would be investigated for potential degradation of the ISFSI components. Increased levels could indicate a reduction in the ability of the concrete and steel to provide adequate radiation shielding, or could indicate a breach in the confinement function of the FSC. Radiological monitoring results have never indicated degradation of ISFSI components that shield and confine radioactive material. The staff finds that the current AMP is acceptable because monitoring would detect significant failures of the confinement system.

4.4 Corrective Actions

Corrective actions, including root cause determinations and prevention of recurrence, are performed in accordance with the licensee's corrective action program, which may initiate a Work Request or Non-Conformance Report (NCR). Corrective actions are to be taken in a timely manner in accordance with the significance of the NCR. Deficiencies are either promptly corrected or are evaluated to be acceptable through an engineering analysis, which provides reasonable assurance that the intended function is maintained consistent with the current licensing basis condition for a minimum period of time until the next required inspection. Increased inspection intervals or increased number of inspection items or locations may be determined to be necessary. Given the AMRs and AMPs provided by the licensee and that there have been no NCRs generated related to SSC aging mechanisms and effects, the staff finds that the licensee's corrective action program is sufficiently comprehensive to identify and correct safety related problems which may arise during the operation of the FSV ISFSI.

4.5 Changes to the Technical Specifications

The licensee proposed changes to the existing technical specifications, as listed in Appendix D of the application. The changes listed by the licensee were editorial in nature and are acceptable to the staff. In addition to the editorial changes the licensee requested a change to Section 5.5.2, Step 6 of the technical specifications, deleting "the Bases implemented without prior NRC approval shall be provided to the NRC on a frequency consistent with" and changed "72.70(b)" to "72.70(c)(6)". This change to the TS was an editorial correction. After resolution of the Requests for Additional Information, additional TS were added as a condition of the license renewal. These included: 1) establishing and implementing procedures for remote visual inspection of the FSC, SS, CFS underside (vault ceiling), and vault wall and floor surfaces for signs of degradation 2) repair and/or additional inspection of concrete and metal conditions exceeding second tier-criteria within the guidance of ACI 349.3R 3) the development of a concrete inspector training and qualification program in accordance with ACI 349.3R 4) sampling the gas inside six FSCs for hydrogen prior to June 2015 to ensure that there was no build up of flammable hydrogen during the initial licensing period. The staff amended section 5.5.5 of the TS to require periodic AMP inspections as committed to in Section 9.4 of the SAR.

5.0 CONCLUSION

The licensee performed a scoping evaluation to identify those components of the FSV ISFSI that were within the scope of the license renewal process. As part of this scoping study, the licensee reviewed the AMP. The AMP process involved the following four (4) major steps:

- Identification of in-scope subcomponents requiring AMR, and their intended functions
- Identification of materials and environments
- Identification of aging effects requiring management
- Determination of the type of program for managing the effects of aging

The staff has reviewed the AMR process with associated AMA in-process results, and finds that the overall process is well constructed and executed and meets the requirements of 10 CFR Part 72 and specifically the regulations for license renewal, 10 CFR Part 72.42(a)(1) and 10 CFR Part 72.42(a)(2). Operating experience has not indicated any significant degradation to any of the FSV ISFSI components. Significant degradation is not expected for the next 20 years. Periodic inspection and radiological monitoring as required in the TS is sufficient to detect and correct unexpected aging impacts.

In conclusion, the staff finds the FSV ISFSI to be adequately managed with respect to the requirements of 10 CFR Part 72 and NUREG-1927, "Standard Review Plan for Renewal of Independent Spent Fuel Storage Installation Licenses and Dry Cask Storage System Certificates of Compliance," requirements have been followed ensuring the Current Licensing Basis will be maintained for the 20-year license renewal period.

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[1] Preliminary NRC Staff Guidance for 10 CFR Part 72 License Renewal [for Site-Specific Independent Spent Fuel Storage Installations], U.S. Nuclear Regulatory Commission, May 17, 2001 (Carolina Power and Light Letter Serial No. RRA-01-0054)

[2] Engineering Design File (EDF) No. 7675, FSV ISFSI Scoping Evaluation for Aging Management Review Process, current revision

[3] American Concrete Institute (ACI) 201.1R-92, American Society of Civil Engineers (ASCE) Standard "Guideline for Structural Condition Assessment of Existing Buildings," SEI/ASCE 11-99.

[4] ACI 349.3R-02, "Evaluation of Existing Nuclear Safety-Related Concrete Structures" June 17, 2002.

[5] ACI 349-06, "Code Requirements for Nuclear Safety-Related Concrete Structures." Appendix E.4, "Concrete temperatures." American Concrete Institute, September 2007.