SAFETY EVALUATION REPORT

Docket No. 72-3
H. B. Robinson Independent Spent Fuel Storage Installation
License No. SNM-2502
License Renewal

SUMMARY

This Safety Evaluation Report (SER) documents the review and evaluation of an application for renewal of the H. B. Robinson Steam Electric Plant, Unit 2, (HBRSEP) Independent Spent Fuel Storage Installation (ISFSI) license, Special Nuclear Materials License No. SNM-2502. By application dated February 27, 2004, Progress Energy Carolinas, Inc. (PEC) requested a renewal of ISFSI Special Nuclear Materials (SNM) License No. SNM-2502. In the application, PEC requested an exemption from the license renewal period in 10 CFR 72.42(a) of 20 years. PEC requested a license renewal period of 40 years. The application, as supplemented, included the necessary engineering analyses and proposed Safety Analysis Report (SAR) supplement pages.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the application and exemption request, as supplemented, including the applicable general, technical, and environmental supporting information, and proposed SAR supplement, submitted with the application. Based on statements and representations in the application, as supplemented, the staff concludes that the License No. SNM-2502, meets the requirements of 10 CFR Part 72 for renewal. In addition, in accordance with 10 CFR 72.7, the Commission has determined that the exemption is authorized by law and will not endanger life or property or the common defense and security and is otherwise in the public interest. The exemption will be included as a condition of the 10 CFR Part 72 license and will be effective upon issuance. Thus, License No. SNM-2502 will be renewed for 40 years.

1.0 GENERAL INFORMATION

PEC requested renewal of the ISFSI license for the HBRSEP ISFSI, License No. SNM-2502. The original 20 year ISFSI license will expire August 31, 2006. PEC requested the renewal of the original ISFSI license for a renewal period of 20 years, and an exemption for an additional 20 years. This SER provides the technical basis for a 40 year renewal period.

PEC, licensee of the HBRSEP, applied the 10 CFR Part 72 ISFSI license renewal pilot process developed by the NRC during review of the Virginia Electric and Power Company (Dominion), Surry Power Station (SPS) ISFSI license renewal application. Lessons learned from this pilot process were used to develop the HBRSEP ISFSI license renewal application. HBRSEP's ISFSI license renewal methodology follows the comments on the "Preliminary Guidance for License Renewal for Site-Specific ISFSI's" that were provided to the NRC on June 26, 2001, by Dominion.

The proposed 10 CFR Part 72 license renewal process adopts the regulatory philosophy of 10 CFR Part 54, "The License Renewal Rule." This philosophy is summarized in the two principles of license renewal from the 10 CFR Part 54 "Final Rule Statements of Consideration" published in the Federal Register on May 8, 1995, (60 FR 22464), and re-stated below:

> "The first principle of license renewal was that, with the exception of age-related degradation unique to license renewal and possibly a few other issues related to safety only during the period of extended operation of nuclear power plants, the regulatory process is adequate to ensure that the licensing bases of all currently operating plants provides and maintains an acceptable level of safety so that operation will not be inimical to public health and safety or common defense and security. Moreover,

> consideration of the range of issues relevant only to extended operation led the Commission to conclude that the detrimental effects of aging are probably the only issue generally applicable to all plants. As a result, continuing this regulatory process in the future will ensure that this principle remains valid during any period of extended operation if the regulatory process is modified to address age-related degradation that is of unique relevance to license renewal.
>
> The second and equally important principle of license renewal holds that the plant-specific licensing basis must be maintained during the renewal term in the same manner and to the same extent as during the original licensing term. This principle would be accomplished, in part, through a program of age-related degradation management for systems, structures, and components that are important to license renewal....."

Based upon these principles, license renewal is not intended to impose requirements beyond those that were met by the facility when it was originally licensed by the NRC. Therefore, the current licensing basis (CLB) for the ISFSI will be carried forward through the renewed license period.

PEC submitted information on the organization of the applicant, a general description of the ISFSI site, administrative information as required by 10 CFR 72.22, summary of abbreviations and intended function code definitions, and a distribution list for written correspondence related to the application.

The staff has reviewed the details of the licensee's general information with respect to the Preliminary NRC Staff Guidance for 10 CFR Part 72 License Renewal, issued March 29, 2001, and regulatory requirements. The staff finds their evaluations to be appropriate and complete. Thus, the staff finds that the licensee's general information meets the requirements for license renewal of 40 years.

2.0 SCOPING EVALUATION

The first step in the license renewal process involved the identification of the in-scope ISFSI systems, structures, and components (SSC). The applicant accomplished this by evaluating the SSCs that comprise an ISFSI against the following scoping criteria provided in the Preliminary NRC Staff Guidance for License Renewal:

> *Any SSC that meets either of the criteria shall be evaluated further in the aging management review (AMR) process described later. The categories of SSCs are those that are:*
>
> 1. *Important to safety; that is, the SSCs are relied on to perform any of the following functions:*
>
>   i. *Maintain the conditions required to store spent fuel safely.*
>
>   ii. *Prevent damage to the spent fuel during handling and storage.*
>
>   iii. *Provide reasonable assurance that spent fuel can be handled, packaged, stored, and retrieved without undue risk to the health and safety of the public, as identified in the current licensing basis (CLB).*
>
> 2. *Classified as not important to safety, but, according to the CLB, 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. This means that the primary function, not an ancillary function, is the determining factor causing an item to be within scope of license renewal.

SSCs which perform ISFSI support functions are generally not within the scope of license renewal.

Any ISFSI SSC that met either criteria 1 or 2 above was determined to be within the scope of license renewal.

The HBRSEP ISFSI uses the NUHOMS® horizontal storage module design. This design employs a stainless steel, all-welded, irradiated (spent) fuel canister that is placed horizontally into a concrete shielding structure called the horizontal storage module (HSM). The fuel canister contains up to 7 irradiated fuel bundles with associated neutron poison for criticality control. The HSM functions as the primary radiation shield, weather cover, and convection cooling path for the enclosed fuel canisters. Because the fuel canister does not contain sufficient shielding materials by itself, a separate, heavily shielded transfer cask (General Electric model IF-300) is used to transport the loaded fuel canisters from the loading building to the HSM. The HSMs at the HBRSEP ISFSI have a capacity for eight loaded fuel canisters, one loaded fuel canister per HSM.

The basic premise of the license renewal scoping process is that the CLB determines which SSCs perform intended functions that meet either of the two principal scoping criteria. The CLB is comprised of three documents for the ISFSI: the Safety Analysis Report (SAR), the Technical Specifications (TS), and Docketed Licensing Correspondence.

Details of the scoping study are provided in the HBRSEP ISFSI license renewal application. The scoping study identified four main components of the ISFSI that are within the scope of license renewal. Those major components are the:

* horizontal storage modules (HSMs)
* dry shielded canisters (DSCs)
* irradiated (spent) fuel assemblies (IFAs)
* IF-300 transfer cask

For these identified components, the primary issues involving license renewal are age and/or environmentally related materials degradation. These effects require evaluation by an AMR process.

The staff has reviewed the details of the licensee's scoping evaluation with respect to the Preliminary Staff Guidance and regulatory requirements. The staff finds the licensee's evaluations to be appropriate and complete. Thus, the staff finds that the licensee's scoping evaluation meets the requirements for license renewal.

3.0 Aging Management Review

The AMR process involved consideration of the following four major steps:

1) Identification of in-scope subcomponents requiring AMR.
2) Identification of materials and environments.
3) Identification of aging effects requiring management.
4) Determination of the activities required to manage the effects of aging.

3.1 In-scope Subcomponents

The identified subcomponents of the storage casks are tabulated in SAR tables 3.2-1 (HSMs), 3.3-1 (DSCs), 3.4-1 (IFAs), and 3.5-1 (IF-300 transfer cask). They include all safety related components that are exposed to either the exterior weather environment of the ISFSI site or the cask internal inerted environment containing the irradiated fuel. Note that irradiated fuel is an identified subcomponent and is subject to its own evaluation for potential degradation mechanisms and effects.

Results of the next two steps of the aging management review; identification of materials and environments, and, identification of aging effects requiring management, are discussed, in turn, for each of the four main components of the ISFSI (horizontal storage modules, dry shielded canisters, irradiated fuel assemblies, transfer cask). A separate section then discusses the aging management program (inspections, corrective actions, etc.).

3.2 Aging Management Review - Horizontal Storage Module

The HSM (referred to as concrete overpack in ISFSI license renewal guidance) is a reinforced concrete and steel storage receptacle for the dry shielded canister, which contains the spent fuel. A detailed description of the HSM is found in the SAR for the HBRSEP ISFSI.

In brief, the HSM incorporates a reinforced concrete foundation, pad, and a thick, wall-like storage structure for the spent fuel canisters. The thick concrete walls and roof provide neutron and gamma radiation shielding. Baffled air inlets and outlets provide passages for the cooling air. Heavy section steel or steel encased lead closures seal off the front and rear wall openings after the DSC is inserted into the HSM. These closures provide radiation shielding and weather protection. The interior of each HSM contains auxiliary steel parts such heat shields, and rails or skid plates. These rails are used for inserting/withdrawing the DSC and locating it radially inside the HSM opening. Stainless steel screens cover the air inlet/outlet openings to prevent entry of animals or debris. A lightening protection system is attached to the exterior of the HSMs.

3.2.1 Horizontal Storage Module Materials

The AMR process for the HSM involved the identification of the materials of construction for each component of the storage system and the environments to which these materials are exposed, for any HSM subcomponents that require an AMR. The materials of construction for the subcomponents of the HSM are listed below, grouped as metals, concrete, and polymers. The specific grade of material used for each subcomponent is identified in the HBRSEP ISFSI SAR, attached to the license renewal application.

Metals:

- Carbon Steel
- Galvanized steel
- Austenitic stainless Steel
- Lead
- Copper/brass (some nickel plated)

Concrete (and carbon steel rebar):

- 4000 psi concrete

Polymers:

- Polyethylene block injected with 5% boron

Some subcomponents have external coatings. Although the coating may be designed to inhibit corrosion of the underlying material, it is not assumed to eliminate aging effects that require management.

3.2.2 Environment for the Horizontal Storage Module

The environmental conditions identified include any conditions known to exist on a recurring basis. They are based upon original design criteria and operating experience, unless design features have been implemented to preclude those conditions from recurring.

The HBRSEP ISFSI site is located in Darlington County, South Carolina. The external environment for the ISFSI is bounded by an air temperature range of -40EF (-40EC) to 125EF (52EC). The outdoor air environment includes precipitation, humidity, ultraviolet radiation, and wind.

Portions of the HSM subcomponents are below grade and experience the same outdoor conditions with the added exposure to slightly aggressive/acidic ground water due to the pH being less than 5.5.

Inside each HSM, considered to be an indoor environment with no air-conditioning, subcomponents are protected from outdoor effects (precipitation), but do experience higher temperatures and radiation in an air environment.

Based upon actual measurements, the normal mode maximum interior concrete temperature is less than 150EF (66EC). Therefore the temperature range used for all concrete (indoor and outdoor), and embedded steel is -40EF (-40EC) to 149EF (65EC). A design temperature of 300EF (149EC) was used for all the structural steel components inside an HSM.

Based upon the original shielding analysis for an HSM, the total gamma dose rate at the most limiting location (HSM air outlet with no shielding) is 4450 mrem/hr. This converts to an integrated gamma dose of 2.3^{E6} Rads over an assumed ISFSI life of 60 years. Similarly, the accumulated neutron dose for the HSM is 3.2^{E13} neutrons/sq. cm for an assumed 60 year ISFSI life. Neither of these radiation doses is significant with respect to causing any deterioration of the exposed components.

3.2.3 Horizontal Storage Module Aging Effects Requiring Management

Based upon the HSM material and environment combinations, and consideration of the conditions during extended ISFSI service, the following aging effects and associated mechanism(s) were determined to require management for the applicable HSM metallic subcomponents.

C Loss of material due to general corrosion (outdoor environment only). This potentially affects carbon and galvanized steel portions of the HSMs, where not inside the concrete bays.

C Loss of material due to crevice and pitting corrosion (outdoor environment only). This potentially affects certain stainless steel and brass subcomponents attached to the external surfaces of the HSMs. These subcomponents are conservatively considered to be susceptible.

C Change in material properties due to corrosion (outdoor environment only). Certain brass subcomponents of the lightening protection system are conservatively considered to be susceptible.

There are no aging effects that require management during the renewed license period for subcomponents located inside an HSM. This is due to the more benign interior environment. The external components made of identical materials act as leading indicators for deleterious corrosion conditions that could be postulated to occur to components located inside an HSM bay. Internal inspections, discussed later, have demonstrated this reasoning to be valid.

With respect to concrete (and reinforcing steel), no aging effects/mechanisms were identified that require management for the above grade concrete. However, accessible HSM concrete that is above grade is conservatively considered to require management.

In past years, two interior remote inspections of the HSM were performed. No degradation was observed. As a result of this experience and NRC staff acceptance of the results, interior inspections were discontinued. No additional remote inspections of the interior concrete and steel surfaces are planned during the renewal period because of the durable corrosion resistant materials used and the lack of an aggressive environment. Further, the exterior concrete surface is a leading indicator of the interior concrete surface. Consideration of the radiation exposures (to inspection personnel) associated with such an inspection are contrary to the ALARA principle in the absence of significant benefit.

The following aging effects and associated mechanisms require management during the renewed license period for below grade concrete (and reinforcing steel) due to exposure to aggressive groundwater with pH less than 5.5:

C Loss of material due to aggressive chemical attack
C Loss of material due to corrosion of embedded steel/rebar
C Change in material properties from aggressive chemical attack

The aging management program for these mechanisms is discussed later.

Review of industry and site-specific operating experience did not reveal any other aging effects for an HSM during extended operation.

3.3 Aging Management Review - Dry Shielded Canisters

The Dry Shielded Canister (DSC) is an all-welded stainless steel cylinder sized to hold seven spent fuel assemblies. It serves as the confinement vessel for the fuel during transport to the ISFSI and when in the HSMs. Shielded end plugs provide shielding during transport and for the front and rear accesses to the HSM. The end plugs are made of stainless steel encased lead. The closure of the DSC is a conventional double welded lid design. The fuel basket inside the DSC is of an egg-crate type design and provides structural support for the spent fuel and the neutron poison plates. A total of eight DSCs are stored in corresponding HSMs at the HBRSEP ISFSI.

3.3.1 Dry Shielded Canister Materials

Austenitic stainless steel
Aluminum-boron metal matrix composite (Boral)
Lead
Epoxy-resin sealant (only used on two instrumented DSCs)

Specific material types and grades are identified in the HBRSEP ISFSI SAR, attached to the license renewal application.

3.3.2 Dry Shielded Canister Environment

3.3.2.1 Exterior

The exterior of each DSC is exposed to the same environment as the interior of the HSM. That is an indoor, not-air conditioned, environment protected from precipitation and wetting. The normal maximum operating temperature is 284EF (140EC). This surface temperature is conservatively extended into the license renewal period. The integrated gamma and neutron radiation dose is the same as for the interior of the HSM (described previously).

3.3.2.2 Interior

A design temperature of 400EF (204EC) was used for the DSC internal structures in the aging management review. The internal environment of the fuel canister is helium gas. The helium gas temperature inside the canister is a function of the fuel cladding temperature, and decreases over time. The 400EF (204EC) design temperature was conservatively assumed for the license renewal period.

After 20 years of storage, the fast neutron flux and gamma radiation doses are expected to be on the order of 1^{E14} neutrons/cm^2 and 1^{E9} Rads respectively. A simple extrapolation of these values out to 60 years increases these values by a factor of 3, conservatively assuming the activity levels remain the same instead of naturally decreasing. These flux and dose levels are well below the values that would cause any degradation of the DSC materials.

3.3.3 Dry Shielded Canister Aging Effects Requiring Management

Based upon a review of the DSC materials and environments experienced during extended ISFSI operation, the applicant concluded that there were no aging effects requiring management for the subject DSC components.

There are no aging effects requiring management for the stainless steel or lead subcomponents of the DSCs because of the corrosion-resistant materials of construction, double seal-welded closure, and the environments to which each DSC is exposed. The interior of the DSCs are sealed with an inert helium environment. The fuel assemblies are in a sub-critical condition, resulting in a lower neutron fluence than exists in an operating reactor.

Each DSC is placed into an HSM and, thereafter, exposed to only a relatively mild ambient environment. In addition, a continued decrease in both temperature and radiation levels will occur with time. Two remote inspections of an HSM interior were performed at five year intervals and verified the lack of aging effects.

No deterioration is expected of the aluminum-boron neutron poison plates in the DSC interior. This material has a long history of use. In the dry environment of the DSC interior, no corrosion can proceed. The temperature is insufficient to cause any deleterious effects. As will be discussed later in the time-limited aging analysis (TLAA), no significant depletion of the boron due to neutron capture will occur.

For the epoxy-resin seals associated with instrumentation penetrations of two DSCs, there are no significant aging effects requiring management of the outer seals that are exposed to a relatively mild environment. This is because the seals do not experience the heat and radiation effects that exist on the inside surface of the DSCs.

There are no aging management programs or activities required for DSC subcomponents during the renewed license period. Therefore no aging management activities are credited.

With respect to the possible re-use of a DSC, the applicant has stated that each sealed DSC will not be reused to store different fuel.

3.4 Aging Management Review – Irridiated Fuel Assemblies

Table 3.4-1 of the LRA provides a summary of irradiated fuel assembly (IFA) components identified as within the scope of license renewal and that are subject to an aging management review. The table provides the following information related to each sub-component requiring aging management review: 1) the intended function, 2) the material group, 3) the operating environment, 4) the aging effects requiring management, and 5) the specific aging management activities that manage those aging effects. Other components whose failure would not compromise the SSC intended function were identified as being outside the scope of the review.

Following initial loading, temperatures inside the fuel cladding are expected to be less than 716EF (380EC) for the hottest fuel rod on the hottest day conditions. With time these temperatures continue to decrease substantially. After 12 years of storage (17 years after discharge from the reactor) the temperature is expected to be less than 347EF (175EC). The environmental condition for the fuel is helium, which is inert and expected to be dry.

The staff finds that there are no aging effects requiring management during the renewed license period for the fuel and the other sub-components of the IFAs. This finding is consistent with the findings and guidance documented in American Society for Testing and Materials (ASTM) International Designation C 1562-03, "Standard Guide for Evaluation of Materials Used in Extended Service of Interim Spent Nuclear Fuel Dry Storage Systems." This finding is also consistent with the results of the Electric Power Research Institute (EPRI) Dry Cask Storage Characterization Project which gives results of tests of fuel and other components inspected at Idaho National Engineering and Environmental Laboratory (INEEL) and tested at Argonne National Laboratory (ANL). The staff concludes that, based upon the ASTM C1562 guidance and the results of this INEEL/ANL project, the properties of the fuel and other components of the IFAs, as licensed for storage at H.B. Robinson, are not expected to be degraded by the proposed extended storage service to any extent that would compromise their safety functions during the proposed license renewal period.

The above conclusions, that there are no aging effects requiring management during the license renewal period for the fuel and the other sub-components of the IFAs, support the finding that the IFAs will continue to serve in an inert environment that is free of air and with decreasing temperatures over the extended storage period.

3.5 Aging Management Review – IF-300 Transfer Cask

The IF-300 transfer cask is used to transfer DSC's between the spent fuel loading facility and the HSMs. It provides a portion of the shielding needed when a loaded DSC is moved to/from the loading facility or HSMs.

As detailed in the HBRSEP ISFSI SAR, the transfer cask body is a three-layer structure composed of a heavy, double-walled stainless steel shell encasing a cylindrical depleted uranium shield. A forged closure flange is welded to one end.

Externally, there are several attachments:

* Four structural rings to provide side impact protection and to also support the neutron shield water jacket sections.

* Radially mounted impact fins are welded in place at the cask bottom and to the closure head and valve boxes.

* Lifting trunnions.

* Valve boxes, two for the neutron shield water jacket cavities and two for the cask inner cavity (for dewatering after fuel loading/unloading).

3.5.1 IF-300 Materials

Carbon steel
Austenitic stainless steel
Depleted uranium

3.5.2 IF-300 Environment

The cask exterior is exposed to borated water during fuel loading while the cask is in the spent fuel pool, and to demineralized water in the annulus between the inner wall of the IF-300 and the exterior of the DSC. Following the fuel loading operations, all water is removed. The brief exposure period (several days for a loading operation) does not contribute significantly to the aging of the transfer cask materials when these operations are being performed. There is no adverse impact resulting from the extended service life accompanying a renewed license.

The IF-300 may be staged outdoors or in a sheltered location prior to and between usage for the infrequent ISFSI transfers. As such, the external environment for the cask is bounded by ambient air at temperatures in the range of -5EF (-21EC) to 130EF (54EC) . The outdoor air environment includes the intermittent effects of precipitation, ultraviolet radiation, ozone, and wind. For sheltered staging, an indoor, non-air conditioned environment is used.

The internal cavities of the cask experience the same ambient air temperatures. When in use for a fuel transfer operation, the fluence and integrated gamma dose are residual, due to the beneficial effects of DSC shielding materials and the short duration of exposure. No additional gamma or neutron fluence needs to be estimated for the extended duration of a renewed license.

Portions of the IF-300 are continuously exposed to a treated water environment in the cask neutron shield water jacket. The annulus fluid (treated water) for this neutron shield is a 50/50 mix of demineralized water and ethylene glycol at atmospheric pressure.

3.5.3 IF-300 Aging Management Activities

Because of the durable steel construction and relatively mild environments to which the IF-300 transfer cask subcomponents are normally exposed during staging prior to and between infrequent ISFSI transfers, only the following require aging management:

* Carbon steel subcomponents
* Surfaces that are continuously exposed to the glycol/water mixture in the neutron shield water jacket, or are intermittently exposed to wetting, if located (staged) outdoors

Carbon steel components exposed to moisture or those portions of the shield water jacket continuously wetted could experience a loss of material by way of general corrosion of carbon steel, or, pitting and crevice corrosion of wetted stainless steel portions of the shielding jacket.

4.0 AGING MANAGEMENT PROGRAMS

The HBRSEP aging management program (AMP) is divided into two parts, the ISFSI aging management program and the IF-300 transfer cask aging management program.

4.1 ISFSI Aging Management Program

Given that the only aging management issues for the ISFSI identified only involve the HSMs, the AMP is consequently intended to accomplish two objectives:

a) Ensure that no significant degradation to the horizontal storage modules occurs.
b) Maintain the air inlets and outlets free from obstructions.

The scope of the HBRSEP ISFSI AMP involves monitoring the external surfaces of the ISFSI. This includes visual inspection of the accessible concrete (including below grade concrete, if exposed during excavation) and exposed steel components. It also includes monitoring area radiation levels, and airborne and smearable contamination levels at selected areas, and ensuring that the inlets and outlets do not become blocked.

Daily surveillances are performed by Operations personnel to ensure the air inlets and outlets are free from obstructions.

The examination of the accessible concrete and steel is a visual examination at an established frequency. The frequency is based upon the conditions observed and is regulated by 10 CFR 50.65, "Maintenance Rule," but does not exceed 10 years. Additionally, at each refueling cycle, a system report is completed that includes an assessment of material condition.

The radiation surveillance is performed yearly. If any of the pre-established limits are exceeded, the Robinson Engineering Section is required to be notified for evaluation and appropriate corrective actions.

A review of the Corrective Action Program history indicated that only minor corrosion was noted on some of the exterior carbon steel components, which required touch-up painting. Loose concrete was observed around some of the embedded plates during the baseline inspection performed in 2003. Cosmetic repairs were determined to be acceptable.

Visual inspections of the interior surfaces were performed using fiberoptic technology during 1993 and 1998. No concrete degradation was observed during either inspection. No degradation of metallic components was noted.

Plant specific and industry operating experience, as well as review of the system files, did not indicate any aging related deficiencies with the ISFSI components, particularly the structural steel and concrete associated with the HSMs.

4.2.1 ISFSI Aging Management Program Summary

Operating experience to date has not indicated any significant degradation to any of the ISFSI components. Inspections and surveillances continue to be implemented that would identify any deficiencies. A Corrective Action Program is in place to track and correct deficiencies in a timely manner.

Continued implementation of the ISFSI Aging Management Program provides reasonable assurance that the aging effects will be managed, such that the intended functions of the ISFSI components, particularly the structural concrete and steel of the HSMs will be maintained under current licensing basis conditions for the renewed license period.

4.3 IF-300 Transfer Cask Aging Management Program

The purpose of the Transfer Cask Aging Management Program is to ensure that no significant degradation to the IF-300 Transfer Cask occurs prior to its use for future retrieval of a DSC from the corresponding HSM. The focus of this aging management program (AMP) is on the stainless steel subcomponents that have continuously wetted surfaces and, conservatively, those external surfaces exposed to outdoor conditions and intermittent wetting. It also conservatively includes carbon steel subcomponents that are exposed to weather and/or other forms of moisture (e.g., humidity).

The program performs visual inspections of the exterior surfaces and monitors the water chemistry of the cask neutron shield water jacket fluid to prevent corrosion of exposed surfaces. If the environmental conditions are changed at a later date, such as by moving the cask to indoor storage and/or draining the neutron shield water jacket fluid, there will be no need to continue visual inspection of the stainless steel external surfaces of the cask and/or monitoring the chemistry of the neutron shield water jacket fluid.

Visual inspections of external cask, cask collar, and cask lid surfaces are performed periodically, at a minimum of within 1 year prior to moving a DSC (if no other inspections have been performed). This is to ensure that the intended function of the pertinent cask subcomponents are not compromised. Sampling and analysis of the neutron shield jacket fluid for contaminant concentrations is performed once per year.

Any detected unsatisfactory condition is entered into the existing plant Corrective Action Program for resolution. Corrective actions are taken in a timely manner in accordance with the significance of the nonconforming condition. As such, deficiencies are either promptly corrected or are evaluated to be acceptable through engineering analysis, which provides reasonable assurance that the intended function is maintained consistent with current licensing basis conditions. All such activities are monitored under quality assurance program controls, which are implemented under the requirements of 10 CFR Part 50, Appendix B.

Operating experience history and independent inspections and assessments have confirmed the effectiveness of activities to manage the IF-300 aging. This provides objective evidence that the effects of aging have been and will continue to be adequately managed.

5.0 IDENTIFICATION OF TIME-LIMITED AGING ANALYSES

Time Limited Aging Analyses (TLAAs) are defined in the staff's Preliminary Guidance for License Renewal for Site-Specific ISFSIs. TLAAs encompass those components, which have a limited life that is based upon some measured or calculated parameter. That parameter could be hours of operation, or, number of cycles of use for example.

The following TLAAs have been identified by reviewing necessary design basis documents. The original analyses were found to remain valid. They further showed that either no degradation due to these mechanisms would affect the functionality/safety of the specified component, or, that the aging will be adequately managed for the duration of the license renewal period.

5.1 Dry Shielded Canister Shell Cracking Due to Fatigue

The fatigue cumulative usage factor (CUF) was originally calculated to be 0.21 for a 50 year service period. An additional 10 years of service was calculated to increase the usage factor to 0.25. This value is less than the allowable value of 1.0. Therefore, the CUF has been re-analyzed and projected to be valid for an extended period of operation that will encompass the original plus a renewed license period totaling as much as 60 years.

5.2 Dry Shielded Canister Epoxylite Seal Radiation Exposure

Two of the first three DSCs installed at the HBRSEP ISFSI contained sheathed thermocouples which feed through a penetration plug assembly in the bottom end plug. The thermocouple wires were sealed to the associated sheathing inside and outside the assembly using a heat-cured epoxy resin (Epoxylite 8611) material. The integrated exposure, assuming that neutron radiation had negligible effect, for Epoxylite at the inner seal after 40 years was previously calculated to be 2.21^{E11} ergs/g, and after 50 years to be 2.56^{E11} ergs/g.

Extrapolation of this information has projected the integrated exposure after 60 years of service to be less than 2.91^{E11} ergs/g. This is below the acceptable level of 1^{E12} ergs/g for this type of resin. Therefore the effects of ionizing radiation (gamma dose) on the Epoxylite seal inside each instrumented DSC has been analyzed and projected to be valid for the license renewal period.

The validity of the above assumption regarding the negligible effects of neutron radiation for the epoxy-resin material for the renewed license period was also confirmed. To determine the neutron fluence at the inner seal of the penetration assembly, the neutron fluence at the inner surface of a DSC end plug, through which the penetration assembly passes, was conservatively projected for 60 years of service.

The neutron dose level at this location was extrapolated from the outside surface of the end plug by using an increase factor of 4.6, to account for the lead shielding and to provide some margin in the dose level. This dose level inside a DSC end plug was then converted using a fast neutron flux to dose conversion factor of 1^{E-1} mRem/hr/neutrons/cm^2-sec. In 60 years, the neutron flux at the inner seal of the penetration assembly is projected to be 5.2^{E12} neutrons/cm^2, which is less than the allowable dose of 4^{E13} neutrons/cm^2, reported in the original ISFSI SAR analysis.

5.3 Dry Shielded Canister Poison Plate Depletion of Boron

Boron depletion can result in reduced neutron absorption capability for neutron poison materials, such as the aluminum-boron metal matrix used in the DSC baskets. The total flux was estimated to be 4.1^{E8} neutrons/cm^2/sec. After 60 years of service, the total flux (fluence) is estimated to be 7.8^{E17} neutrons/cm^2. Conservatively assuming that the total flux is thermal, the depletion of boron B-10 will be less than 0.3% which is negligible. Thus, the depletion of poison plate boron will not be a factor for a total ISFSI service life of 60 years.

5.4 5% Boron-Polyethylene Degradation due to Radiation Effects

With respect to the boron-polyethylene shielding material, the NRC staff raised the question of possible degradation of the neutron shielding material due to radiolysis of hydrogen in the polymer. There is a limited amount of technical information available regarding the loss of neutron shield effectiveness due to possible loss of hydrogen from the polymer caused by radiolysis. Periodic radiation surveys are used to determine if the problem exists.

Periodic radiation surveys were established initially after loading the ISFSI, and are continuing to be utilized to determine radiation levels outside the HSMs. This is described in detail in the License Renewal Application. One of the specific locations for the radiation survey for neutron and gamma radiation levels is the centerline of each front access cover plate. The radiation levels are compared to established limits. Increased neutron radiation dose rates could indicate a reduction in the ability of the boron-polyethylene material to provide adequate neutron shielding. If the established radiation levels are ever exceeded, corrective actions are required to be taken. The radiation levels have not been exceeded to date, and there has not been an increasing trend in the radiation levels.

5.5 Irridiated Fuel Assemblies

No TLAAs were identified for the irradiated fuel assemblies, for reasons discussed in Section 3.4 of this evaluation. The potential aging mechanisms of creep, stress corrosion cracking, and delayed hydride cracking were considered during the AMR process.

5.6 IF-300 Transfer Cask

The transfer cask is not continuously exposed to increased temperatures and radiation. Such conditions only occur intermittently during a fuel transfer. The conditions that could result in a weakened state of the transfer cask do not exist under those conditions. Thus no, TLAAs were identified for the transfer cask.

The staff has reviewed the details of the licensee's Time Limited Aging Analyses with respect to the Preliminary Staff Guidance and regulatory requirements. The staff finds their review to be comprehensive in identifying in-scope components, associated time limited aging effects and respective analyses. Some analyses were revised and found to be appropriate as revised. No TLAAs were discovered that require further management during the proposed license renewal period of 40 years. Thus, the staff finds that the licensee's TLAAs are adequate, require no further action, and meet the requirements for license renewal.

6.0 OTHER RENEWAL ISSUES

During the NRC staff review of the license renewal application, items not included within the licensee's discussion of Scoping, Aging Management, or TLAAs were identified as requiring review. Subsequent evaluations or discussions with the applicant specific to these items revealed them to be of no technical significance for license renewal. This was either due to the SSC in question not being defined as safety related and therefore out of the scope of review, or, analysis showed that the potential technical issue was found to have a negligible impact on the ability of a SSC to perform its intended function.

For completeness, these items are summarized below:

6.1 Lead Slumping

Lead is used as a gamma shield material in the HSM access plate. There are no aging effects identified for lead that would cause changes in the physical properties of the material or loss of material.

Slumping of the gamma lead shield over time was considered. The lead is entirely enclosed within the access plate shell. Due to being so confined in place, no free space is available to allow the lead to shift or slump.

6.2 License Renewal Scope Excludes Fuel Pellet

The fuel pellets were determined not to be within scope of license renewal as they were not relied upon to perform any of the important safety functions listed in the NRC's Preliminary Staff Guidance. Additionally, it was determined that their failure would not prevent an important to safety function from being fulfilled.

The fuel pellet's physical properties are not expected to change significantly throughout the storage period. As indicated in ASTM Standard C 1562-03, "Standard Guide for Evaluation of Materials Used In Extended Service of Interim Spent Nuclear Fuel Dry Storage Systems," post-operation degradation of the fuel pellet would primarily occur as a result of oxidation which requires direct exposure to air or water. Because the storage environment is evacuated of air and moisture and then back-filled with helium, the spent nuclear fuel (SNF) environment is inert. With the monitored, helium-inerted atmosphere, there is no reasonable basis to assume that pellet degradation would occur by this mechanism. Ongoing confirmatory research being conducted by the NRC has verified this expectation, as detailed in NUREG/CR-6745, "Dry Cask Storage Characterization Project–Phase 1: CASTOR® V/21 Cask Opening and Examination," September, 2001, and NUREG/CR-6831, "Examination of Spent Fuel PWR Fuel Rods After 15 Years in Dry Storage," September 2003.

Included within this confirmatory research program was examination of the cladding for swelling caused by the effect of oxidation of the fuel pellets. Precision measurements of the cladding dimensions revealed no abnormalities, thereby confirming the absence of significant pellet oxidation. Additionally, no indications of cladding oxidation occurring during the 15 year storage period were found. This further verified the efficacy of the inert environment.

6.3 Thermal Analysis of Fuel Cladding Temperature/Cladding Integrity Over the Renewal Period

Section 3 of the LRA references EPRI Report 1002882,“ Dry Cask Storage Characterization Project,” Final Report, September 2002. This report benchmarks the internal environmental conditions, specifically the maximum expected fuel temperatures, for use in the aging management review process.

The CASTOR® V/21 cask evaluated at INEEL (and documented in the EPRI report) was instrumented to provide fuel temperatures. This provided a benchmark for the heat transfer model used to predict cladding temperatures in storage casks.

A comparison of the predicted fuel cladding temperatures for the casks in use at HBRSEP showed them to be bounded by the temperatures obtained from the evaluations of the CASTOR® V/21 in the EPRI study. The analyses for the casks resulted in predicted maximum cladding temperatures ranging from a high of 698EF (370EC) to a low of 565EF (296EC), depending upon the specific cask design and associated fuel load.

These predicted temperatures fall below the temperature levels at which adverse degradation mechanisms could occur that would compromise the cladding integrity. Although not a requirement of the HBRSEP license, these temperatures comply with the current NRC staff guidance for maximum allowable cladding temperatures. Since the cladding temperatures are moderate, no detrimental storage induced changes to the cladding are expected. Thus, the cladding integrity during the proposed 40-year license renewal period has been ensured.

The potential for iodine induced stress-corrosion cracking of the cladding was considered. Under reactor operation, when the fuel pellet is operating at a very high temperature, iodine, a decay product, can be emitted by the fuel pellet. Under the high temperatures of reactor operation, the iodine generated may react with the cladding and cause cracking. Two factors of dry storage eliminate this potential mechanism from occurring: 1) the lower temperatures of storage completely inhibits the reaction from occurring, and, 2) no significant nuclear fission processes are occurring to produce iodine in significant quantities. NRC confirmatory research into the effects of spent fuel storage, referenced in the previous section discussing fuel pellets, confirms this assessment.

6.4 Criteria for Corrective Actions

AMR evaluations determined that monitoring for corrosion, concrete degradation, deviations from appropriate jacket water chemistry, and radiation levels are adequate to manage the aging effects of the HBRSEP ISFSI. A deviating condition for any of these monitored conditions could initiate a corrective action. For example, corrosion observed during routine or one-time inspections would typically be considered a deviating condition. The deviating condition would be evaluated thoroughly to determine the cause and any required actions. This evaluation would also consider the applicability of the deviation to other ISFSI subcomponents with similar material/environment conditions. Corrective actions would be identified to preclude future occurrences and restore the condition of any degraded component. As such, a deviating condition report would be generated and an engineering evaluation would be required to assess the deviation. This process is a part of the normal plant corrective actions program that is required by NRC regulations.

6.5 Thermal Fatigue and Maximum Cumulative Usage Factor (CUF)

The licensee performed the calculation for the Cumulative Usage Factor (CUF) for a 60 year design life by using linear scaling of the value calculated for the 50 year design life. This resulted in the CUF changing from a value of 0.21 to 0.25 (0.21+ 0.21 x (10/50)). It was requested that the licensee provide additional detail regarding how this calculation was performed so that the fatigue calculation methodology could be assessed. The licensee provided the methodology for the original calculation of the CUF which included fatigue sources of temperature fluctuation, internal pressure fluctuation, and a single design basis seismic event. All events utilized conservative assumptions to develop the alternating stress intensities as well as number of cycles that would be expected for each case. The licensee noted, that the linearly scaled CUF for the 60 year design life was also obtained using the more rigorous analysis approach originally applied to the 50 year design life CUF.

6.6 Availability of Spent Fuel Pool for Duration of License Renewal Period

The spent fuel pool is necessary (1) to perform some cask maintenance activities, (2) to satisfy action requirements in technical specifications and (3) to unload spent fuel, should that be necessary. Currently, the ISFSI SAR states that the spent fuel pool at the Robinson Nuclear Plant (RNP) (Unit 2) will remain functional until the ISFSI is decommissioned unless other facilities are licensed and constructed. Expiration of the 10 CFR Part 50 power license, should that occur, under which the pool is licensed, would not obviate the need to meet the ISFSI license requirements.

The licensee shall submit for NRC review any program by which the licensee intends to manage all irradiated fuel at the site following permanent cessation of reactor operation per the requirements of 10 CFR 50.54, “License Conditions,” Item (bb). Should alternative facilities become necessary, licensing actions would be initiated at the appropriate time to gain the necessary approvals for alternative methods or facilities to perform cask maintenance activities, satisfy action statements, or unload or transfer spent fuel.

7.0 SAFETY ANALYSIS REPORT SUPPLEMENT

The SAR supplement must contain a summary description of the programs and activities relied upon to manage the effects of aging and the evaluation of TLAAs for the renewal period. HBRSEP proposed SAR changes as described in Appendix C, “Safety Analysis Report Supplement and Changes.” Notably HBRSEP provided a new SAR Section 9.7, “Aging Management,” which includes a summarized description of the activities for managing the effects of aging. The new section also presented the evaluations of time limited aging analysis for the renewal period.

The staff has verified that the updates and additions to the SAR are consistent with aging management and TLAA programs with respect to the Preliminary Staff Guidance and regulatory requirements. Thus, the staff finds that the licensee’s SAR supplement is adequate and meets the requirements for license renewal.

8.0 ADDITIONAL INFORMATION

The applicant provided additional information that addressed the other requirements of 10 CFR Part 72, Subpart B, including training and qualifications, financial assurance and decommissioning, and emergency planning.

The staff reviewed these sections, and verified that they do not affect previous staff findings, and they are consistent with respect to the Preliminary Staff Guidance and regulatory requirements.

REFERENCES

1) "Preliminary NRC Staff Guidance for 10 CFR Part 72 License Renewal," March 29, 2001, E.W. Brach, Director, Spent Fuel Project Office, to W.R. Matthews, Vice President Nuclear Operations, Virginia Electric and Power Company.

2) ASTM C1562$^{\varepsilon 1}$-03, "Standard Guide for Evaluation of Materials Used in Extended Service of Interim Spent Nuclear Fuel Dry Storage systems," ASTM International, March 2003.

3) EPRI report "Dry Cask Storage Characterization Project, Final Report, Electric Power Research Institute , Palo Alto, CA, September 2002," [EPRI Report No. 1002882].

REQUIREMENTS FOR NOTICING PROPOSED ACTION

The staff considered the license renewals potential impact on the health and safety of the public. Accordingly, a Notice of Docketing, Notice of Proposed Action, and Notice of Opportunity for a Hearing for renewal of Materials License SNM-2502 for the H. B. Robinson ISFSI, were published in the Federal Register on April 15, 2004, (69 FR 20073).

ENVIRONMENTAL REVIEW

Pursuant to Part 51 of the Code of Federal Regulations, an Environmental Assessment (EA) has been prepared for this action and a Finding of No Significant Impact (FONSI) was issued. The EA and FONSI were published in the Federal Register on March 17, 2005 (70 FR 13053).

CONCLUSION: ISFSI ASSESSMENT FOR LICENSE RENEWAL

The licensee has performed a screening program to identify those components of the ISFSI that are within the scope of the license renewal process. As part of this scoping study, the licensee reviewed the existing Aging Management Program. The Aging Management Program process involved the following four major steps:

1. Identification of in-scope subcomponents requiring AMR.
2. Identification of materials and environments.
3. Identification of aging effects requiring management.
4. Determination of the activities required to manage the effects of aging.

The staff has reviewed the AMR plan and in-process results and finds that the overall program is well constructed and executed and meets the intent of the NRC staff for license renewal.

The staff has reviewed the licensee's operating experience review and Aging Management Program. The operating experience review incorporated lessons learned from other related industry experience. The HBRSEP ISFSI operating experience did not reveal any unanticipated degradation or degradation mechanisms. The Aging Management Program properly identifies actual or potential aging mechanisms. Through the plant Corrective Actions Program, the licensee has in place an appropriate program to correct non-conforming conditions that are uncovered during operations or by the Aging Management Program.

The Commission is granting an exemption to the 20 year license period requirement of 10 CFR 72.42(a), and is renewing License No. SNM-2502 for 40 years.

In conclusion, the staff finds the HBRSEP ISFSI is adequately managed and meets the intent of the staff guidance for ISFSI license renewal.

Issued with Materials License No. SNM-2502 on March 30, 2005.