~~SECURITY-RELATED INFORMATION – WITHHOLD UNDER 10 CFR 2.390~~

VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

July 11, 2022

10 CFR 50.90

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Serial No.: 22-027A
NRA/GDM: R3
Docket Nos.: 50-280
50-281
License Nos.: DPR-32
DPR-37

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2
LICENSE AMENDMENT REQUEST - APPLICATION OF RISK-INFORMED APPROACH FOR TORNADO CLASSIFICATION OF THE FUEL HANDLING TROLLEY SUPPORT STRUCTURE
SUPPLEMENTAL INFORMATION

By letter dated May 11, 2022, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML22131A351), Virginia Electric and Power Company (Dominion Energy Virginia) submitted a license amendment request (LAR) for Surry Power Station (SPS) Units 1 and 2. The proposed amendment would apply a risk-informed approach to demonstrate the fuel handling trolley support structure (FHTSS), as designed, meets the intent of a tornado resistant structure (i.e., Tornado Criterion "'T") under the current SPS licensing basis for a 360 miles per hour (mph) maximum tornado wind speed.

By letter dated June 21, 2022 (ADAMS Accession No. ML22166A009), the U. S. Nuclear Regulatory Commission (NRC) informed Dominion Energy Virginia that additional information was required before the NRC would accept the LAR for formal review. A conference call was held on June 21, 2022, to clarify the supplemental information the NRC needed to complete their acceptance review. The NRC provided Dominion Energy Virginia an opportunity to supplement the proposed LAR by submitting the requested supplemental information within thirteen working days, i.e., by July 11, 2022.

Dominion Energy Virginia's response to the NRC request for supplemental information is provided in the enclosure. Figure 1 in the enclosure contains security-related information; therefore, it is requested that Figure 1 be withheld from public disclosure pursuant to 10 CFR 2.390.

The supplemental information provided in the enclosure does not affect the conclusions of the significant hazards consideration determination or the environmental assessment included in the May 11, 2022 LAR.

FIGURE 1 IN THE ENCLOSURE CONTAINS ~~SECURITY-RELATED INFORMATION~~ AND MUST BE PROTECTED ACCORDINGLY. UPON SEPARATION OF FIGURE 1, THIS LETTER IS DECONTROLLED.

Should you have any questions or require additional information, please contact Mr. Gary D. Miller at (804) 273-2771.

Respectfully,

Gerald T. Bischof
Senior Vice President – Nuclear Operations and Fleet Performance

Commitments contained in this letter:

1. The significance of the FHTSS with respect to high wind events will be incorporated into design basis documentation and the SPS UFSAR.

Enclosure: Response to NRC Request for Supplemental Information

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Mr. Gerald T. Bischof, who is Senior Vice President – Nuclear Operations and Fleet Performance, of Virginia Electric and Power Company. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 11th day of July, 2022.

My Commission Expires: August 31, 2023.

GARY DON MILLER
Notary Public
Commonwealth of Virginia
Reg. # 7629412
My Commission Expires August 31, 2023

Notary Public

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Serial No. 22-027A
Docket Nos. 50-280/281

Enclosure

RESPONSE TO NRC REQUEST FOR SUPPLEMENTAL INFORMATION

PROPOSED LICENSE AMENDMENT REQUEST

APPLICATION OF RISK-INFORMED APPROACH FOR TORNADO CLASSIFICATION OF THE FUEL HANDLING TROLLEY SUPPORT STRUCTURE

Virginia Electric and Power Company
(Dominion Energy Virginia)
Surry Power Station Units 1 and 2

FIGURE 1 IN THE ENCLOSURE CONTAINS ~~SECURITY-RELATED INFORMATION~~ AND MUST BE PROTECTED ACCORDINGLY. UPON SEPARATION OF FIGURE 1, THIS ENCLOSURE IS DECONTROLLED.

RESPONSE TO NRC REQUEST FOR SUPPLEMENTAL INFORMATION

License Amendment Request - Application of Risk-Informed Approach for Tornado Classification of the Fuel Handling Trolley Support Structure

Surry Power Station Units 1 and 2

BACKGROUND

By letter dated May 11, 2022, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML22131A351), Dominion Energy Virginia submitted a license amendment request (LAR) for Surry Power Station (SPS) Units 1 and 2. The LAR applies a risk-informed approach to demonstrate the fuel handling trolley support structure (FHTSS), as designed, meets the intent of a tornado resistant structure (i.e., Tornado Criterion "'T") under the current SPS licensing basis for a 360 miles per hour (mph) maximum tornado wind speed.

The LAR proposes modifying the design and licensing basis requirement for the FHTSS from a code-compliant, deterministic structural design for a 360 mph tornado wind speed (to which the FHTSS does not currently conform) to a requirement to maintain the building design to an acceptably low risk of building structural failure based on the FHTSS structural capacity, as defined by a building fragility curve and the frequency of tornado events, to demonstrate the design of the building is adequate to preserve public health and safety. The technical basis for the LAR combines a tornado wind speed probability function with a FHTSS fragility curve to calculate the risk of spent fuel damage as a function of tornado wind speed. The likelihood of mechanical damage to spent fuel due to structural failure of the FHTSS was conservatively estimated to have an increase on the order of 1E-6/yr. The structural failure of the FHTSS is conservatively assessed to not result in damage to the spent fuel pool (SFP) structure that results in loss of SFP inventory or cooling, and to result in less damage to spent fuel in the SFP than the fuel damage associated with the accidental drop of a spent fuel storage cask into the same affected region of the pool. The radiological consequences of a spent fuel storage cask accident are demonstrated to be less than those associated with fuel assembly handling accidents as described in Updated Final Safety Analysis Report (UFSAR) Section 14.4.1. The radiological consequences of fuel handling accidents (FHAs) are much less than those associated with a Large Early Release, which is defined by the PRA standard as "the rapid, unmitigated release of air-borne fission products from the containment to the environment occurring before the effective implementation of off-site emergency response and protective actions such that there is a potential for early health effects." Therefore, the highly unlikely event of a structural failure of the FHTSS will not result in radiological consequences that challenge public health and safety.

In summary, the LAR asserts that, because: (1) the conservative estimate of increase in risk of damage to spent fuel due to structural failure of the FHTSS associated with accepting the as-built FHTSS design meets RG 1.174 acceptance criteria for change in

risk, and (2) the failure of the FHTSS will not result in radiological consequences that challenge public health and safety, the increase in risk associated with accepting the as-built FHTSS structural design is acceptable. Therefore, the FHTSS, as designed, meets the intent of a tornado resistant structure to protect the health and safety of the public.

The NRC staff performed an acceptance review of the SPS LAR to determine whether sufficient technical information was provided in scope and depth to allow the NRC staff to commence its detailed technical review. By letter dated June 21, 2022, the U. S. Nuclear Regulatory Commission (NRC) informed Dominion Energy Virginia that additional information was required before the NRC would accept the LAR for formal review. The NRC provided an opportunity to supplement the proposed LAR by submitting the requested supplemental information within thirteen working days, i.e., by July 11, 2022. Dominion Energy Virginia's response to the NRC request for supplemental information is provided below.

NRC COMMENT:

<u>Radiological Risk and Radiological Accident Analysis</u>

In the license amendment request (LAR), the licensee stated that a potential radioactive release resulting from spent fuel damage is expected to be bounded by the fuel accidents analyzed under the design basis, including the cask-drop and fuel handling accidents, because the cask-drop analysis conservatively assumed that all 324 fuel assemblies stored in the first three rows of storage racks adjacent to the cask loading area, under the fuel handling trolley support structure (FHTSS), would fail. The licensee stated that the estimated releases associated with these accidents are less than the release criteria for Large Early Release Frequency (LERF).

In the LAR, the licensee stated that spent fuel pool integrity was evaluated against potential impact loads from falling structural members of the FHTSS. The licensee stated that only single impacts from the heaviest falling members of the FHTSS were considered due to the low likelihood of multiple falling members targeting the spent fuel pool with an angle of attack that can result in localized damage to the spent fuel pool. The licensee stated that falling members from the FHTSS may cause local perforation of the spent fuel pool liner, but no significant leakage is expected because there will be no perforation in the reinforced concrete walls or floor mat of the spent fuel pool.

To support the NRC staff's acceptance review, the licensee is requested to provide the following information in sufficient detail to support the NRC staff's detailed review:

1. *A justification for the statement that a potential release resulting from spent fuel damage is expected to be bounded by the fuel accidents analyzed under the design basis, including the cask-drop and fuel handling accidents. For this item, the licensee needs to include: (1) a description of the accident scenarios and radiological conditions considered when evaluating a potential radioactive release resulting from*

tornado wind damage to the FHTSS, and (2) a description of the methodology and results of the analysis demonstrating that a potential radioactive release resulting from tornado wind damage to the FHTSS is bounded by the failure of all 324 fuel assemblies stored in the first three rows of storage racks adjacent to the cask loading area.

Dominion Energy Virginia Response

Civil/structural assessment concluded spent fuel damage resulting from falling structural members of the FHTSS was limited to Region 1. Because the spent fuel cask drop accident radiological dose analysis assumes all 324 assemblies in Region 1 are damaged, the extent of spent fuel damage and radiological dose consequences resulting from a spent fuel cask drop accident were concluded to bound those associated with FHTSS structural failure. The dose consequences of the cask drop accident analysis are, in turn, bounded by the FHA analysis of record (AOR). The FHA analysis demonstrates the dose consequences at the exclusion area boundary (EAB) meet the acceptance criterion of 6.3 Rem TEDE, per Regulatory Guide 1.183. As described further in the response to NRC Request No. 2, the radiological consequences of an FHA are much less than those associated with a Large Early Release, defined by the PRA standard[1] as "the rapid, unmitigated release of air-borne fission products from the containment to the environment occurring before the effective implementation of off-site emergency response and protective actions such that there is a potential for early health effects." Additional background on supporting evaluations is presented below.

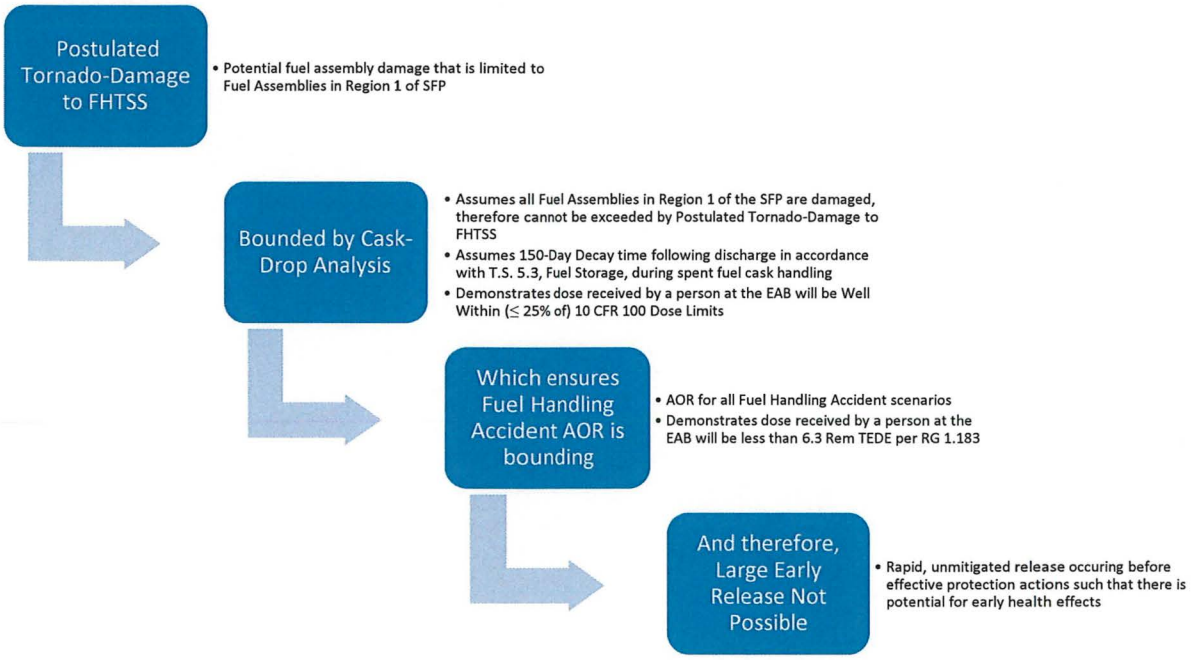
FHTSS structural failure is postulated to result in the structure partially or fully collapsing. In the worst-case, both ends of structural members may detach from the FHTSS and fall into the SFP, thereby impacting stored spent fuel assemblies or the SFP walls or mat. SFP inventory and fuel cooling integrity are maintained in this scenario because falling FHTSS members do not have enough energy to perforate the reinforced concrete SFP structure, and the fuel cooling components are not located where they could be impacted by falling members. Since SFP leakage and/or loss of cooling aren't credible, the dose consequence evaluation is limited to direct damage caused by falling members that impact spent fuel assemblies. This scenario could release gaseous fission products from the fuel rods into the fuel building; however, fission products contained in the fuel pellets would not be released since decay heat removal is not at risk of being lost.

The yellow highlighted area of Figure 1 shows the area of concern known and referred to as the "High Bay". The blue highlighted area shows the area SPS defines as "Region 1" of the SFP. Based on civil and structural assessment, any postulated failure of the High Bay caused by a tornado would result in limited damage, if any, to spent fuel assemblies, and any damage to spent fuel is assessed to be limited to only Region 1.

[1] ASME/ANS Standard, RA-Sb-2013, Addenda to ASME/ANS RA-S-2008 Standard for Level 1 / Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications, 2013.

The SPS cask-drop analysis assumes every spent fuel assembly in Region 1 of the SFP is damaged. It is not credible to damage more fuel as a result of tornado damage to the FHTSS than is assumed in the cask-drop analysis.

In summary, Dominion Energy Virginia's evaluation is based upon the inputs, assumptions, and methodology of the existing cask-drop analysis being bounding for the postulated tornado damage to the FHTSS, and the FHA analysis results bounding the cask drop analysis.



2. *A justification for the statement that the estimated releases associated with the fuel accidents analyzed under the design basis are less than the release criteria for Large Early Release Frequency (LERF). For this item, the licensee needs to include: (1) a justification and technical basis for comparing consequence-based criteria from design-basis fuel accidents in terms of Total Effective Dose Equivalent (TEDE) (i.e., 6.3 rem TEDE for offsite dose) against the release criteria for LERF, (2) a description of the estimated releases associated with these accidents, (3) the release criteria for LERF, and (4) the analysis demonstrating the release from the design-basis fuel accidents bounds the release criteria for LERF.*

Dominion Energy Virginia Response

When evaluating the criteria for LERF and determining if a Large Early Release could be possible following tornado damage to the FHTSS, Dominion Energy Virginia considered the definition of a Large Early Release and determined that meeting design basis acceptance criteria prevents a Large Early Release.

The PRA standard defines a Large Early Release as "the rapid, unmitigated release of air-borne fission products from the containment to the environment occurring before the effective implementation of off-site emergency response and protective actions such that there is a potential for early health effects." This definition can be broken down into "large release" and "early release" aspects, i.e., for a large release, the definition refers to a release of such magnitude that health effects are possible, and for an early release, it refers to a release that would occur with such speed that the emergency plan is not capable of providing adequate protective action recommendations before the possible health effects can be prevented.

The acceptance criterion for the SPS FHA AOR is to be less than or equal to 6.3 Rem TEDE in accordance with Regulatory Guide 1.183. The limit is established to protect the health and safety of the public, and therefore prevent health effects. Consequently, the more restrictive requirements of the design basis analysis ensure a Large Early Release will not occur.

The four items included in NRC information request No. 2 are addressed below:

1) Deterministic, design basis type, accident analysis acceptance criteria use more restrictive rules and requirements and must meet the requirements set forth by the NRC to protect the health and safety of the public. Meeting these requirements ensures a Large Early Release (i.e., a rapid, unmitigated release with the potential for early health effects) is prevented.

2) Descriptions of the releases associated with FHAs are provided in SPS UFSAR Chapter 14, Section 14.4.1. The UFSAR description and details for the cask-drop analysis are limited; therefore, a summary of inputs and assumptions is included in the response to NRC Request No. 4.

3) While there is no quantitative threshold in terms of TEDE for Large Early Release, the PRA standard defines it as "the rapid, unmitigated release of air-borne fission products from the containment to the environment occurring before the effective implementation of off-site emergency response and protective actions such that there is a potential for early health effects." Since the existing FHA analysis is bounding, it ensures the health and safety of the public is maintained, and therefore ensures there is no potential for early health effects. A design basis accident analysis is not required to show that a Large Early Release is prevented, as the PRA standard allows other analysis under less restrictive rules to show this. However, a bounding design basis analysis is used to demonstrate a Large Early Release is not possible.

4) The SPS cask-drop analysis is described in SPS UFSAR Chapter 9, Appendix B, Section 9B.1.5, and Chapter 14, Section 14.4.1.1. The details of the cask-drop dose analysis were not incorporated into the UFSAR. The original cask-drop dose analysis is included in the referenced licensing correspondence documented in the UFSAR. This analysis was subsequently updated to reflect burnup and enrichment increases approved under other licensing actions, but the framework of the analysis is essentially unchanged, and the UFSAR description remained accurate without the need for an update. The updated dose analysis is summarized in the response to NRC Request No. 4. The cask-drop analysis demonstrates the dose consequences are less than the FHA AOR described in UFSAR Chapter 14, Section 14.4.1. By ensuring the FHA AOR results are bounding, it is demonstrated that a Large Early Release as defined in the PRA standard is not possible.

3. *A justification, with analysis, of how the radiological releases described in this amendment are bounded by the current design-basis accident analysis of record for the cask-drop and fuel handling accidents.*

Dominion Energy Virginia Response

Dominion Energy Virginia does not have event-specific radiological consequence analysis for the postulated failure of the FHTSS. However, an evaluation of the inputs, assumptions, and methodology of the cask-drop analysis has shown the radiological consequences of the cask-drop analysis bound the limited damage to spent fuel caused by postulated structural failure of the FHTSS under tornado winds. The cask-drop analysis is bounding for radiological consequences from postulated tornado damage to the FHTSS, and the FHA AOR is bounding overall.

4. *The current design-basis accident analysis of record for the cask-drop and fuel handling accidents.*

Dominion Energy Virginia Response

Per the clarification call with the NRC held on June 21, 2022, it is Dominion Energy Virginia's understanding that the intent of NRC Request No. 4 is to affirm the SPS UFSAR contains a description of the latest cask-drop and FHA AOR.

FHAs are described in UFSAR Chapter 14, Section 14.4.1. The detailed description of the FHA dose analyses in the UFSAR is current and presented in Sections 14.4.1.2 and 14.4.1.3. The FHAs analysis was submitted and approved by letters dated March 2, 2018, and June 12, 2019 (ADAMS Accession Nos. ML18075A021 and ML19028A384, respectively.) The FHA dose analysis result is closer to the applicable regulatory limits (10 CFR 50.67 and RG 1.183) than the cask-drop dose analysis (Well Within 10 CFR 100 limits), and is the bounding AOR. The cask-drop dose analysis is the analysis that is most similar to the postulated tornado damage to the High Bay and Region 1 of the SFP.

The descriptions of the cask-drop analysis presented in the SPS UFSAR Chapter 9, Appendix B, Section 9B.1.5, and UFSAR Chapter 14, Section 14.4.1.1, include only limited details of the dose analysis, as the focus of the UFSAR sections is the heavy loads lift evaluation. Subsequent to the Safety Evaluation referenced in the UFSAR, Dominion Energy Virginia performed a new analysis with increased enrichment and burnup that did not result in any changes to the UFSAR description. The subsequent analysis was performed to ensure cask-drop acceptance criteria would continue to be met following the increase in enrichment and burnup limits for the SFP. The license amendment request to increase enrichment was submitted by letter dated November 5, 1997 (ADAMS Accession No. ML18151A979) and was approved by NRC letter dated June 19, 1998 (ADAMS Accession No. ML012710055) for SPS Units 1 and 2 license amendments 214 and 214, respectively.

To supplement the information currently in the UFSAR, a summary of inputs, assumptions, acceptance criteria, and results used for the most recent cask-drop dose analysis is provided below.

Cask-Drop Analysis Inputs and Assumptions

- The spent fuel in Region 1 of the SPS SFP was treated as having been discharged for 150 days per SPS Technical Specification (TS) 5.3, *Fuel Storage*, during spent fuel cask handling. Administrative controls associated with TS 5.3 are in place to preclude storage of fuel with <150 days of decay time in Region 1 at all times.
- It was assumed that all damaged fuel assemblies had an initial enrichment of up to 5% by weight U-235, burnup of 60,000 MWD/MTU, core average power of

2546 MWt, and a core average relative power defect (RPD) of 1.2. (Note: The SPS current rated thermal power is 2587 MWt. The 1.2 RPD previously applied ensures the increased MWt rating and calorimetric uncertainty remain bounded.)

- It was assumed that 400 fuel assemblies were damaged. This would account for all the fuel assemblies in Region 1 (324) with an allowance for up to 76 additional fuel assemblies in the cask being damaged.
- Gap Fractions are obtained from RG 1.25.
- Dose conversion factors are obtained from RG 1.109.
- A breathing rate of 3.47E-4 m^3/sec was assumed.
- An EAB X/Q of 2.10E-3 sec/m^3 was used. (Note: the EAB X/Q for the FHA is 1.02E-3 sec/m^3 as documented in UFSAR Table 14.4-2.)
- A pool Decontamination Factor (DF) of 100 was assumed for the removal of iodine.
- The fuel assembly source term was derived using ORIGEN2, and the power, burnup, enrichment and decay assumptions described above included contributions from the following table:

Source Term (Ci/fuel assembly)

Kr-85	7.445E+3
Xe-131m	5.084E+1
Xe-133	2.300E+0
I-129	2.090E-2
I-131	1.246E+0
I-132	4.272E-4

Cask-Drop Acceptance Criteria

The projected radiological doses at the EAB for the postulated cask-drop will be well within (≤25%) of the 10 CFR 100 EAB limits. "Well within 10 CFR 100 EAB limits" is equivalent to 6.25 Rem whole body and 75 Rem thyroid from Iodine.

Cask-Drop Results

Whole Body Immersion Dose at EAB: 0.97 Rem
Inhalation Thyroid Dose at EAB: 0.57 Rem

Comparison to FHA AOR Results (Table 14.4-5 of SPS UFSAR)

EAB Worst 2-hour Dose: 3.2 Rem TEDE

5. *A description of the methodology and results of the analysis calculating the likelihood of falling members of the FHTSS targeting the spent fuel pool with an angle of attack that can result in localized damage to the spent fuel pool. For this item, the licensee should include a discussion of the decision to consider only single impacts from the heaviest falling members of the spent fuel handling trolley support structure when evaluating spent fuel pool integrity.*

Dominion Energy Virginia Response

Methodology: No analysis has been performed to quantify the likelihood of falling members from the FHTSS impacting the SFP because even if all members of the FHTSS were to fall into the SFP, the integrity of the reinforced concrete floor mat and walls of the SFP would be maintained. When structural members of the FHTSS fail under the applied tornado wind loads, they may get separated from the connecting members of the FHTSS and fall into the SFP. However, not all structural members of the FHTSS would cause the worst-case impact to the SFP for the following reasons:

1) Some structural members are not likely to fail under tornado winds because they are oriented parallel to the governing wind direction (i.e., north-south direction) and do not have a large sail area against the tornado wind.
2) Some structural members of the FHTSS (e.g., columns) are longer than the width of the pool. These members will not fit into the pool if they fall along the north-south direction.
3) Structural members may experience plastic deformations but not reach their rupture strain and will therefore remain connected to the FHTSS without falling into the SFP.
4) Members oriented along the east-west direction on the north and south ends of the FHTSS are located outside of the SFP envelope. Even if these structural members fail and get separated from the FHTSS, they are not likely to fall into the pool.
5) Structural members that fall into the SFP can target the floor mat or walls with different angles of attack. An angle of attack that engages a large impact area (e.g., if members hit the SFP horizontally) will result in the impact load being distributed over a larger area such that little or no localized damage would occur. Therefore, while no quantitative analysis has been performed, the probability that structural members of the FHTSS will fail under the tornado wind load, break at both end connections, and target the SFP with the worst-case angle of attack is judged to be very low.
6) It is not credible for multiple members to fall and impact the same location of the SFP simultaneously.
7) The FHTSS is shielded against tornado winds in the west direction by the presence of the Unit 2 Containment Building. This significantly reduces the likelihood that falling members from the FHTSS will impact Region 2 of the SFP.

Therefore, the likelihood of failed members of the FHTSS falling and targeting the reinforced concrete floor mat or walls of the SFP, with the worst-case angle of attack,

was qualitatively assessed and determined to be very low. Conservatively, the integrity of the SFP was evaluated assuming the impact of the heaviest falling member of the FHTSS with the worst-case angle of attack as the bounding case. This worst-case scenario was analyzed to estimate the maximum possible localized damage in the reinforced concrete floor mat or walls of the SFP.

Results of the Evaluation: Based on the considerations noted above, the potential damage to the SFP under the impact of the heaviest structural member of the FHTSS that can fall during a tornado and target the SFP with the worst-case angle of attack was evaluated as the bounding case. The analysis concluded no perforation would occur in the reinforced concrete floor mat or walls of the SFP under such a worst-case impact scenario. Since the worst-case impact from a falling member does not cause perforation in the reinforced concrete floor mat or walls of the SFP, there is no challenge to SFP integrity in terms of maintaining adequate inventory and cooling capacity.

Potential damage to the SFP liner could cause water to leak into the liner test channels. The test channels drain to a 0.5-inch diameter pipe, which is buried under the fuel pool and leads to the fuel building sump. However, leakage from the SFP would not exceed a rate of 5 gallons per minute (gpm), as described in Section 9.12.4.13 of the SPS UFSAR for a cask-drop in the SFP, which is less than the normal makeup capability to the SFP.

In summary, even if all members of the FHTSS were to fail and impact the floor mat or walls of the SFP, there would still be no challenge to maintaining the fuel pool inventory and cooling capacity because impacts from any falling member will not perforate the reinforced concrete walls or floor mat of the SFP. Similarly, multiple impacts of falling structural members that perforate the liner will not challenge the fuel pool inventory or cooling capacity because the leakage rate from the test channels is limited to 5 gpm.

6. *A description of the methodology and results of the analysis demonstrating the worst-case impact of a single falling member of the FHTSS will not result in perforation in the reinforced concrete walls or the floor mat of the spent fuel pool.*

Dominion Energy Virginia Response

Methodology: The integrity of the reinforced concrete floor mat and walls of the SFP was evaluated for overall (global) and local (penetration, perforation, and back-scabbing) effects due to impact loads from postulated falling structural debris following a tornado event.

Overall effects of falling structural debris are assessed by comparison of the kinetic energy transferred to the SFP from the heaviest structural members (columns, girders, beams, and braces) of the FHTSS against the kinetic impact energy due to the postulated cask-drop in the SFP, as described in Section 9.12.4.13 of SPS UFSAR. The integrity of the reinforced concrete walls and floor mat of the SFP is currently

justified to withstand licensing basis tornado missiles as discussed in UFSAR Section 15.2.3, which states in part that:

"... test data and analytical studies, in accordance with Appendix C of SWECO 7703[2], have confirmed that 2-foot thick, reinforced-concrete test specimens, with similar spans and steel reinforcement as those found in SPS Tornado Criterion "T" structures (Table 15.2-1 of SPS UFSAR), will not experience a ductility ratio, μ, in excess of applicable industry code allowable limits (i.e., μ ≤10), when subjected to tornado load effects, as described in SPS UFSAR, Section 15.2.3."

While the scope of the above UFSAR discussion relates to licensing basis tornado missiles (i.e., the wooden utility pole and the 1-ton automobile traveling at 150 mph, as described in Section 15.2.3 of UFSAR), the kinetic energy of falling structural debris, and therefore the overall effect of their impact, is bounded by that due to the impact of the 1-ton automobile traveling at 150 mph.

Local effects of impact loads due to falling structural debris are evaluated by making an analogy to the cask-drop analysis, following the approach in Appendix B of SWECO 7703 for back-scabbing and depth of penetration calculations. Additionally, local effects of impact loads due to falling structural members are estimated using empirical equations for penetration, perforation, and back-scabbing. Among several empirical equations for estimation of local effects due to impact loads, the Modified National Defense Research Committee (NDRC) method is found to be the most appropriate methodology according to ASCE 58 and was used for estimation of local effects for falling FHTSS structural members. This equation is also referenced in NRC NUREG-0800, Section 3.5.3, Rev. 3, as an acceptable method for determining local effects for barrier design. While the Modified NDRC method is best suited for tornado missiles with velocities larger than 500 ft/s, it was used in this evaluation to provide a conservative estimate of local effects (i.e., penetration, perforation, and back-scabbing).

Results of the Evaluation: The kinetic energy due to the free-fall of the heaviest structural members of the FHTSS is less than 20% of the kinetic energy due to the cask-drop that is transferred to the floor mat or walls. Therefore, the overall effects of the impact from falling structural debris would be bounded by those due to the postulated cask-drop in the SPS safety analysis. Additionally, no back-scabbing is estimated under the impact of falling members based on the SWECO 7703 approach.

Furthermore, the Modified NDRC method shows no back-scabbing or perforation of the reinforced concrete walls or floor mat of the SFP under the impact of falling structural members. This method conservatively considers the damage to the reinforced concrete walls and floor mat to be localized in a small area. The method ignores the presence of the steel liner on the surface of the reinforced concrete walls and floor mat of the SFP. Even with the above conservative assumptions involved in the application of the Modified NDRC method for this study, no perforation or back-scabbing of the reinforced concrete walls or floor mat of the SFP was concluded from analysis results.

[2] SWECO 7703, "Missile-Barrier Interaction", A Topical Report, Stone and Webster Engineering Corporation, September 1977.

7. *A discussion of and results from the evaluation of the baseline risk to the public from a potential radioactive release resulting from tornado wind damage to the FHTSS, assuming the FHTSS met the licensing basis requirements.*

Dominion Energy Virginia Response

For the purpose of evaluating the change in risk, the baseline risk from tornado wind damaging the FHTSS with a design that meets licensing basis requirements is assumed to be zero. Since the change in risk is evaluated by subtracting the baseline risk from the current risk, this assumption results in a conservative evaluation of the increase in risk associated with the change proposed in the LAR. If a theoretical design that is compliant with the current licensing basis requirements were analyzed, the risk associated with the compliant case would effectively be zero because the frequency of high wind events with wind speeds beyond the licensing basis requirement of 360 mph is on the order of 1E-9 events/yr.

NUREG-1738 was provided as a reference for the assessment of the base risk of a SFP for the purpose of confirming the applicability of the acceptance criteria in RG 1.174. The response to NRC Request No. 2 in the second set of NRC information requests below provides additional detail on how the base risk of the SPS SFP is represented by the risk assessment performed in NUREG-1738.

8. *A discussion of and results from the evaluation of the change in risk to the public from a potential radioactive release resulting from tornado wind damage to the as-built FHTSS.*

Dominion Energy Virginia Response

An evaluation of the change in risk was performed for the proposed change. As described in the response to NRC Request No. 7 above, the risk associated with the compliant case was conservatively assumed to be zero for all metrics considered. The increase in Core Damage Frequency (CDF) was assessed to be zero because there are no systems, structures, or components related to reactor core safety that are vulnerable to FHTSS collapse from a high wind event. The increase in LERF was assessed to be zero because the consequences analyzed from a potential FHTSS failure do not generate a source term large enough to be considered a Large Early Release.

The increase in Spent Fuel Damage Frequency (SFDF) was estimated to be 1.97E-6/yr. This is considered a small change when compared to the CDF acceptance guidelines in RG 1.174. This risk increase was estimated by using the frequency of tornados of different wind speeds and the structural failure rate of the FHTSS based on the tornado wind speeds analyzed. Additional detail is provided in the responses to NRC Request Nos. 3 and 4 below regarding the purpose and basis for developing the SFDF as a risk metric for this LAR.

NRC COMMENT:

Regulatory Guide 1.174 Acceptance Guidelines

In the LAR, the licensee stated that they applied the acceptance guidelines in RG 1.174, Revision 3, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," (ADAMS Accession No. ML17317A256) in a similar manner to how the acceptance guidelines were applied in NUREG-1738, "Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants," (ADAMS Accession No. ML010430066). NUREG-1738 was prepared to provide a technical basis for decommissioning rulemaking for permanently shutdown nuclear power plants, which is a completely different context from this LAR. Therefore, it is unclear to the NRC staff if the approach described in NUREG-1738 is applicable to an operating reactor such as Surry Power Station. Section 4.1.1 of NUREG-1738 states the following:

> *For decommissioning plants, the risk is primarily due to the possibility of a zirconium fire involving the spent fuel cladding. The consequences of such an event do not equate directly to either a core damage accident or a large early release as modeled for an operating reactor.*

and

> *Because the changes in Emergency Planning [EP] requirements affect not the frequency of events involving a large early release (i.e., the SFP fire frequency) but the consequences of these releases, the allowable increase in LERF in RG 1.174 is translated into an allowable increase in key risk measures.*

These "key risk measures" are provided in Appendix 4D of NUREG-1738 and are frequency of dose to the public including consideration of evacuation. Therefore, the staff is also unclear how the LAR applies the acceptance guidelines in RG 1.174, Revision 3, consistent with NUREG-1738.

In RG 1.174, the NRC staff provides acceptance guidelines for risk-informed LARs in terms of the following common risk metrics: core damage frequency (CDF), LERF, ΔCDF, and ΔLERF. The NRC staff explains that these risk metrics are based on subsidiary objectives derived from the safety goals and their quantitative health objectives (QHOs). The derivation of risk surrogates for light water reactors is contained in NUREG-1860, Appendix D, "Feasibility Study for a Risk-Informed and Performance-Based Regulatory Structure for Future Plant Licensing, Volumes 1 and 2," December 2007 (ADAMS Accession No. ML080440170).

To support the NRC staff's acceptance review, the licensee is requested to provide the

following information in sufficient detail to support the NRC staff's detailed review:

1. *A discussion of how the proposed change meets all five principles of risk-informed regulation in Regulatory Guide 1.174, Revision 3.*

Dominion Energy Virginia Response

As described below, this request meets the five principles of risk-informed regulation contained in RG 1.174, Revision 3:

Principle 1: The proposed licensing basis change meets the current regulations unless it is explicitly related to a requested exemption (i.e., a specific exemption under 10 CFR 50.12).

Under the proposed change to accept the as-built FHTSS structural design, the FHTSS would continue to meet current regulatory requirements, except for the requirement to withstand the stress levels of the current design basis high wind loads. This is not considered an exemption because, as described herein, (1) the conservative estimate of increase in risk of damage to spent fuel due to structural failure of the FHTSS associated with accepting the as-built FHTSS design meets RG 1.174 acceptance criteria for change in risk, and (2) the failure of the FHTSS will not result in radiological consequences that challenge public health and safety. Therefore, the increase in risk associated with accepting the as-built FHTSS structural design is acceptable, and the FHTSS, as designed, meets the intent of a tornado resistant structure to protect the health and safety of the public.

Principle 2: The proposed licensing basis change is consistent with the defense-in-depth philosophy.

The philosophy of defense-in-depth is still met under this proposed change. Defense-in-depth for protecting the public from fission products from the SFP during a high wind event is provided by the pool structure, the SFP cooling system, and FLEX/Beyond Design Basis (BDB) pumps. The SFP is a robust reinforced concrete structure that is missile-protected against horizontal design basis tornado missiles and has been demonstrated to be able to withstand the impact from falling structural members following FHTSS failure. The spent fuel pool cooling system is a missile-protected system with two redundant trains that provide decay heat removal for spent fuel. Diverse sources of water to support SFP inventory control are available through the Refueling Water Storage Tank (RWST), the Boron Recovery Tank (BRT), and the Fire Protection System. Diesel-driven FLEX/BDB pumps, which are stored onsite in a missile-protected dome, can also be used to provide supplemental cooling and inventory to the SFP if needed. All three of these defense-in-depth layers remain in place and are unaffected by the proposed change.

Principle 3: The proposed licensing basis change maintains sufficient safety margins.

The risk assessment performed to support this LAR demonstrates appropriate safety margins are maintained under this request. The FHTSS is a robust structure, and the high wind events strong enough to pose a threat to this structure are of very low frequency. Since SFP cooling and inventory are preserved in the event of a FHTSS structural failure due to a high wind event, such an event would not cause spent fuel to be at risk of overheating.

Principle 4: When proposed licensing basis changes result in an increase in risk, the increases should be small and consistent with the intent of the Commission's policy statement on safety goals for the operations of nuclear power plants.

The risk assessment confirms the proposed change results in a small increase in risk that is consistent with the intent of the Commission's Safety Goal Policy. The likelihood of mechanical damage to spent fuel due to structural failure of the FHTSS was conservatively estimated to have an increase on the order of 1E-6/yr. This is considered a small increase based on the acceptance criteria for CDF in RG 1.174. Mechanical damage to spent fuel is a less significant consequence than Core Damage, as typically analyzed in PRA, because damage to spent fuel does not involve overheating or the possibility for fission products in the fuel pellets to be released.

Principle 5: The impact of the proposed licensing basis change should be monitored using performance measurement strategies.

The FHTSS is monitored under the aging management program to ensure the structural performance remains consistent with the current as-built design. Additionally, the significance of this structure with respect to high wind events will be incorporated into design basis documentation and the SPS UFSAR. This will ensure any future plant changes take into consideration the importance of this structure, and any design changes maintain the current structural capacity.

2. *A justification for the statement that the proposed approach utilizes the acceptance guidelines in Regulatory Guide 1.174, Revision 3, in a manner similar to how they were applied in NUREG-1738, given the different context and use of frequency of dose to the public as the "key risk measure" in NUREG-1738. For this item, the licensee needs to include: (1) a justification for why the approach described in NUREG-1738, which was prepared to provide a technical basis for decommissioning rulemaking for permanently shutdown nuclear power plants, is applicable to an operating nuclear power plant such as Surry Power Station, and (2) a justification for applying the acceptance guidelines in Regulatory Guide 1.174, Revision 3, to this LAR instead of frequency of dose to the public and the QHOs.*

Dominion Energy Virginia Response

(1) NUREG-1738 was cited to provide a reference point for the SFP base risk to affirm it is reasonable to conclude the base risk associated with the SPS SFP is low enough to be within the range of applicability of RG 1.174. Dominion Energy Virginia does not have an all-modes, all-hazards PRA to precisely characterize the base risk associated with damage to spent fuel in the SFP since spent fuel risk is not considered an input to most risk-informed applications or programs. The risk study documented in NUREG-1738 estimates SFP risk to be on the order of 1E-7 to 1E-6 spent fuel uncover events per year, concluding the risk of SFPs is low and well within the Commission's Quantitative Health Objectives (QHOs). Though all SFPs would have unique exact risk profiles, the general vulnerabilities and insights are applicable for the industry. The dominant risk scenario evaluated in NUREG-1738 was an earthquake that caused a catastrophic pool failure and loss of inventory. Upon reviewing the response to Fukushima Near-Term Task Force (NTTF) Recommendation 2.1, NRC staff review concluded updated seismic hazard information is bounded by the plants existing design basis safe shutdown earthquake, and no further responses or regulatory actions related to seismic risk were required for SPS. Consequently, it is reasonable to conclude the SPS SFP does not have a unique seismic vulnerability greater than what was assessed in the NUREG-1738 analysis.

It is acknowledged the risk assessment in NUREG-1738 assumes Industry Decommissioning Commitments have been met, and that the risk of fuel uncovery may be more than an order of magnitude higher without these changes in place. In this case, the risk would still be low enough for RG 1.174 to be applicable, but the assessed risk would be even lower if the changes put in place by the industry after the Fukushima Daichi earthquake were reflected. At SPS, there are multiple diesel-driven FLEX/BDB pumps stored in an onsite missile protected dome that can be used to provide supplemental cooling and inventory to the SFP if required. In all events that don't involve a catastrophic failure of SFP integrity, operators have a considerable amount of time to implement these FLEX strategies which would provide a significant risk reduction to many sequences and ensure the total SFP risk remains low and in the range of applicability of RG 1.174.

(2) The acceptance guidelines of RG 1.174 were applied to this LAR because they represent reasonable risk increases that may provide some relief to licensees without impacting the health and safety of the public. This approach was used to demonstrate structural modifications performed on the FHTSS that would allow it to meet design basis high wind loads would not have a meaningful benefit to nuclear safety.

There is no CDF impact related to this request, so SFDF was used to compare to the CDF acceptance criteria in RG 1.174. Mechanical damage to fuel assemblies in the SFP due to structural members of the FHTSS falling into the SFP represents

an end state that is undesirable even though it is not correlated with an increased likelihood of a significant fission product release. The consequence of mechanical damage to spent fuel in the SFP is less severe than the consequence of core damage induced by fuel melting because non-gaseous fission products remain contained in the fuel pellets, so it is reasonable and appropriate to relate the estimated SFDF to the acceptance criteria for CDF.

The LERF criteria from RG 1.174 were also considered. The increase in LERF associated with this request is assessed to be zero. This is not an indication that LERF being caused by a high wind event has a frequency of zero, but instead that the as-built design of the FHTSS does not increase the probability of a Large Early Release when compared to a theoretical structural design that is compliant with the original design basis.

Frequency of dose to the public was not used in this LAR because use of SFDF and LERF was considered effective for characterizing the risk impact of the requested change. Precise assessment of frequency of the dose to the public would require generation of scenario-specific source terms based on whether the assumed mechanical damage to spent fuel actually occurred. These terms would need to be combined with probabilistic meteorological data, population density information, and estimations of the effectiveness of emergency preparedness actions, which are typical considerations of a Level III PRA. This type of analysis is highly complex, requires extensive resources, and provides very limited additional value to risk-informed decision making if it has already been sufficiently demonstrated there is no increase in likelihood of LERF and a very small increase in likelihood of spent fuel damage.

The bounding assessment in the LAR of the increase in spent fuel damage frequency due to a high wind event causing a falling member from the FHTSS to damage fuel was estimated to be less than 2E-6 events per year. The radiological consequences for the cask drop analysis have been shown to be less than 1.0 Rem to a person at the site boundary. Therefore, the proposed change could cause less than 2E-6 Rem/yr to each person at the site boundary where the probabilistic population density is near zero. Even without performing a full Level III PRA, it is concluded the consequences of the proposed change fall well within the Commission's QHOs, and there will be no significant dose received by the public as a result of the proposed change.

3. *A discussion of the purpose and basis for developing the Spent Fuel Damage Frequency (SFDF) as a risk metric for this application, given that the NRC has not defined such a risk metric in the context presented in the LAR.*

Dominion Energy Virginia Response

As described in the response to NRC PRA Request No. 2 above, the SFDF was developed to characterize the risk associated with an undesirable end state that is increased by the request described in the LAR. The CDF impact associated with this request is zero because no systems supporting core safety are vulnerable to FHTSS structural failure from a high wind event. The LERF impact associated with this request is also zero because the credible impact to nuclear fuel from FHTSS failure will not provide a source term large enough to constitute a Large Early Release. Since the two common consequence metrics used to assess risk increases were concluded to be zero, SFDF was developed to give context to the magnitude of risk increase associated with this request. The application of this metric in the context of this LAR ensures the risk increase associated with this request is limited, reasonable, and consistent with the intent of the risk-informed regulatory framework used in applications where a quantifiable increase to CDF and LERF can be evaluated.

4. *A justification for using the SFDF as the appropriate risk metric for this LAR. For this item, the licensee needs to include: (1) a technical basis relating the SFDF to the Commission's safety goals and their quantitative health objectives, and (2) a discussion of the technical and regulatory bases for comparing the SFDF to the acceptance guidelines in Regulatory Guide 1.174, Revision 3, for CDF.*

Dominion Energy Virginia Response

As described in the response to NRC PRA Request No. 3 above, the SFDF metric is appropriate for this LAR because it gives context to the impact on risk beyond simply stating there is no increase in CDF or LERF.

(1) The SFDF is used to demonstrate the increase in risk associated with this request is acceptable. Even though the CDF and LERF increases were both determined to be zero, there is still some risk associated with accepting the as-built design of the FHTSS instead of modifying it to meet original design basis wind loads. If the structural capacity of the FHTSS were low enough to be expected to fail under conditions predicted to occur once every hundred years, the risk increase estimated by SFDF would be excessive, and this configuration would not be appropriate to accept even if the consequence of failure is less than that of core damage or a Large Early Release. Together with explanations of the impact to CDF and LERF, the impact to SFDF is presented to provide confidence to the reviewers and to the public that the current design of the FHTSS does not jeopardize nuclear safety.

It is acknowledged the impact to CDF and LERF may still be the most important metrics to reviewers evaluating this LAR. For that reason, the basis for the conclusion of no increase in CDF or LERF is restated here. There is zero increase in CDF associated with this request because there are no systems related to core safety that are vulnerable to damage from a FHTSS failure from a high wind event. There is no increase to LERF because the bounding assessment of the consequence of FHTSS structural failure concluded there is no scenario associated with this failure that could lead to a Large Early Release.

(2) As described in the response to NRC PRA Request No. 2 above, the SFDF metric represents a less severe consequence than CDF or LERF because it is related to mechanical damage that could only release the fraction of fission products in fuel rods that are gaseous. It is also less severe than the frequency of spent fuel uncovery that was calculated in NUREG-1758 and compared to the RG 1.174 CDF acceptance guidelines because the presence of cooled water on spent fuel assemblies, even if damaged by falling structural members, would prevent overheating. The presence of cooled water would also prevent the development of a zirconium fire which is the most significant contributor to the risk of a significant release of fission products from an SFP.

Since it has been demonstrated there is no impact to CDF and LERF associated with this request, it is appropriate to compare the less severe metric of SFDF to the RG 1.174 CDF acceptance guidelines for the purpose of this regulatory review.