NORTH ANNA POWER STATION SITE SPECIFIC INDEPENDENT SPENT FUEL STORAGE

INSTALLATION

MATERIALS LICENSE NO. SNM-2507

DOCKET NO. 72-16

LICENSE AMENDMENT REQUEST NO. 5

REQUEST FOR ADDITIONAL INFORMATION

By letter dated August 24, 2015, as supplemented October 8, November 18, November 19, November 20, December 01, and December 28, 2015, Virginia Electric and Power Company (Dominion) submitted license amendment request (LAR) No. 5 to the U.S. Nuclear Regulatory Commission (NRC) for Materials License No. SNM-2507 for the North Anna site specific independent spent fuel storage installation (ISFSI). This request for additional information (RAI) identifies information needed by the NRC staff (the staff) in connection with its review of the LAR.

Each question describes information needed by the staff for it to complete its review of the application and to determine whether the applicant has demonstrated compliance with regulatory requirements.

SAFETY REVIEW

Chapter 5 – Structural Evaluation

1. Provide AREVA TN Document [E-39973], "Documentation of Previously Analyzed Bounding Cask Outer Shell Analysis for TN-32 in Support of the TN-32B HBU Demonstration Project".

   As of date, the docketed materials relating to the proposed TN-32B HBU demonstration cask does not include any analysis that confirms the structural adequacy of the outer shell, incorporating all the modifications to TN-32 cask described in the application.

   This information is needed to determine compliance with 10 CFR 72.122.

2. Provide AREVA TN Document [E-40199], "Reconciliation of TN 32B HBU Demonstration Cask Trunnions and the Gamma Shield Shell Evaluation".

   As of date, the docketed materials relating to the proposed TN-32B HBU demonstration cask does not include any analysis that confirms the structural adequacy of the cask trunnions, and the gamma shield shell, incorporating all the modifications to TN-32 cask described in the application.

   This information is needed to determine compliance with 10 CFR 72.122.

Enclosure

3. Provide AREVA TN Document [E-39552], “Documentation of Previously Analyzed Bounding Missiles for TN-32 in support of the TN-32B HBU Demonstration Package”.

   As of date, the docketed materials relating to the proposed TN-32B HBU demonstration cask does not include any analysis that confirms the structural adequacy of the cask when subjected to the design basis missiles, incorporating all the modifications to TN-32 cask described in the application.

   This information is needed to determine compliance with 10 CFR 72.122.

Chapter 6 – Thermal Evaluation

1. Clarify why the thermal evaluation performed for normal storage conditions thermally bounds the thermal evaluation during transfer operations.

   Page 17 of LAR with document identification number (IDN) 15-369 states that during transfer operations to the ISFSI pad, the TN-32B HBU cask is exposed to ambient conditions and is not surrounded by other casks. This ensures that there is no radiation heat transfer between the casks as there is during storage on the ISFSI pad. Therefore, the thermal evaluation performed for normal storage bounds the thermal performance of the TN-32B HBU cask during transfer to the North Anna Power Station (NAPS) ISFSI pad.

   However, it is not clear whether during transfer conditions, the cask is in the horizontal or vertical configuration. Depending on the configuration, different correlations are applied to model convective heat transfer to the environment. Correlations obtained for horizontal cylinders may be more limiting and may overcome the lack of radiation heat transfer from surrounding casks.

   This information is needed to determine compliance with 10 CFR 72.122 and 72.128.

2. Explain how the 23-day thermal soak period was obtained for the TN-32B HBU cask.

   Page 18 of LAR IDN 15-369 states that to ensure the TN-32B HBU cask thermocouples are functioning correctly and that the cask and payload have reached a state of thermal equilibrium, the TN-32B HBU cask will remain in the NAPS loading bay for a maximum of 23 days from the time the cask is filled with helium.

   However, the licensee does not provide any details on how the 23-day period was obtained. Analysis that demonstrates the cask will reach thermal equilibrium during this period is needed in order to evaluate the adequacy of this assumption. Boundary conditions and cask configurations should also be properly justified. An adequate response is also necessary to justify Surveillance Requirement (SR) 3.1.3.1.

   This information is needed to determine compliance with 10 CFR 72.122 and 72.128.

3. Clarify if any insert components are planned to be installed in the TN-32 HBU cask. Explain if these components are irradiated and how their decay heat is accounted for in the total heat load of the cask.

   Page 18 of LAR IDN 15-369 states that no irradiated inserts shall be inserted in the TN-32B HBU cask. However, page 13 of document number E-42038 (TN-32B HBU Demonstration Cask Design/Licensing Basis Document) states that any insert components which are planned to be installed in the HBU demonstration cask, such as poison rod assemblies, are installed in designated fuel assemblies during loading operations. It appears these two statements are not consistent. Also, the total decay heat seems to have been considered for the fuel assemblies only and not from any other irradiated components.

   This information is needed to determine compliance with 10 CFR 72.122 and 72.128.

4. Explain how the thermocouple lances installed though the cask lid will indirectly monitor the fuel assembly cladding temperature during the demonstration storage period.

   Page 8 of E-42038 states that the TN-32B HBU demonstration cask will have thermocouple lances installed to indirectly monitor the fuel assembly cladding temperature.

   However, the licensee does not provide any details on the location of the thermocouples and how these measurements will indirectly monitor the fuel cladding temperature.

   This information is needed to determine compliance with 10 CFR 72.122 and 72.128.

5. Clarify if the installed thermocouples will adequately capture the maximum fuel cladding temperature.

   Page 8 of E-42038 states that a number of thermocouple lances will be installed in specific assemblies. However, the licensee does not provide any details on the number of thermocouples per lance location.

   The staff needs details on the number of thermocouples used to obtain measurements. Also, the staff needs to know if the purpose of the temperature measurements is to capture both the axial profile and the maximum cladding temperature (See also RAI-6-4).

   This information is needed to determine compliance with 10 CFR 72.122 and 72.128.

6. Clarify which thermal analysis will be benchmarked using the measured data obtained from the TN-32B HBU cask during the thermal soak period.

   Page 14 of E-42038 states that during the thermal soak period, measured data (temperatures, pressures, etc.) will be utilized to more fully understand the loading and drying temperature transients for benchmarking thermal analysis techniques, and to identify any rod failures, should they occur.

However, the LAR does not provide any thermal analysis for loading operations (for example vacuum drying) because the licensee stated these operations are bounded by normal storage conditions (see also RAI 6-1).

This information is needed to determine compliance with 10 CFR 72.122 and 72.128.

7. Justify the methodology used to evaluate the TN-32B HBU cask hypothetical fire accident. Provide reasons why the methodology adequately capture the maximum temperature of the fuel cladding, cask components, and seals.

   Page 15 of document number 19885-0403 (Thermal Evaluation of TN-32B HBU Cask for Normal and Accident Conditions) states that simplified models are used to model the conditions during the fire accident and to obtain the maximum temperature of the fuel cladding, cask components, and seals. However, the licensee does not provide adequate justification why these simplified models bound analyses based on a thermal model of the entire cask.

   This information is needed to determine compliance with 10 CFR 72.122 and 72.128.

8. Explain why a very small thermal margin is acceptable for the radial neutron shield material. Provide the maximum predicted value of this material. Perform additional analysis to determine that the predicted temperatures in this region are mesh independent.

   Page 39 of document number 19885-0403 (Thermal Evaluation of TN-32B HBU Cask for Normal and Accident Conditions) states that the average resin temperature in the radial direction at the hottest cross section is only three degrees lower than the allowable limit. However, the LAR does not provide the maximum predicted value or an explanation why this very small margin is acceptable. Also, additional analyses should be performed to demonstrate the predicted results are mesh independent.

   This information is needed to determine compliance with 10 CFR 72.122 and 72.128.

9. Clarify how the correlations to calculate the convection heat transfer coefficients on the TN-32B HBU cask external surfaces are used. Justify the applicability of the selected correlations to the TN-32B HBU cask geometry to calculate these coefficients.

   Page 41 of calculation number 19885-0403 states that correlations for vertical cylindrical surface and flat horizontal surfaces are used to obtain the average Nusselt numbers which are used to calculate the convection heat transfer coefficients.

   However, it is not clear if the Nusselt numbers are obtained using the average temperature of the surface or the local face nodal or face temperature of a given cell or element. These correlations are usually obtained based on average surface temperatures. Therefore, they may not be applicable to a surface where the local temperature is varying with location and flow regime (laminar, transitional, or turbulent). Appropriate correlations may exist in the literature that depend on both the location and Rayleigh number but their application to the considered geometry must be fully justified. One approach to demonstrate the adequacy of the predicted heat transfer coefficients will be to model the ambient. If this approach is used, the location of the boundary should be sufficiently far from the external surfaces to avoid any nonphysical effect on the cask heat transfer characteristics. Also, the mesh close

to the surface should be sufficiently fine to properly capture the heat transfer and to follow the specific guidelines for the selected turbulence model.

This information is needed to determine compliance with 10 CFR 72.122 and 72.128.

10. Obtain the analysis discretization error for the normal conditions of storage by calculating the grid convergence index (GCI) following the procedure described in American Society of Mechanical Engineers Verification and Validation 20-2009 (ASME V&V 20-2009), "Standard for Verification and Validation in Computational Fluid Dynamics and Heat Transfer."

    The licensee presents the TN-32B HBU cask maximum component temperatures for normal storage conditions. However, the LAR does not provide the analysis discretization error or adequate validation for the analytical methods used in the evaluations. The licensee needs to obtain this error so the staff can verify the adequacy of the results. Also, due to the predicted small margin in the radial neutron shield, discretization error should also be obtained for this region.

    This information is needed to determine compliance with 10 CFR 72.122 and 72.128.

Chapter 7 – Shielding Evaluation

1. Provide the basis for choosing 6 hours per evolution, and how many staff hours is required (number of staff *time) for the cask loading.

    Table 4.4-1 of the DLBD (Design/ Licensing Basis Document, DOCUMENT NUMBER: E-42038) states that six hours is the time needed for cask loading from the pool. There is no documentation provided to justify the estimated time required for cask loading, particularly with consideration of the installation of the lances and poison rod assemblies.

    This information is needed to determine the TN-32B HBU cask design compliance with 10 CFR 72.126.

2. Check and correct, if necessary, the dose rates reported in tables 4.4-2, 4.3-1, and 4.3-2 of the DLBD and revise the expected dose for occupational workers per the requirement of 10 CFR 72.126.

    Table 4.4-2 stated that the estimated dose rates for gamma is 0.5 mrem/hr and for neutron is 0.5 mrem/hr during cask loading. However, the average dose rates for normal/off normal and accident conditions in tables 4.3.1 and 4.3.2 are much higher than that of table 4.4-2. The applicant needs to cross check the numbers in these tables and make corrections if necessary to the data and expected dose to the occupational workers.

    This information is needed to determine the TN-32B HBU cask design compliance with 10 CFR 72.126.

3. Explain why the dose rates under normal/off normal conditions are higher than the dose rates under accident conditions.

Referring to tables 4.3-1 and 4.3-2 of the DLBD for normal/ off normal and accident conditions respectively, the dose rates for the side surface above the shield seem to be higher under normal conditions than the cask under accident conditions. This seems to be inconsistent with the assumptions made in the safety analyses that the cask will lose the neutron shield under accident conditions. However, there is no explanation for this unusual result.

This information is needed to determine ISFSI design with the addition of the TN-32B HBU cask compliance with 10 CFR 72.104 (a), 10 CFR 72.106 (b), and 72.126.

4. Provide a justification for using the annual dose at 500 meters from the cask pad as the annual dose rate at the site boundary. In addition, provide the actual distance between ISFSI and the site controlled area boundary and an explanation for not estimating the dose rates at the actual boundary of the ISFSI or the annual dose at 500 meters bounds the controlled area boundary.

   In the radiological protection section and the Far Field section of the DLBD, dose rate estimation at a distance of 500 meters is selected for dose rate at the boundary. But, the applicant provide no information on bases for this determination. The applicant needs to provide information on the estimated annual dose at the controlled area boundary resulting from the addition of the TN-32B HBU cask.

   This information is needed to determine ISFSI design with the addition of the TN-32B HBU cask compliance with 10 CFR 72.104 and 10 CFR 72.106.

5. Provide documentation or a reference for the site boundary dose rates.

   In the conclusion of the radiological protection section of the application document 15-369, the applicant states that “an evaluation performed by Dominion that demonstrated the site boundary annual dose is not increased with the TN 32B HBU cask installed at the NAPS ISFSI”. The applicant needs to provide the documentation or a reference to the document that provides information for the calculations of the site boundary dose.

   This information is needed to determine ISFSI design with the addition of the TN-32B HBU cask compliance with 10 CFR 72.104.and 10 CFR 72.106.

6. Provide the locations at which high dose rates are expected with the corresponding dose rate values and revise, if necessary, the calculated values of the expected doses under radiation protection chapter.

   On page 11 of document Serial No. 15-369, the applicant provides the calculated average dose rates at the side and top of the TN-32B HBU cask and used that for calculations of the expected dose for occupational workers performing the cask loading and installation operations. To get a reliable estimated of the expected dose for these operations, it is imperative to clearly understand the actual dose rates at various locations of the cask and identify hot spots rather than only an average dose rate. For example, based on the information in the document number E-42038, the applicant did not model the penetration explicitly. Given that the cask has two thick steel layers for shielding gammas and one thick borated resin layer for shielding neutrons, it is conceivable that these penetrations will significantly alter the gamma and particularly the neutron shielding at the cask top. In

addition, considering the fact that the cask will be loaded with much hotter fuel (high burnup and shorter cooling time), the staff is concerned if these through-cuts of the neutron and gamma shields will provide streaming paths and create hot spots at the top of the cask lid, especially for neutron radiation. The applicant needs to provide a calculation for the dose rate at the top of the cask or a justification that the through-cuts of the neutron shields and gamma shield will not significantly impact the dose rates at the top of the cask where a significant amount of operations will be performed by the workers.

This information is needed to determine the TN-32B HBU cask design compliance with 10 CFR 72.126.

7. Provide justification for not evaluating potential operational difficulties during cask loading in estimation of dose rates received by the occupational workers.

   On page 12 of document Serial No. 15-369, the applicant discusses radiation protection during cask loading operation. However, the applicant did not provide evaluation for the cases in which potential operational difficulties may occur or proper justifications for not considering any potential operational difficulties given that this is a very unique cask design with the installation of the instrumentation and lances.

   This information is needed to determine the TN-32B HBU cask design compliance with 10 CFR 72.126.

Chapter 8 – Criticality Evaluation

1. Provide the name or material composition, the material density of the cladding material of poison rods, the material density of the B_4C, and revise Table 5.1-1 of the DLBD to include this information.

   The applicant states in the safety analysis report (SAR) for the North Anna ISFSI amendment request dated August 24, 2015, that poison rod assemblies are used in the TN-32B HBU cask for criticality safety control. Table 5.1-1 of the DLBD provides information on the poison rods, material composition of the poison, and geometric dimensions of the rods. However, the SAR does not include information on the material composition and density for the poison rod assembly cladding material and the B_4C material density.

   This information is needed to determine compliance with 10 CFR 72.126.

Chapter 9 – Confinement Evaluation

1. Provide updated figures and drawings for the thermocouple lance assembly and penetrations in the modified TN-32B lid.

   The figures and drawings presented in the LAR as not of sufficient quality and detail needed for evaluation. The requested drawings and figures update should include clear details of the sealing location, bolting patterns, and any welds that are necessary to make the lid modification. Preferable figures would include 3D renderings of the assembly and seal region; however, 2D drawings and figures are acceptable provided they include the level of detail requested and are of sufficient quality. The 2D drawings and figures should include a

side or elevation view, a top view, as well as detail callouts for areas such as the seal location.

This information is needed to determine compliance with 10 CFR 72.24(c)(3) and 10 CFR 72.122(h)(1).

2. Justify the difference in the durations reported in Table 6.3-3 of the DLBD for the estimated time to exceed dose limits of 10 CFR 72.106 and those reported in the TN-32 UFSAR.

   Inspection of the latent seal leak calculations provided in the TN-32 UFSAR and supporting documents for this LAR illustrate that durations for time to alarm and time to loss of Over Pressuring system pressures are similar for both the TN-32 and TN-32B, as expected. In the accident conditions scenario, the time to exceed dose limits of 10 CFR 72.106, was significantly longer for the TN-32B s than for the TN-32 for each of the representative leak rates provided. Staff is unclear as to why this would be the case given the similarities of the two casks.

   This information is necessary to demonstrate compliance with 10 CFR 72.24(c)(3) and 10 CFR 72.122(h)(1).

3. Provide a verification that the radionuclide release concentrations in Table 6.2-3 are bounding

   It is not clear to the NRC staff how the multiple fuel assemblies with various burnup and cooling time in Table 6.2-1 were translated into the single set isotope inventory. The supporting documentation does not indicate whether a bounding assembly was used to generate the data in Table 6.2-3.

   This information is necessary to demonstrate compliance with 10 CFR 72.24(c)(3) and 10 CFR 72.122(h)(1).

Chapter 10- Materials Evaluation

1. Provide a revised SAR for the North Anna ISFSI accounting for the proposed amendment, which defines and includes all applicable revisions of the drawings to the TN-32B demonstration cask. Provide a list of drawings changes from those previously approved for the TN-32 cask in the TN-32 FSAR, Rev. 2 (with clear mapping to where the changes were made from the approved TN-32 drawings, e.g. Change XXX in Section A-8 of Drawing YYY). Provide a copy of the TN-32 FSAR, Rev. 2, which should include the approved drawings for the TN-32 cask to which changes were made.

   Drawings in the LAR (Document No. E-42038) are not legible. In addition, all drawings pertinent to the revised TN-32 design were not submitted in the LAR. For example, Drawing 19885-30-1, Rev. 0, “TN-32 HBU Demonstration Cask Assembly and Parts List” (dated 5-29-15) was unofficially submitted to the staff in an external shared site but was not included in the LAR. This appears to be an alternate version of Drawing 19885-70-1, “TN-32B HBU Demonstration Cask General Arrangement” (dated 6/8/15), which was submitted in the LAR but is not legible. As another example, there appears to be two different drawings for the cask lid: Drawing 19885-70-3, Sheets 1-3, Rev. 0, “TN-32B HBU Demonstration Cask Lid Assembly and Details” (dated 6/8/15, submitted in the LAR) and Drawing 19885-30-4, Rev.

0, Sheets 1-4, “TN-32B HBU Demonstration Cask Lid Assembly and Parts List” (dated 5/31/15 and unofficially submitted to the staff in an external shared site). It appears that there are two sets of applicable drawings for the amendment, namely 19885-70-X series and 19885-30-X series. The staff is unclear what set of drawings is applicable to the amendment. The staff cannot complete the review until all drawings pertinent to the amendment are clearly submitted and properly referenced (and included) in the revised North Anna ISFSI SAR. The drawings must be clear and legible.

The staff further notes that it cannot complete the review of the modifications to the cask protective cover until it receives applicable legible drawings (identified as Drawing 19885-30-07, Sheets 1-3 in the LAR).

In addition, Drawing 02-8076670D, referenced in Drawing No. 19885-30-4 was not submitted in the LAR, which is needed to verify the material composition of the thermocouple lance assembly, weld requirements for the two seals welds at the closure flange and the metallic seals used in the lance assembly.

The LAR further identified changes to the top neutron shield elevation and the external shell of the cask bod; changes that are unclear in which specific drawings are located.

This information is needed to determine compliance with 10 CFR 72.11(a) and 72.24.

2. Revise the LAR to justify that Section 3.3.4 of the TN-32 SAR, Rev. 2 remains valid for the revised HBU fuel content.

   Section 3.3.4 of the TN-32 SAR, Rev. 6 states that gamma radiation has no significant effect on metals, and the effect of fast neutron irradiation is insignificant below 10^{17} n/cm^2. The design-bases fuel for the TN-32 SAR, Rev. 2 resulted in an integrated fast neutron flux in the range of 10^{17} n/cm^2. The LAR should adequately justify that the integrated fast neutron flux for the TN-32B is bounded by the analysis in Section 3.3.4 of the TN-32 SAR, Rev. 2. The justification should be included in the revised SAR for the North Anna ISFSI requested in RAI 1.

   This information is needed to determine compliance with 10 CFR 72.24.

3. Regarding progressive liquid penetrant (PT) or magnetic particle non-destructive examination, revise the LAR to justify that as low as reasonably achievable (ALARA) principles will be followed and clarify provisions for correcting weld defects or any additional drying and purging that may be necessary.

   The application requested the alternative use of progressive PT examination for the partial penetration welds attaching the thermocouple lance penetration sleeves to the lid. The guidance in NUREG-1536, Rev. 1, states that the alternative may be accepted if a stress-reduction-factor of 0.8 is imposed on the weld strength. The staff verified that the applicant properly identified the reduction factor in the Design Requirements in Section 4.0 of Specification 19885-0101. However, NUREG-1536, Rev. 1 further states that the SAR should also ensure ALARA principles are followed and include acceptable provisions for correcting weld defects and any additional drying and purging that may be necessary. The application should be revised to clarify if these considerations are applicable to the lid

fabrication, and if so, properly address them in the LAR and the revised North Anna ISFSI SAR.

This information is needed to determine compliance with 10 CFR 72.24.

Chapter 11 Conduct of Operations Evaluation

1. Clarify why an evaluation for conduct of operation is not provided in the NAPS ISFSI LAR.

   Document with identification number E-42038 includes the evaluation for different areas or disciplines. However, the licensee did not provide an evaluation for Conduct of Operations. The licensee needs to provide adequate justification why this evaluation was not provided as part of the LAR.

   This information is needed to determine compliance with 10 CFR 72.24.

ENVIRONMENTAL REVIEW

1. Dominion is requesting an amendment to materials license number SNM-2507 for the NAPS ISFSI. The amendment requests changes to the Technical Specification to use a modified TN-32B cask (TN-32B HBU cask) to store high burnup spent fuel from North Anna Units 1 and 2. The TN-32B HBU cask will be modified to insert thermocouples through the cask lid and into the fuel assemblies to monitor fuel temperatures in the cask. Please provide information regarding additional changes to (i) routine operations or maintenance activities and (ii) land-disturbance as a result of this license amendment request, if any are anticipated.

   This information is needed to determine compliance with 10 CFR 51.30

2. Identify applicable regulatory requirements and permits (federal, state, or local) necessary to carry out the proposed action. The information provided should identity the issuing agency, describe the type of license, permit or approval needed, and provide the status of securing the license, permit or approval.

   This information is needed to determine compliance with 10 CFR 51.30.

3. In the environmental report that Dominion submitted on October 8, 2015, Dominion explains that “AREVA, Inc. performed a complete cask analysis, including thermal and criticality assessments,” “cask/fuel components analyzed included: outer surface, radial neutron shield (resin/aluminum), seal/lid, fuel compartment, and fuel cladding,” and concluded that the “material limits for the TN-32B HBU cask are not exceeded.” It is not clear that the AREVA, Inc. analysis referenced in the environmental report is the same analysis discussed in the license amendment request dated August 24, 2015, which includes a criticality evaluation, radiological protection, accident evaluation, occupational exposures, thermal evaluation, and structural evaluation. Please confirm that this is the same analysis or provide the AREVA, Inc. analyses referenced in the environmental report.

   In the environmental report Dominion also explains that storage of high burnup fuel assemblies in the TN-32B HBU cask “has no effect on the analysis of record for offsite dose at the site boundaries” and that the “the analysis of record assumed the presence of 28

casks." In addition, Dominion states that "an analysis of dose at the site boundary that modeled the TN-32B HBU cask on Pad 1 with the resident casks" was re-performed and the analysis showed no changes to the analysis of record. Please, provide the analysis of record that is referenced in the environmental report and the analysis of dose that Dominion re-performed.

This information is needed to determine compliance with 10 CFR 51.30.

4. In the license amendment request Dominion submitted on August 24, 2015, Dominion explains that the current plan is to load the cask with high burnup spent fuel in July 2017 and place it on Pad 1 of the specifically-licensed ISFSI before the end of August 2017. Dominion further explains that the cask will remain at the site for approximately ten years and then will be shipped to a fuel examination facility for characterization of the fuel. Please, provide additional information about the transportation impacts (including, but not limited to, transportation mode, routes, destination, transportation cask, doses) of shipping the cask to an examination facility.

   This information is needed to determine compliance with 10 CFR 51.30.

5. Discuss any past, present, or reasonably foreseeable future actions which could result in cumulative impacts when combined with the proposed action. These future actions may be occurring on or near the NAPS specifically-licensed ISFSI.

   Finally, the information the NRC uses to conduct and inform its NEPA environmental reviews, including the information in the environmental report, must be publicly available, as appropriate. Therefore, please ensure that the information included in response to these requests for additional information can be made publicly available.

   This information is needed to determine compliance with 10 CFR 51.30.