SAFETY EVALUATION REPORT

Docket No. 72-2
Surry Independent Spent Fuel Storage Installation
License No. SNM-2501
License Renewal

SUMMARY

This Safety Evaluation Report (SER) documents the review and evaluation of an application for renewal of the Surry Independent Spent Fuel Storage Installation (ISFSI) license, Special Nuclear Materials License No. SNM-2501. By application dated April 29, 2002, and supplemented October 6, 2003, Virginia Electric and Power Company (Dominion) requested a renewal of License No. SNM-2501. In the application, Dominion requested an exemption from the license renewal period in 10 CFR 72.42(a) of 20 years. Dominion requested a license renewal period of 40 years. The application, as supplemented, included the necessary engineering analyses and proposed Final Safety Analysis Report (FSAR) 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 FSAR supplement, submitted with the application. Based on statements and representations in the application, as supplemented, the staff concludes that the Nuclear Materials License No. SNM-2501, 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, Nuclear Materials License No. SNM-2501 will be renewed for 40 years.

1.0 GENERAL INFORMATION

Dominion requested renewal of the ISFSI license for the Surry Power Station, License No. SNM-2501. The original 20 year ISFSI license will expire July 31, 2006. Dominion 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.

Dominion 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 the information submitted 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 (SSCs). The applicant did 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.
>
> *Also, SSCs which perform ISFSI support functions are generally not within the scope of license renewal.*

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

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 FSAR, the Technical Specifications (TS), and the docketed licensing correspondence.

Details of the scoping study are provided in the Surry License Renewal Application (LRA). The scoping study identified the ISFSI dry storage casks and spent fuel assemblies as the components that are within the scope of license renewal. For those components, the primary issues involving license renewal are age and/or environmentally related materials degradation. These effects require evaluation by an aging management review (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 the following four (4) 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 first three steps of this process are discussed in this Section. Section 4 provides details on the aging management surveillance and maintenance programs for managing the effects of aging.

1. In-scope Subcomponents

The identified subcomponents of the storage casks 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 spent fuel. The spent fuel is also an identified subcomponent, and is subject to its own evaluation for potential degrading mechanisms and effects.

2. Cask Materials and Environments

There are currently five types of dry storage casks, supplied by four vendors, in use at the Surry ISFSI. These include:

General Nuclear Services CASTOR V/21, (21 fuel assembly capacity)
General Nuclear Services CASTOR X/33, (33 fuel assembly capacity)
Westinghouse MC-10, (24 fuel assembly capacity)
Nuclear Assurance Corporation I-28, (28 fuel assembly capacity)
Transnuclear TN-32, (32 fuel assembly capacity)

The second step of the AMR process involved first, the identification of the materials of construction for each type of cask and, second, the environments to which these materials are exposed, for any subcomponents that require an AMR.

The materials of construction for the subcomponents of the casks are listed below, grouped as metallics and non-metallics. Note, the specific grade of metallic or non-metallic material used for each cask subcomponent is identified in the license renewal application summary results tables, Table 3.2-1 through Table 3.2-5.

Materials of construction - Metallics:
Cast Iron
Low-alloy Steel
Carbon Steel
Nickel-based Alloy
Stainless Steel (includes borated stainless steel)
Aluminum (includes borated aluminum as a metal matrix composite)
Lead
Silver

Materials of construction - Non-Metallics:
Polyethylene
Polypropylene
BISCO NS-3 (a borated polymer)
BISCO NS-4 FR (a borated polymer)
Borated Polyester

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

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.

Regarding the external environment, the dry storage casks are located at the Surry ISFSI site, in Surry County, Virginia, on the south shore of the James River. The external environment for the casks is bounded by an air temperature range of -20° to 115°F. The outdoor air environment includes precipitation, ultraviolet radiation, ozone, and wind.

The internal environment of the five different types of dry storage casks in use at the Surry ISFSI is primarily helium gas. Additionally, trace amounts of nitrogen, oxygen, argon and fission product gasses may be present. The cask internal pressure varies between 800 and 2230 mbar (11.6 and 32.3 psia), depending upon the cask type. The helium gas temperature inside the casks is a function of fuel cladding temperature, and decreases over time.

Following initial cask loading, the fuel temperature inside the fuel cladding is expected to be less than 662°F (350°C) except in some localized areas where the temperature may be slightly higher during the first few years after cask loading. After 20 years of dry storage, the fuel cladding temperature is expected to be less than 347°F (175°C) and will decrease to less than 248°F (120°C) after several additional years of extended storage.

After 20 years of dry storage, the fast neutron fluence and gamma radiation exposures are expected to be less than approximately 10^{14} neutrons/cm^2 and 10^9 Roentgen, respectively.

The dry storage casks are exposed to borated water during fuel loading. This water, with the exception of trace amounts, is removed following fuel loading. Therefore, borated water is not considered an internal environment during long-term storage.

3. Aging Effects Requiring Management

From an engineering assessment, two aging effects, associated with the ISFSI casks, were identified to require management. Those effects are loss of material (corrosion) and change in material properties (radiation induced changes in polymers).

An additional aging effect, that of Time Limited Aging Analysis (TLAA), such as thermal fatigue, was identified as an issue requiring analysis. Discussion of the TLAAs and their disposition follows in Section 5 of this safety evaluation.

With respect to corrosion, an operating experience review (detailed below) confirmed the continuing need for the existing periodic inspections. Such inspections provide reasonable assurance that the casks will perform their intended safety function(s) throughout the renewal period by identifying any corrosion before it progresses to the point of adversely affecting the performance of the component.

With respect to changes in material properties, radiolytic decomposition and thermal degradation of polymeric compounds can produce off-gassing and a consequent weight reduction of the polymer. The weight loss occurs at an exponentially decreasing rate and effectively stops after a period of time. The chemical by-products emitted during the weight loss include water, although the percentage of water that makes up the total weight loss is unknown. Since this weight loss could potentially affect the performance of the neutron shielding material, this effect was identified as an issue requiring evaluation.

The effectiveness of any neutron shielding material is primarily a function of its hydrogen content, which is why hydrogenous materials such as polymers are routinely chosen for neutron moderation/shielding. Because the polymer used for the cask shields ages by releasing water as one of the byproducts, a loss of hydrogen occurs as an aging effect. The amount of hydrogen loss that could occur over the duration of the renewal period cannot be predicted with precision. It is, however, expected to be negligible or small. This is because the location of the neutron shielding is in the outer regions of the casks where the temperatures are lower and the levels of ionizing gamma radiation from the fuel (SNF) have been attenuated substantially by the inner components.

Since it is not possible to predict the amount of hydrogen that is lost as the polymer ages in service, the existing ISFSI radiation monitoring activities have been added to the Aging Management Activities and are identified in the proposed ISFSI FSAR Supplement. License Condition No. 15 captures these activities. Discussion of this program is provided in Section 4 of this SER.

Other radiation induced changes to materials, such as embrittlement of the cask structural steels were assessed. As detailed later, no effect from this mechanism would occur due to the relatively low fluence levels of neutrons during storage. Neutron fluence levels from dry storage casks are orders of magnitude below the threshold levels required for any significant effects.

The Surry ISFSI has been in operation since the mid-1980s. The required quarterly inspections of the dry storage casks have identified minor cases of corrosion or coating degradation (a precursor to corrosion). During 2000 and 2001, approximately 40 dry storage casks underwent six visual inspections each. This corresponds to approximately 240 individual dry storage cask

inspections. A total of five work activities were initiated to repair coatings on four dry storage casks. When coating degradation has been discovered, the condition has been repaired.

There have been six instances of seal replacement since the placement of the first dry storage cask at the Surry ISFSI. One occurred on a CASTOR X/33 dry storage cask secondary lid. The other five occurred on lid seals for the TN-32 dry storage cask. An evaluation of the TN-32 lid seal failures identified a design problem involving moisture intrusion under the environmental cover. This problem was corrected with a new weather cover design and different seal material.

The EPRI Dry Cask Storage Characterization Project, Interim Progress Report, documented the occurrence of corrosion on one of the bolts holding the rear breech plate in place on the CASTOR V/21 cask. It was concluded that the entrapment of water between the cask bottom and the concrete pad provided the necessary conditions for pitting corrosion of the stainless steel fasteners. Similar conditions exist at the Surry ISFSI, therefore, this potential aging mechanism requires management.

The closure cover on the Westinghouse MC-10 cask is held in place by fasteners, which are hand tightened. Elastomer O-rings are compressed to form a seal against the outside atmosphere. These elastomer O-rings were not credited in the aging management review of the cask; therefore, the potential for loss of material from the carbon steel components beneath the closure cover is managed by an inspection that verifies the absence of corrosion in the sealed area.

The staff has reviewed the details of the licensee's Aging Management Review with respect to the Preliminary Staff Guidance and regulatory requirements. The staff finds the licensee's review to be comprehensive in identifying in-scope components, materials, and environments. Appropriate engineering consideration of potential aging effects was made. The licensee examined and benefitted from lessons learned from its own and the industry's operating experiences with ISFSIs. Thus, the staff finds that the licensee's Aging Management Review meets the requirements for license renewal.

4.0 AGING MANAGEMENT SURVEILLANCE AND MAINTENANCE PROGRAMS

Dry storage cask inspection activities are conducted for each of the five types of casks currently in use at the Surry ISFSI.

The purpose of the Dry Storage Cask Inspection Activities is to:

1. Determine that no significant deterioration (corrosion) of the exterior of the dry storage casks which are in service has occurred,

2. Determine that no significant degradation of the dry storage cask seals has occurred, and,

3. Determine that no significant degradation of the in-service dry storage cask polymer neutron shield materials has occurred.

The scope of the Dry Storage Cask Inspection Activities involves:

1. The continuous pressure monitoring of the in-service dry storage casks,

2. The quarterly visual inspection of all types of licensed dry storage casks that are in service at the Surry ISFSI,

3. A visual inspection of the MC-10 dry storage cask seal cover area is to be performed prior to the end of the current operating license period,

4. A visual inspection of the oldest CASTOR V/21 dry cask storage container bottom, which will be performed prior to the end of the current operating license period on July 31, 2006. This inspection will verify the condition of the V/21 cask bolts (a potential issue identified in the EPRI study) and also due to the age of this cask design, will serve as a bounding inspection for all cask bottoms of all types and materials present at the site, and,

5. Visual inspections of other normally inaccessible areas of casks will be conducted when possible, e.g., whenever they are lifted in preparation for movement or when an environmental cover is removed for maintenance. Other normally inaccessible areas are identified as underneath the tip-over impact limiter on the single CASTOR X/33 cask and on the two NAC I-28 casks. Additionally, shield plugs located where the lifting trunnions have been removed from the body of the Westinghouse MC-10 cask form another inaccessible area, and,

6. A radiation monitoring program at the ISFSI facility boundary.

The Dry Storage Cask Inspection Activities are designated as a condition monitoring activity. The inspection activities will be performed as documented in License Condition No. 15. No preventive actions are performed during an inspection activity. Preventive/corrective actions are performed under other programs as discussed later. These activities are described below.

Pressure Monitoring

The pressure of the cover gas is monitored (at various locations, depending on the cask type) to verify the integrity of the seals in the dry storage cask closure covers. Seal degradation due to loss of material (corrosion) would be detected by changes in monitored pressure. The redundant seal system design is adequate to protect against any undetected degraded state of the metallic seals.

The acceptance criterion for pressure monitoring is the absence of an alarmed condition. Alarm panel response procedures (1) identify the various criteria for the different types of dry storage casks in use at the Surry ISFSI, and (2) specify any required corrective actions and responses.

Visual Inspections

The condition of the exterior of each dry storage cask is inspected visually to ensure that the intended function of the casks exterior subcomponents is not compromised. Visual inspections look for signs of deterioration (corrosion) of the dry storage cask surface,

and the inspections identify any debris accumulating on the dry storage cask surfaces. This debris can create the potential for localized conditions that support and enhance the corrosion process. Additionally, the normally inaccessible areas of the casks will be visually inspected if they are lifted in preparation for movement, or if an environmental cover is removed for maintenance. The aging effect that is monitored by these inspections is loss of material, i.e., general corrosion and pitting.

The CASTOR X/33 impact limiter external surface is manufactured of aluminum which has no identified aging effects in the outdoor environment. The casks' exterior coating is effective in preventing corrosion of the casks' cast iron surfaces. However, no credit is taken for the coating with regards to aging management of the cask exterior. If the coating surface is damaged and the cast iron is exposed to the outdoor environment, loss of material via general corrosion (rust) would be expected. Since such corrosion would occur on the vertical side wall of the cask, evidence of the rust would be visible (as streaking) during quarterly inspections well before the corrosion could compromise the integrity of the cask outer wall. Therefore, a special inspection prior to the end of the current ISFSI license period is not warranted.

The exteriors of the NAC I-28 casks and their impact limiters are stainless steel and are not coated. Loss of material is a possible aging effect for stainless steel in an atmosphere/weather environment. Loss of material would be visible on the outer surfaces of the NAC I-28 casks during the quarterly inspection. Since the normally inaccessible area under the impact limiter is of the same materials as the exterior of the cask, the inspections of the accessible areas provide an indication of the conditions at the impact limiter/cask wall interface. Therefore, a special inspection of these areas prior to the end of the current ISFSI license period is not warranted.

An inspection to assess the condition of the MC-10 dry storage cask seal cover area will be performed prior to the end of the current ISFSI license period, and again in 20 $\pm$ 5 years. This will be a visual inspection to ensure that water intrusion is not occurring. This visual inspection will look for signs of deterioration (corrosion) in the area of the seal cover.

A visual inspection of the oldest Castor V/21 cask bottom will be performed to assess the condition of the breech plate bolts and cask bottom. Since the materials of construction and age of this cask bound all other cask designs, this inspection will serve to benchmark the condition of all other cask bottoms at Surry. This inspection, as defined in License Condition No. 15, will be performed again in 20 $\pm$ 5 years.

The acceptance criterion for all visual inspections is the absence of anomalous indications that are signs of degradation. Engineering evaluations determine whether observed deterioration of material condition is significant enough to compromise the ability of the dry storage cask to perform its intended function. Occurrence of degradation that is adverse to quality will be entered into the existing Surry site Corrective Action System.

Radiation Monitoring to Verify Neutron Shield Efficacy

As discussed in Section 3 above, the continued effectiveness of the polymeric neutron shield materials was identified as a potential aging issue. To assure the continued acceptability of the shielding's safety functioning, existing ISFSI radiation monitoring activities were added to the Aging Management Activities described in the FSAR.

The applicant stated that the Surry ISFSI Technical Specifications require quarterly radiation monitoring at the ISFSI perimeter fence. Health Physics procedures implement this requirement through continuous monitoring at the ISFSI perimeter fence using Thermal Luminescent Dosimeters (TLD), as well as quarterly radiation surveys at the ISFSI security and perimeter fence locations. The procedure's acceptance criteria for the survey doses (neutron and gamma) provide assurance that the limits of 10 CFR Part 20 for doses to the general public are met at the Surry site boundary. Part 20 also establishes the occupational dose limits and the concept of As Low As Reasonably Achievable (ALARA) to assure that Surry plant personnel exposure is controlled and minimized. Additionally, the radiation monitoring activities ensure the requirements of 10 CFR 72.104(a) are met with regards to offsite individuals. Survey results that do not meet the acceptance criteria would be reported to plant supervision and a Plant Issue would be initiated. Therefore, the applicant stated that should the shielding effectiveness of the polymeric materials be reduced such that compliance with 10 CFR Part 20 or 10 CFR 72.104(a) is challenged, it would be detected by the quarterly surveys, or, prior to work activities within the ISFSI controlled area, and corrective actions would be initiated.

Although the NRC staff does not expect any significant degradation of the shielding materials over the proposed 40-year license renewal period, the possibility is not discounted. Employing the outlined monitoring program, in compliance with the current TS requirements, provides reasonable assurance that degradation could not occur without being discovered. Such discovery would permit timely evaluation and appropriate corrective actions to be performed. This activity was also captured in License Condition No. 15.

Corrective actions for conditions that are adverse to quality are performed in accordance with the requirements of the existing Surry site Quality Assurance Program. Any resultant maintenance or repair activities are performed in accordance with approved procedures.

Corrective actions provide reasonable assurance that deficiencies adverse to quality are either promptly corrected or are evaluated to be acceptable. Where evaluations are performed without repair or replacement, engineering analysis must provide reasonable assurance that the intended function is maintained consistent with the current licensing basis. If the deficiency is assessed to be significantly adverse to quality, the cause of the condition is determined, and an action plan is developed to remedy the deficiency and to preclude a repeat occurrence. Corrective actions identify recurring discrepancies and initiate additional corrective action to preclude recurrence.

Evaluation of post-maintenance conditions provides a reasonable assurance that the corrective actions have been satisfactorily implemented. The quarterly inspections of the dry storage casks provide confirmation that corrective actions have been completed and are effective.

The staff has reviewed the licensee's surveillance and maintenance programs with respect to the Preliminary Staff Guidance and regulatory requirements. The staff finds the licensee's programs to be effective for identifying age and service related non-conforming conditions that may be adverse to quality or safety. An appropriate corrective actions program was shown to be in place. The licensee has further committed to modifying the existing radiation protection program to monitor the safety function of the polymeric neutron shield materials. License Condition No. 15 captures these activities. Thus, the staff finds that the licensee's surveillance and maintenance programs meet the requirements for license renewal.

5.0 IDENTIFICATION OF TIME-LIMITED AGING ANALYSES (TLAAs)

TLAAs are defined in the staff's Preliminary NRC Staff Guidance for 10 CFR Part 72 License Renewal (March 29, 2001). 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.

The following TLAAs have been identified by reviewing necessary design basis documents:

Fatigue Analysis for Cask Wall for CASTOR V/21 Casks.

Fatigue Analysis for Cask Wall and secondary lid bolts for CASTOR X/33 Casks.

Neutron Irradiation Influence on the Nil Ductility Transition (NDT) Temperature of the Cask Body for Westinghouse MC-10 Cask.

Thermal Fatigue Analyses for Westinghouse MC-10 Cask.

Effect on Criticality due to Depletion of the Boron-10 in the Boral™ Plates due to Spontaneous Fission for Westinghouse MC-10 Cask.

The original analyses were found to remain valid. The licensee further showed that no degradation due to these mechanisms would affect the functionality/safety of the specified component for the duration of the proposed 40-year license renewal period.

The evaluation of all TLAAs for the Surry ISFSI revealed that none of the identified degradation mechanisms were limiting with respect to the proposed license extension period of 40 years. Consequently, no further action regarding these mechanisms is required. However, for completeness of discussion, the disposition of each TLAA follows:

Fatigue Analysis for Cask Wall for CASTOR V/21 Casks.

The only TLAA identified for the CASTOR V/21 casks is a cask wall fatigue analysis due to daily temperature cycles. The original analysis was performed for the cask wall for a 30-year period consisting of 900 cycles of a temperature range of 0 degrees F to 70 degrees F, 150 cycles of a temperature range of 0 degrees F to 70 degrees F with rain/or snow, and 9900 cycles of a temperature range of 50 degrees F to 90 degrees F.

The maximum Cumulative Usage Factor (CUF) for fatigue was calculated to be 0.111 for 30 years. The total period for the license will be the original 20 year license period plus the renewal period of 40 years. Therefore, extrapolating linearly, CUF for up to 60 years can be conservatively estimated to be 0.222. This value of 0.222 is less than the allowable value of 1.0. Thus, the CUF has been projected to be valid for the license renewal period.

Fatigue Analysis for Cask Wall and secondary lid bolts for CASTOR X/33 Casks.

The TLAAs identified for the CASTOR X/33 casks were a fatigue analysis of the cask wall and a fatigue analysis of the secondary lid bolts.

The original cask wall fatigue analysis was performed for a 30 year period with 900 cycles of a temperature range of 0 degrees F to 70 degrees F, 150 cycles of a temperature range of 0 degrees F to 70 degrees F with rain/or snow, and 9900 cycles of a temperature range of 50 degrees F to 90 degrees F.

The maximum Cumulative Usage Factor (CUF) for cask wall fatigue was calculated to be 0.128 for 30 years. The total period for the license will be the original 20 year license period plus the renewal period of 40 years. Therefore, extrapolating linearly, CUF for up to 60 years can be conservatively estimated to be 0.256. This value of 0.256 is less than the allowable value of 1.0. Thus, the CUF has been projected to be valid for the license renewal period.

The original fatigue analysis was also performed for the secondary lid bolts for 100 cycles of a pressure range of 0 psi to 90 psi and 1 million cycles of plus or minus 3g acceleration for the transport load. The maximum CUF for fatigue was calculated to be 0.14 for 30 years. Using a conservative linear extrapolation, the total CUF for up to a 60 year period would be 0.28. This value of 0.28 is less than the allowable value of 1.0. Thus, the CUF has been projected to be valid for the license renewal period.

Neutron Irradiation Influence on the Nil Ductility Transition (NDT) Temperature of the Cask Body for Westinghouse MC-10 Cask.

The influence of neutron irradiation over 60 years on the nil ductility transition (NDT) temperature of the MC-10 cask body was evaluated. The MC-10 Safety Analysis Report (SAR) states, "A 40 year neutron fluence ... at the vessel wall is not expected to shift the NDT temperature." Since this statement implies that there is a TLAA related to NDT temperature, a calculation has been performed to show that the expected shift in the NDT temperature due to 60-year neutron fluence would be acceptable. Based on testing, no shift is expected in NDT temperature below the irradiation value of 10^{17} neutrons /cm^2. Since the neutron fluence for 60 years is calculated to be 2.2×10^{14} neutrons/cm^2, the applicant concluded that there will be no shift in NDT temperature. The neutron irradiation influence on the NDT temperature of the cask body has been re-analyzed and projected to be valid through a 60 year cask service period.

Thermal Fatigue Analyses for Westinghouse MC-10 Cask.

The Cumulative Usage Factors for thermal fatigue for several components were identified as TLAAs. Those components included:

Cask Body (vessel wall)
Cask Bottom
Shield Cover
Primary Cover
Shield Cover Studs
Primary Cover Cap Screws
Seal Cover Weld

The CUF for all these components was calculated to be 0.0146, except for the primary cover cap screws, which was originally calculated to be 0.82, for 40 years. This was the only CUF that would exceed the allowable value of 1.0 if linearly projected for a period of up to 60 years. The original evaluation for the cap screw threads and shank-to-head shoulder region assumed the smaller diameter of the shank and applied a reduction factor for the threaded portion. In the evaluation for a 60 year period, separate CUFs for cap screw threads and the shank-to-head shoulder region were calculated. The calculations have been based upon daily fluctuations with total cycles of 21,900 for 60 years. The CUF values, for up to 60 years, are determined to be 0.43 for the cap screw threads and 0.222 for shank-to-shoulder region. Both of these recalculated values are within the allowable value of 1.0. The CUF of all other components listed above was linearly extrapolated out to 60 years with a resultant value of .0219. Thus, the CUF has been projected to be valid for the license renewal period.

Effect on Criticality due to Depletion of the Boron-10 in the Boral™ Plates due to Spontaneous Fission for Westinghouse MC-10 Cask.

When the cask cavity is dry or has borated water in it, the MC-10 meets the criticality criterion of $k_{eff} < 0.95$ without other neutron poisons (e.g., Boral) present. With pure water in the cask, the MC-10 meets the criticality criterion of $k_{eff} < 0.95$ with Boral poison in the cask, as prescribed in the original design and described in the FSAR. The analysis showed that the k_{eff} criterion may not be met if the Boral is not present. During storage, a small fraction of the original Boron-10 (neutron poison material) could be consumed over time by a B^{10} (η,α) Li^{7} transmutation that results from spontaneous fission within the spent fuel.

A calculation was performed to demonstrate that there is sufficient neutron poison material remaining, including a sufficient margin, after an additional 40-year life with pure water present in the cask cavity and that the Topical Safety Analysis Report (TSAR) conclusions do not therefore change for a cask service period of up to 60 years. The effect on criticality of any depletion of the Boron-10 in the Boral plates, due to spontaneous fission, is thereby re-analyzed and projected to be valid for the proposed license renewal period.

With respect to the physical properties of the Boral, there is ample industry-wide operating experience with this material in spent fuel pools to demonstrate that no

adverse, radiation induced effect such as embrittlement will occur. Consideration of the neutron fluence over the original 20 year license period plus an additional 40 year extension shows that the total fluence is still orders of magnitude below the threshold for embrittling any metal. Further, the mechanical properties of the Boral are not credited for any analyses. This is because the design of the fuel basket incorporates a welded cover over the Boral plates that completely supports the material and effectively encapsulates it to prevent any shifting or loss of material. This cover material is not significantly affected by the radiation levels inside the cask.

The staff has reviewed the licensee's Time Limited Aging Analyses with respect to the Preliminary Staff Guidance and regulatory requirements. The staff finds the licensee's 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. 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

The applicant addressed other renewal issues that were not specifically addressed in the Preliminary Staff Guidance. The staff reviewed the applicant's analysis of these issues and found them to be acceptable.

Elastomer Seals

Rubber o-ring seals are used on the various casks in conjunction with various weather shields that are used to minimize the intrusion of rain water and thus prevent corrosion. The areas protected by such weather covers include pressure monitoring equipment and the cask lid outer metallic gasket, depending upon the cask design. These elastomer seals were judged to be outside the scope of license renewal because they are not part of the casks' radiological boundary and they are not credited as being leak-tight. Since these seals are not credited with being leak-tight, inspections are performed on an opportunity basis of the normally inaccessible areas under the weather covers to ensure that no corrosion is progressing within the areas protected by the weather covers. Appropriate actions will be taken to correct any problems that may be discovered.

Lead Slumping

Lead is used as a gamma shield material in the NAC I-28 cask. Lead slumping associated with a cask drop accident was evaluated in the TSAR for the I-28 cask. The licensee's license renewal team considered both the validity of the original accident analysis evaluation, as well as the potential for non-accident slumping of lead over an additional 40 year period, bounding the 40 year license renewal.

The original cask drop accident evaluation for the I-28 cask concluded that the deformation of the lead gamma shield resulting from the hypothetical drop accident was minimal. The consequent dose impact was determined to be acceptable. There are no aging effects identified for lead that would cause changes in the physical properties of the material or loss of

material. Since the accident scenario is constant and the material conditions of the lead gamma shield would not change over the license renewal period, the TSAR accident analysis is still valid.

Non-accident slumping of the gamma lead shield over time was considered. The lead is cast into the NAC I-28 cask body shell (comprised of 1.5 inch or thicker stainless steel). Welded seal rings enclose the lead completely. In the fabrication of the storage system, the lead is cast in place; hence, no free space is available to allow the lead to shift or slump. Therefore, without the forces of a cask drop acting upon the lead and its supporting stainless steel shell, lead slumping does not occur over time.

License Renewal Scope Excludes Fuel Pellet

The current licensing basis for the dry cask storage systems evaluates conservative criticality safety scenarios assuming the cask is loaded with unirradiated fuel. Fuel pellet characteristics for these evaluations are applicable to the fuel assembly type and have been determined to be the most limiting from a criticality safety standpoint.

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. Since 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 related to license renewal and 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 an examination of the cladding for swelling caused by the effect of either: (1) stresses due to gas pressure from within the cladding or (2) oxidation of the fuel pellets. Precision measurements of the cladding dimensions revealed no abnormalities, thereby confirming stresses from gas pressure to be at expected levels and pellet oxidation to be insignificant or absent. Additionally, no indications of cladding oxidation occurring during the 15 year storage period were found. This further verified the efficacy of the inert environment. These findings also confirm the predicted behavior of the cladding as outlined in ASTM Standard C-1562-03.

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

Two EPRI documents were referenced in Section 3 of the LRA. Those are "Dry Cask Characterization Project-Interim Report" (EPRI Tech Report No. 1003010) and "The CASTOR V/21 PWR Spent Fuel Storage Cask: Testing and Analysis, Interim Report" (NP-4887). These documents were referenced in conjunction with the establishment of 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 reports) 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 Surry 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 370 degrees C to a low of 296 degrees C, depending upon the specific cask design and associated fuel load.

These predicted temperatures all fall below the temperature levels at which degradation mechanisms could occur that would compromise the cladding integrity. Although not a requirement of the Surry license, the NRC staff notes that 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 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 may react with the cladding and cause cracking. Two factors of dry storage eliminate this potential mechanism from occurring: 1) the much lower temperatures of storage completely inhibits the reaction from occurring, and, 2) the fact that no significant nuclear fission processes are occurring to produce iodine in significant quantities. The ongoing NRC staff sponsored confirmatory research into the effects of spent fuel storage, referenced in the previous section discussing fuel pellets, confirms this assessment.

Criteria for Corrective Actions

AMR evaluations determined that corrosion monitoring, cask pressure monitoring, and radiation monitoring are adequate to manage the aging effects of all casks at Surry. 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. As such, a Plant Issue would be generated and an engineering evaluation would be required for the deviation. This process is a part of the normal plant corrective actions program that is required by NRC regulations.

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 cask designs with similar material/environment conditions. Corrective actions would be identified to preclude future occurrences and restore the condition of any degraded component.

Thermal Fatigue and Maximum Cumulative Usage Factor (CUF)

The structural evaluation of the possible effect of thermal fatigue on the cask structure is based upon the cumulative usage factor (CUF). The CUF is the sum total of the effect of thermal fatigue from all causes. The CUF varies among the different cask types due to their design differences. For example, the CASTOR V/21 cask is designed to accommodate 5-year-old

discharged fuel and utilizes fins on the outer surface to dissipate the heat load. The CASTOR X/33 cask is designed for a larger number of assemblies of older, colder fuel. This cask is larger in diameter and therefore more rigid. Thus differing stress levels are induced by similar externally imposed thermal loads.

The LRA showed that thermal fatigue effects would be negligible over the proposed license renewal period and thus would not require any aging management program.

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 FSAR states that the spent fuel pool at the Surry Power Station will remain functional until the ISFSI is decommissioned unless other facilities are licensed and constructed. Expiration of the 10 CFR Part 50 power reactor license, under which the pool is licensed, would not obviate the need to meet the ISFSI license requirements.

In accordance with 10 CFR 50.54, Item (bb), the licensee is required to submit to NRC for review any program by which the licensee intends to manage all irradiated fuel at the site following permanent cessation of reactor operation. 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.

Potential Reuse of Existing Spent Fuel Storage Casks

While there are no plans to unload currently loaded casks and then reload them with different fuel assemblies, the current ISFSI license does not preclude this possibility, except for license condition 14. The license renewal evaluation performed by Dominion has established that the spent fuel casks being used at Surry will perform their required function over the license renewal period assuming the casks are loaded with fuel which meets the requirements of the current Technical Specifications. Based upon the implementation of aging management activities identified through the aging management reviews for the cask components, it is concluded that the durability of the cask design and materials is not compromised by aging effects. No credit has been taken for additional fuel decay or reduction in heat load in the development of this stated conclusion.

As the functionality of the casks is not expected to degrade over the license renewal period, the unloading and reloading of the casks should not be precluded if it is deemed prudent to do so and fuel meeting the Technical Specifications requirements for the cask is available. It should be noted that fuel currently being discharged from the Surry reactors would not meet the storage requirements for the older casks and would, therefore, make their re-use unlikely for newly discharged spent nuclear fuel from Surry reactors.

Should a cask be reused to store different fuel than originally stored, the cask and fuel basket would undergo visual and other inspections during the unloading/loading sequence to ensure no degradation had occurred. New seals would be used with any cask closure. Prior to placement at the ISFSI, the casks must meet TS limits on surface dose rates. For reloaded

casks this TS measurement would provide assurance that the shielding ability of the cask still meets its design function and would continue to do so for the storage period.

Cask Seals–Potential for Undetected Degraded State

The potential for an undetected degraded state of the metallic seals in any cask design cannot be dismissed but it is accounted for by the redundant seal system design. There are no identified aging effects for the inboard metallic lid seals subject to the inert helium environment. Any seal failure would most likely affect the outboard metallic lid seals that are potentially subject to atmosphere/weather environment. Since the region between the two seals are continuously monitored for integrity, leakage of either metallic seal would be indicated. Any time a lid is removed, both seals are discarded and replaced with new seals. Previously used seals cannot be reused.

The seal leaks that occurred at Surry were entirely due to corrosion of the outer seal. The leaks were detected by means of the pressure monitoring equipment. When a seal fails due to corrosion, a pinhole forms somewhere in the seal and the leak is detected. This failure mode has been confirmed by inspection of the failed seals that occurred. There has never been a failure of the entire seal all at once. That is highly unlikely due to the nature of the corrosion mechanism (pitting of the metallic seal), which is a highly localized form of corrosion, and the leak detection system, which is highly reliable.

After the seal failures, the weather cover on the TN-32 cask was redesigned to exclude moisture intrusion, and the seal material was changed to silver, which will not corrode under the conditions experienced at Surry. Thus, significant degradation of both seals is not expected over the duration of the proposed license renewal period.

7.0 FINAL SAFETY ANALYSIS REPORT SUPPLEMENT

The FSAR 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. Dominion provided a proposed new FSAR 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 FSAR 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 FSAR 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 C1562-03, "Standard Guide for Evaluation of Materials Used in Extended Service of Interim Spent Nuclear Fuel Dry Storage systems", ASTM International, March 2003.

REQUIREMENTS FOR NOTICING PROPOSED ACTION

The staff considered the amendment's 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-2501 for the Surry ISFSI, were published in the Federal Register on January 14, 2003, (68 FR 1871).

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 February 24, 2005 (70 FR 9114).

CONCLUSION

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 devised an Aging Management Program. The Aging Management Program process involved the following four (4) 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 reviewed the application for renewal of the Surry ISFSI License, SNM-2501, as supplemented, including applicable general, technical, and environmental supporting information, and proposed FSAR supplement, submitted with the application. Based on the information provided in the application, as supplemented, the staff concludes that the Surry ISFSI Special Nuclear Materials License, SNM-2501, meets the requirements of 10 CFR Part 72 for license renewal.

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-2501 for 40 years.

Issued with Materials License No. 2501, on February 25, 2005.