UNITED STATES
NUCLEAR REGULATORY COMMISSION
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July 10, 2018

Mr. Joseph W. Shea
Vice President, Nuclear Regulatory Affairs
and Support Services
Tennessee Valley Authority
1101 Market Street,
Chattanooga, TN 37402

SUBJECT: WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2 – STAFF REVIEW OF SEISMIC PROBABILISTIC RISK ASSESSMENT ASSOCIATED WITH REEVALUATED SEISMIC HAZARD IMPLEMENTATION OF THE NEAR-TERM TASK FORCE RECOMMENDATION 2.1: SEISMIC (CAC NOS. MF9879 AND MF9880; EPID L-2017-JLD-0044)

Dear Mr. Shea:

The purpose of this letter is to document the staff's evaluation of the Watts Bar Nuclear Plant, Units 1 and 2 (WBN, Watts Bar) seismic probabilistic risk assessment (SPRA) which was submitted in response to Near-Term Task Force (NTTF) Recommendation 2.1 "Seismic." The U.S. Nuclear Regulatory Commission (NRC) has concluded that WBN's SPRA report meets the intent of NTTF Recommendation 2.1 "Seismic" and that the results and risk insights provided by the SPRA support the NRC's determination that no further response or regulatory actions are required.

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the NRC issued a request for information under Title 10 of the *Code of Federal Regulations* Part 50, Section 50.54(f) (hereafter referred to as the 10 CFR 50.54(f) letter). The request was issued as part of implementing lessons-learned from the accident at the Fukushima Dai-ichi nuclear power plant. Enclosure 1 to the 10 CFR 50.54(f) letter requested that licensees reevaluate the seismic hazards at their sites using present-day methodologies and guidance. Enclosure 1, Item 8, of the 10 CFR 50.54(f) letter requested that certain licensees complete an SPRA to determine if plant enhancements are warranted due to the change in the reevaluated seismic hazard compared to the site's design-basis seismic hazard.

By letter dated June 30, 2017 (ADAMS Accession No. ML17181A485), Tennesee Valley Authority (TVA, the licensee), provided its SPRA report in response to Enclosure 1, Item (8) of the 10 CFR 50.54(f) letter, for WBN. The SPRA report was later supplemented by letter dated April 10, 2018 (ADAMS Accession No. ML18100A966). The NRC staff assessed the licensee's implementation of the Electric Power Research Institute's (EPRI's) Report 1025287, "Seismic Evaluation Guidance - Screening, Prioritization, and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic" (ADAMS Accession No. ML12333A170), as endorsed by NRC letter dated February 15, 2013 (ADAMS Accession No. ML12319A074), through the completion of the reviewer checklist in Enclosure 1 to this letter. As described below, the NRC has concluded that WBN's SPRA report meets the intent of the SPID guidance and that the risk and safety insights provided by the SPRA support

the NRC's determination that no further response or regulatory action is required.

BACKGROUND

The 10 CFR 50.54(f) letter requested, in part, that licensees reevaluate the seismic hazards at their sites using updated hazard information and current regulatory guidance and methodologies. The request for information and the subsequent NRC evaluations have been divided into two phases:

> **Phase 1**: Issue 10 CFR 50.54(f) letters to all licensees to request that they reevaluate the seismic and flooding hazards at their sites using updated seismic and flood hazard information and present-day regulatory guidance and methodologies and, if necessary, to request they perform a risk evaluation.
>
> **Phase 2**: Based upon the results of Phase 1, the NRC staff will determine whether additional regulatory actions are necessary (e.g., updating the design basis and structures, systems, and components (SSCs) important to safety) to provide additional protection against the updated hazards.

By letter dated March 31, 2014 (ADAMS Accession No. ML14098A478), TVA submitted the reevaluated seismic hazard information for the WBN site. The NRC performed a staff assessment of the submittal and issued a response letter on October 5, 2015 (ADAMS Accession No. ML15055A543). The NRC's assessment concluded that the licensee conducted the hazard reevaluation using present-day methodologies and regulatory guidance, appropriately characterized the site, and met the intent of the guidance for determining the reevaluated seismic hazard.

By letter dated October 27, 2015 (ADAMS Accession No. ML15194A015), the NRC documented a determination of which licensees were to perform: (1) an SPRA; (2) limited scope evaluations; or (3) no further actions based on a comparison of the reevaluated seismic hazard and the site's design-basis earthquake. As documented in that letter, WBN was expected to complete an SPRA, which would also assess high frequency ground motion effects, and a limited-scope evaluation for the spent fuel pool (SFP). These seismic evaluations were expected to be submitted to the NRC by March 30, 2017, and December 31, 2017, respectively.

The completion of the October 5, 2015, NRC staff assessment for the reevaluated seismic hazard and the scheduling of WBN's SPRA report submittal described in the NRC's October 27, 2015, letter marked the fulfillment of the Phase 1 process for WBN.

In its June 30, 2017, letter, TVA provided the SPRA report that initiated the NRC's Phase 2 decisionmaking process for WBN. The NRC described this Phase 2 decisionmaking process in a guidance memorandum from the Director of the Japan Lessons-Learned Division to the Director of the Office of Nuclear Reactor Regulation (NRR) on September 21, 2016 (ADAMS Accession No. ML16237A103). This memorandum details a Senior Management Review Panel (SMRP) consisting of three NRR Division Directors that are expected to reach a screening decision for each plant submitting an SPRA. The SMRP is supported by appropriate technical staff who are responsible for consolidating relevant information and developing recommendations for the consideration of the panel. In presenting recommendations to the SMRP, the supporting technical staff is expected to recommend placement of each SPRA plant into one of three groups:

1) **Group 1** includes plants for which available information indicates that further regulatory action is not warranted. For seismic hazards, Group 1 includes plants for which the mean seismic core damage frequency (SCDF) and mean seismic large early release frequency (SLERF) clearly demonstrate that a plant-specific backfit would not be warranted.

2) **Group 2** includes plants for which further regulatory action should be considered under the NRC's backfit provisions. This group may include plants with relatively large SCDF or SLERF, such that the event frequency in combination with other factors result in a risk to public health and safety for which a regulatory action is expected to provide a substantial safety enhancement.

3) **Group 3** includes plants for which further regulatory action may be needed, but for which more thorough consideration of both qualitative and quantitative risk insights is needed before determining whether a formal backfit analysis is warranted.

The evaluation process that was performed to provide the basis for the staff's grouping recommendation to the SMRP for WBN is described below.

EVALUATION

Upon receipt of the licensee's SPRA report, a technical team of NRC staff and contractors performed a completeness review to determine if the necessary information to support Phase 2 decisionmaking had been included in the licensee's submittal. The technical team performing the review consisted of staff experts in the fields of seismic hazards, fragilities evaluations, and plant response/risk analyses. By August 15, 2017, the technical team determined that sufficient information was available to perform the detailed technical review in support of the Phase 2 decision.

The review of the WBN SPRA submittal followed the generic audit plan in letter dated July 6, 2017 (ADAMS Accession No. ML17177A446) to assist in the timely and efficient closure of activities associated with the 10 CFR 50.54(f) letter. The generic audit plan follows the audit process described in Office Instruction LIC-111, "Regulatory Audits", dated December 29, 2008 (ADAMS Accession No. ML082900195). A summary of the audit supporting this assessment is provided in Enclosure 3 of this letter.

As described in the 10 CFR 50.54(f) letter, the staff's detailed review focused on verifying the technical adequacy of the licensee's SPRA such that an appropriate level of confidence could be placed in the results and risk insights of the SPRA to support regulatory decisionmaking associated with the 10 CFR 50.54(f) letter. As stated in its June 30, 2017, submittal, the licensee developed and documented the SPRA in accordance with the SPID guidance including performing a peer review against the American Society of Mechanical Engineers (ASME)/American Nuclear Society (ANS) Standard RA-S 2008, "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications", including Addendum B, 2013.

Appendix A to the WBN SPRA submittal provided a summary of the peer review completed by the licensee, and a description of the licensee's disposition of the peer review team facts and observations classified as findings. The submittal explained that guidance in Appendix X to

Nuclear Energy Institute (NEI) 05-04, NEI 07-12, and NEI 12-13, "Close-Out of Facts and Observations (F&Os)" (ADAMS Accession No. ML17086A431) (hereafter referred to as NEI Appendix X) was followed by TVA to confirm the disposition of peer review findings on the WBN SPRA. The NRC accepted the use of NEI Appendix X in a letter dated May 3, 2017 (ADAMS Accession No. ML17079A427). The NRC staff used the guidance in its letter dated May 1, 2017 (ADAMS Accession No. ML17121A271), to understand the licensee's implementation of the NEI Appendix X criteria. The May 1, 2017, letter has the NRC staff's expectations for the industry to implement the NEI Appendix X independent assessment process. To support the NRC staff review, the licensee made available for audit the independent technical report prepared by Jensen Hughes, a consulting company. In this report, Jensen Hughes assessed actions taken by TVA to address findings from the WBN SPRA peer review team. The same report stated that Jensen Hughes concluded that findings from the peer review team are considered resolved with the exception of one finding, which is technically resolved but still has documentation to be processed. The fact that documentation was not processed at the time the Jensen Hughes report was issued does not represent a safety concern or an impediment for this review.

On November 20, 2017, the NRC staff (including technical support contractors) exercised the audit process in the form of a conference call. In preparation for the call, the NRC staff developed questions to verify information in the SPRA submittal and to gain an understanding of non-docketed supporting information. The questions (ADAMS Accession No. ML17307A086) were sent to the licensee in advance of the call. This was done to facilitate clear communication and to ensure that the appropriate licensee staff were available and ready for the discussion.

During the November 20, 2017, call, the licensee and the NRC staff discussed aspects of the detailed work done in the areas of component and structural fragilities and plant response of the WBN SPRA submittal. The licensee pointed out that supporting documents would be made available for audit in an online portal. After the call, the NRC staff proceeded to audit these supporting documents to gain a better understanding of the licensee's detailed analysis supporting the SPRA submittal. An audit summary is provided in Enclosure 3 of this letter.

Responses to the clarification questions were found to be significant enough to support the NRC staff evaluation and conclusions. For this reason, the licensee supplemented its SPRA submittal with a letter dated April 10, 2018 (ADAMS Accession No. ML18100A966). The supplement letter included responses to clarification questions discussed on November 20, 2017, and a technical road map document prepared by TVA to assist the NRC staff review.

Based on the staff's review of the licensee's submittals, including the licensee's successful implementation of the finding-closure process of NEI Appendix X, the NRC staff concluded that the technical adequacy of the licensee's SPRA submittal was sufficient to support regulatory decisionmaking associated with Phase 2 of the 10 CFR 50.54(f) letter.

Following the staff's conclusion of the SPRA's technical adequacy, the staff reviewed the risk and safety insights contained in the WBN SPRA submittal. The staff's review process included the completion of the SPRA Submittal Technical Review Checklist (SPRA Checklist) contained in Enclosure 1 to this letter. As described in Enclosure 1, the SPRA Checklist is a document used to record the staff's review of licensees' SPRA submittals against the applicable guidance of the SPID in response to the 50.54(f) letter. The SPRA Checklist also focuses on areas where the SPID contains differing guidance from standard industry SPRA guidance. Enclosure 1 contains the staff's application of the SPRA Checklist. As documented in the SPRA Checklist, the staff concluded that the SPRA met the intent of the SPID. The staff further concluded that

the peer review findings have been addressed and the analysis used by the licensee in dispositioning these findings is acceptable for the purposes of this evaluation.

The staff also used the screening criteria described in the August 29, 2017, staff memorandum titled, "Guidance for Determination of Appropriate Regulatory Action Based on Seismic Probabilistic Risk Assessment Submittals in Response to Near Term Task Force Recommendation 2.1: Seismic" (ADAMS Accession No. ML17146A200) to determine in which Group the technical team would recommend placing WBN to the SMRP. The criteria in the staff's guidance document describes thresholds to assist in determining whether or not to apply the backfit screening process described in Management Directive 8.4, "Management of Facility-Specific Backfitting and Information Collection", dated October 9, 2013 (ADAMS Accession No. ML12059A460), to the SPRA report review.

The WBN SPRA report demonstrated that the plant SCDF was sufficiently low such that no further review is warranted under Near-Term Task Force (NTTF) Recommendation 2.1: Seismic. The NRC staff noted that the SLERF value was above the threshold value in the August 29, 2017, memorandum. As a result, the NRC staff assessed the WBN SPRA report and other available information to complete a detailed screening with respect to the SLERF.

After evaluating potential plant modifications that could reduce the SCDF and SLERF, the NRC staff concluded that there were no further potential improvements that would rise to the level of a substantial safety improvement or would warrant further regulatory analysis. This conclusion was reached because the NRC staff did not identify a potential modification necessary for adequate protection or compliance with existing requirements, no potential cost-justified substantial safety improvement was identified based on the estimated achievable reduction in SCDF and SLERF; and additional consideration of containment performance did not identify a modification that would result in a substantial safety improvement. A discussion of the detailed screening evaluation completed by the NRC staff and contractors is provided in Enclosure 2 of this letter.

Based on the NRC staff evaluation of the SPRA submittal and supplemental information, the technical team recommended WBN be classified as a **Group 1** site and that a plant-specific backfit is not warranted.

As a part of the Phase 2 decisionmaking process for SPRAs, the NRC formed the Technical Review Board (TRB), a board of senior-level NRC subject matter experts, to ensure consistency of review across the spectrum of plants that will be submitting SPRA reports. The technical team provided the results of the review to the TRB with the Phase 2 recommendation that WBN be categorized as a Group 1 plant, meaning that no further response or regulatory actions are required. The TRB members assessed the information presented by the technical team and agreed with the team's Group 1 recommendation for WBN.

Subsequently, the technical team met with the SMRP and presented the results of the review including the recommendation for WBN to be categorized as a Group 1 plant. The SMRP members also asked questions and provided input to the technical team. The SMRP approved the staff's recommendation that WBN should be classified as a Group 1 plant, meaning that no further response or regulatory action is required.

AUDIT REPORT

The July 6, 2017, generic audit plan describes the NRC staff's intention to issue an audit report that summarizes and documents the NRC's regulatory audit of licensee's submittals associated with reevaluated seismic hazard analyses. The NRC staff's audit of the WBN submittal and supporting documents included a clarification call that took place on November 20, 2017 and the review of licensee documents through an electronic reading room. An audit summary document is included as Enclosure 3 to this letter.

CONCLUSION

Based on the staff's review of the licensee's submittal against the endorsed SPID guidance, the NRC staff concludes that the licensee responded appropriately to Enclosure 1, Item (8) of the 10 CFR 50.54(f) letter. Additionally, the staff's review concluded that the SPRA is of sufficient technical adequacy to support Phase 2 regulatory decisionmaking in accordance with the intent of the 10 CFR 50.54(f) letter. Based on the results and risk insights of the SPRA report, the NRC staff also concludes that no further response or regulatory actions associated with NTTF Recommendation 2.1 "Seismic" are required.

Application of this review is limited to the review of the 10 CFR 50.54(f) response associated with NTTF Recommendation 2.1 "Seismic" review. The staff notes that assessment of the SPRA for use in other licensing applications would warrant reviewing of the SPRA for its intended application. The NRC may use insights from this SPRA assessment in its regulatory activities as appropriate.

If you have any questions, please contact Milton Valentin at (301) 415-2864 or via e-mail at Milton.Valentin@nrc.gov.

Sincerely,

Louise Lund

Louise Lund, Director
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket Nos. 50-390 and 50-391

Enclosures:
1. NRC Staff SPRA Submittal Technical Review Checklist
2. NRC Staff Executive Summary on Detailed Screening Evaluation
3. NRC Staff Audit Summary

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NRC Staff SPRA Submittal Technical Review Checklist

Several nuclear power plant licensees are performing seismic probabilistic risk assessments (SPRAs) as part of their required submittals to satisfy Near-Term Task Force (NTTF) Recommendation 2.1: Seismic. These submittals are prepared according to the guidance in the Electric Power Research Institute – Nuclear Energy Institute (EPRI-NEI) Screening, Prioritization, and Implementation Details (SPID) document (EPRI-SPID, 2012), which was endorsed by the staff for this purpose (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12319A074). The SPRA peer reviews are also expected to follow the guidance in NEI 12-13 (NEI, 2012).

The SPID indicates that an SPRA submitted for the purpose of satisfying NTTF Recommendation 2.1: Seismic must meet the requirements in the ASME-ANS Probabilistic Risk Assessment (PRA) Methodology Standard (the ASME/ANS Standard). Either the "Addendum A version" (ASME/ANS Addendum A, 2009) or the "Addendum B version" (ASME/ANS Addendum B, 2013) of the ASME/ANS Standard can be used.

Tables 6-4, 6-5, and 6-6 of the SPID also provide a comparison of each of the Supporting Requirements (SRs) of the ASME Standard to the relevant guidance in the SPID. For most SRs, the SPID guidance does not differ from the requirement in the ASME Standard. However, because the guidance of the SPID and the criteria of the ASME Standard differ in some areas, or the SPID does not explicitly address an SR, the staff developed this checklist, in part, to help staff members to address and evaluate the differences.

In general, the SPID allowed departures or differed from the ASME Standard in the following ways:

(i) In some technical areas, the SPID's requirements tell the SPRA analyst "how to perform" one aspect of the SPRA analysis, whereas the ASME Standard's requirements generally cover "what to do" rather than "how to do it".

(ii) For some technical areas and issues the requirements in the SPID differ from those in the ASME Standard.

(iii) The SPID has some requirements that are not in the ASME Standard.

All of the technical positions in the SPID have been endorsed by the U.S. Nuclear Regulatory Commission (NRC) staff, subject to certain conditions concerning peer review outlined in the staff November 12, 2012, letter to NEI (NRC, 2012).

The following checklist is comprised of the 16 "Topics" that require additional staff guidance because the SPID contains specific guidance that differs from the ASME Standard or expands on it. Each is covered below under its own heading, "Topic 1," "2," etc. The checklist was discussed during a public meeting held on December 7, 2016 (ADAMS Accession No. ML16350A181).

- Topic 1: Seismic Hazard (SPID Sections 2.1, 2.2, and 2.3)
- Topic 2: Site Seismic Response (SPID Section 2.4)
- Topic 3: Definition of the Control Point for the SSE-to-GMRS-Comparison Aspect of the Site Analysis (SPID Section 2.4.2)
- Topic 4: Adequacy of the Structural Model (SPID Section 6.3.1)
- Topic 5: Use of Fixed-Based Dynamic Seismic Analysis of Structures for Sites Previously Defined as "Rock" (SPID Section 6.3.3)
- Topic 6: Use of Seismic Response Scaling (SPID Section 6.3.2)
- Topic 7: Use of New Response Analysis for Building Response, ISRS, and Fragilities
- Topic 8: Screening by Capacity to Select SSCs for Seismic Fragility Analysis (SPID Section 6.4.3)
- Topic 9: Use of the CDFM/H Methodology for Fragility Analysis (SPID Section 6.4.1)
- Topic 10: Capacities of SSCs Sensitive to High-Frequencies (SPID Section 6.4.2)
- Topic 11: Capacities of Relays Sensitive to High-Frequencies (SPID Section 6.4.2)
- Topic 12: Selection of Dominant Risk Contributors that Require Fragility Analysis Using the Separation of Variables Methodology (SPID Section 6.4.1)
- Topic 13: Evaluation of LERF (SPID Section 6.5.1)
- Topic 14: Peer Review of the SPRA, Accounting for NEI 12-13 (SPID Section 6.7)
- Topic 15: Documentation of the SPRA (SPID Section 6.8)
- Topic 16: Review of Plant Modifications and Licensee Actions

TOPIC 1: Seismic Hazard (SPID Sections 2.1, 2.2, and 2.3)

The site under review has updated/revised its probabilistic seismic hazard assessment (PSHA) from what was submitted to NRC in response to the NTTF Recommendation 2.1: Seismic 50.54(f) letter.	Yes
The guidance in the SPID was followed for developing the site's probabilistic seismic hazard.	Yes

Notes from staff reviewer:

The licensee used a PSHA and site profile developed for Watts Bar Nuclear Plant, Unit 2 (Watts Bar, WBN) licensing and use in the SPRA. The NRC staff notes that there are very minor differences between the PSHA developed for response to the 50.54(f) letter and the PSHA used for the SPRA. These differences are very minor and are generally acceptable.

Deviation(s) or deficiency(ies) and Resolution:

Fact and observation (F&O) 20-5 (classified as a finding by the peer review), related to requirement SHA-I1 as it relates to screening for hazards associated with seismic failure of upstream dams, was reported as open. The peer review team determined that the licensee had not adequately screened for the seismic failure of upstream dams in its analysis. Subsequently, the licensee included such a screening analysis in its SPRA and considers that the F&O is technically resolved. In addition, this topic was considered in the NRC's review of flooding hazard at Watts Bar as documented in staff interim assessment dated December 1, 2015 (ADAMS Accession No. ML15310A085). For that reason, this deficiency is considered as solved.

Consequence(s): None.

The NRC staff concludes that:	
• the peer review findings have been addressed and the analysis approach has been accepted by the peer reviewers. The peer review findings referred to relate to the SHA requirements in the Standard, as well as to the requirements in the SPID.	Yes
• although some peer review findings and observations have not been resolved, the analysis is acceptable on another justified basis.	Yes
• the guidance in the SPID was followed for developing the probabilistic seismic hazard for the site.	Yes
• an alternate approach was used, and is acceptable on a justified basis.	NA

TOPIC 2: Site Seismic Response (SPID Section 2.4)

The site under review has updated/revised its site response analysis from what was submitted to NRC in response to the NTTF Recommendation 2.1: Seismic 50.54(f) letter.	Yes
The guidance in the SPID was followed for developing a site profile for use in the analysis to develop control point seismic hazard curves (site response).	Yes
An alternate approach was used.	No
Notes from staff reviewer: None Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): None.	
The NRC staff concludes that:	
• the peer review findings have been addressed and the analysis approach has been accepted by the peer reviewers. The peer review findings referred to relate to the SRs SHA-E1 and E2 in the Standard, as well as to the requirements in the SPID.	Yes
• although some peer review findings and observations have not been resolved, the analysis is acceptable on another justified basis.	N/A
• the licensee's development of PSHA inputs and base rock hazard curves meets the intent of the SPID guidance or another acceptable approach.	Yes
• the licensee's development of a site profile for use in the analysis adequately meets the intent of the SPID guidance or another acceptable approach.	Yes
• although the licensee's development of a V_s [shear] velocity profile for use in the analysis does not meet the intent of the SPID guidance, it is acceptable on another justified basis.	N/A

TOPIC 3: Definition of the Control Point for the SSE-to-GMRS Comparison Aspect of the Site Analysis (SPID Section 2.4.2)

The objective of this topic is to understand actions taken to establish the control point where the safe shutdown earthquake (SSE) is defined. Most sites have only one SSE, but some sites have more than one SSE, for example one at rock and one at the top of the soil layer. This control point is needed because it is used as part of the input information for the development of the seismic site-response analysis, which in turn is an important input for analyzing seismic fragilities in the SPRA. The SPID (Section 2.4.1) recommends one of two criteria for establishing the control point for a logical SSE-to-GMRS [ground motion response spectra] comparison:	
A) If the SSE control point(s) is defined in the final safety analysis report (FSAR), it should be used as defined.	N/A
B) If the SSE control point is not defined in the FSAR, one of three criteria in the SPID (Section 2.4.1) should be used.	Yes
C) An alternative method has been used for this site.	N/A
The control point used as input for the SPRA is identical to the control point used to establish the GMRS.	Yes
If yes, the control point can be used in the SPRA and the NRC staff's earlier acceptance governs.	Yes
If no, the NRC staff's previous reviews might not apply. The staff's review of the control point used in the SPRA is acceptable.	N/A
Notes from staff reviewer: None. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): None.	
The NRC staff concludes that: • The peer review findings have been addressed and the analysis approach has been accepted by the peer reviewers. The peer review findings referred to relate to the requirements in the SPID. No requirements in the Standard specifically address this topic.	Yes
• Although some peer review findings and observations have not been resolved, the analysis is acceptable on another justified basis.	N/A

• The licensee's definition of the control point for site response analysis adequately meets the intent of the SPID guidance.	Yes
• The licensee's definition of the control point for site response analysis does not meet the intent of the SPID guidance, but is acceptable on another justified basis.	N/A

TOPIC 4: Adequacy of the Structural Model (SPID Section 6.3.1)

The NRC staff review of the structural model finds an acceptable demonstration of its adequacy.	Yes
Used an existing structural model	Yes
Used an enhancement of an existing model	Yes
Used an entirely new model	Yes
Criteria 1 through 7 (SPID Section 6.3.1) are all met.	Yes

Notes from staff reviewer:

1. Existing structural lumped-mass-stick-models for Reactor Building (RB) and Refueling Water Storage Tank (RWST) were used.
2. Existing lumped-mass-stick model for the refueling storage tank was enhanced.
3. New 3D finite element model (FEM) analyses were used for four structures: Auxiliary Control Building (ACB), Diesel Generator Building (DGB), North Steam Valve Rooms (NSVRs), and Intake Pump Station (IPS).
4. Provisions in SPID Criteria 1-7: SPID Section 4.3.3 have been met. For Criteria 2, the Tennessee Valley Authority (TVA, or the licensee) stated (in supplement dated April 10, 2018 (ADAMS Accession No. ML18100A966), 3D FEM analysis for all buildings except DGB revealed that coupling between vertical and horizontal responses were not significant. Ground motions were combined in one structural model for DGB modeling. For Criteria 4, TVA stated (in its supplement) that cut-off frequencies for all modes of vibration for all structures were greater than 20 Hertz.
5. In Table A-1 of the SPRA Submittal, there were 11 F&Os that are Not-Met on SRs SFR-C1-C6. However, these were subsequently resolved in NEI 12-13 Appendix-X Independent Review.
6. No questions generated from Peer Review F&O's.

Deviation(s) or deficiency(ies) and Resolution: None.

Consequence(s): None.

The NRC staff concludes that:	
• The peer review findings have been addressed and the analysis approach has been accepted by the peer reviewers. The peer review findings referred to relate to the SRs SFR-C1 through C6 in the Standard, as well as to the requirements in the SPID.	Yes
• Although some peer review findings and observations have not been resolved, the analysis is acceptable on another justified basis.	N/A

• The licensee's structural model meets the intent of the SPID guidance.	Yes
• The licensee's structural model does not meet the intent of the SPID guidance, but is acceptable on another justified basis.	N/A

TOPIC 5: Use of Fixed-Based Dynamic Seismic Analysis of Structures for Sites Previously Defined as "Rock" (SPID Section 6.3.3)

Fixed-based dynamic seismic analysis of structures was used, for sites previously defined as "rock." If no, this issue is moot. If yes, on which structure(s)? NSVRs, located next to RBs and are separated by two-inch expansion gap.	Yes
If used, is V_S > about 5000 feet (ft.)/second (sec.)?	N/A
If 3500 ft./sec. < V_S < 5000, was peak-broadening or peak shifting used?	N/A
Potential Staff Finding: The demonstration of the appropriateness of using this approach is adequate.	Yes
Notes from staff reviewer: The NSVRs, which protect isolation valves of the main steam lines, are small structures in very close proximity to the RBs. These structures are treated (in the SPRA report) as if they are mounted on the Shield Building (SB) wall, allowing use of a fixed-based dynamic seismic analysis. The response time history of SB was used as input horizontal input ground motion for the NSVRs. Peak-broadening was not discussed in the SPRA report. Use of peak-broadening or peak-shifting for the fragility of the isolation valve is not required because the NSVR is a small structure and the isolation valve inside the NSVRs are likely to be located on the ground floor. No F&Os on fixed-based analysis were identified in Table A-1 of the SPRA submittal. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): None.	
The NRC staff concludes that: • The peer review findings have been addressed and the analysis approach has been accepted by the peer reviewers. The peer review findings referred to relate to the requirements in the SPID. No requirements in the Standard specifically address this topic.	N/A

• Although some peer review findings and observations have not been resolved, the analysis is acceptable on another justified basis.	N/A
• The licensee's use of fixed-based dynamic analysis of structures for a site previously defined as "rock" adequately meets the intent of the SPID guidance.	Yes
• The licensee's use of fixed-based dynamic analysis of structures for a site previously defined as "rock" does not meet the intent of the SPID guidance, but is acceptable on another justified basis.	Yes

TOPIC 6: Use of Seismic Response Scaling (SPID Section 6.3.2)

Seismic response scaling was used. If no, this issue is moot. If yes, on which structure(s)? Five of the Nuclear Steam Supply System (NSSS) components: Reactor Vessel, NSSS Piping, Steam Generator, Reactor Coolant Pump, and Pressurizer. Scaling based on: Previously developed In-Structure Response Spectra (ISRS) Shapes of previous uniform hazard spectra /review-level earthquake (UHS/RLE) Shapes of new UHS/RLE Structural natural frequencies, mode shapes, participation factors Potential Staff Findings: If a new UHS or RLE is used, the shape is approximately similar to the spectral shape previously used for ISRS generation. If the shape is not similar, the justification for seismic response scaling is adequate. Consideration of non-linear effects is adequate.	Yes Yes Yes Yes No N/A Yes Yes
Notes from staff reviewer: TVA stated in its supplement (ADAMS Accession No. ML18100A966) that fragility of five NSSS components was based on scaling of the existing safety analysis results. Rather than scaling at specific natural frequencies of the NSSS components, the scaling was based on the average ratio of test-to-peak response spectra over a broadened frequency range centered at the natural frequency, using clipped spectra. There were no F&Os associated with requirement SFR-C3. TVA stated in its supplement that non-linear effects were considered. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): None.	
The NRC staff concludes that: • The peer review findings have been addressed and the analysis approach has been accepted by the peer reviewers. The peer review findings referred to relate to the requirement	N/A

SFR-C3 in the Standard, as well as to the requirements in the SPID.	N/A
• Although some peer review findings and observations have not been resolved, the analysis is acceptable on another justified basis.	
• The licensee's use of seismic response scaling adequately meets the intent of the SPID guidance.	Yes
• The licensee's use of seismic response scaling does not meet the intent of the SPID guidance but is acceptable on another justified basis.	N/A

TOPIC 7: Use of New Response Analysis for Building Response, ISRS, and Fragilities

The SPID does not provide specific guidance on performing new response analysis for use in developing ISRS and fragilities. The new response analysis is generally conducted when the criteria for use of existing models are not met or more realistic estimates are deemed necessary. The requirements for new analysis are included in the standard. See SRs SFR-C2, C4, C5, and C6. One of the key areas of review is consistency between the hazard and response analyses. Specifically, this means that there must be consistency among the ground motion equations, the soil-structure-interaction analysis (for soil sites), the analysis of how the seismic energy enters the base level of a given building, and the in-structure-response-spectrum analysis. Said another way, an acceptable SPRA must use these analysis pieces together in a consistent way. The following are high-level key elements that should have been considered: 1. FIRS site response developed with appropriate building specific soil velocity profiles. Structure #1 name: *Auxiliary-Control Building (ACB)* Structure #2 name: *Reactor Building (RB)* Structure #3 name: *Intake Pump Station (IPS)* Structure #4 name: *Diesel Generator Building (DGB)* Structure #5 name: *Refueling Water Storage Tank (RWST)*	
Are all structures appropriately considered?	Yes
2. Are models adequate to provide realistic structural loads and response spectra for use in the SPRA?	Yes
Is the Soil Structure Interaction (SSI) analysis capable of capturing uncertainties and realistic?	Yes
Is the probabilistic response analysis capable of providing the full distribution of the responses?	N/A
Notes from staff reviewer: ACB, RB, IPS founded on firm rock, DGB on crushed rock, RWST on granular backfill. For the ACB, RB, and IPS, the SSI analyses are based on best estimate soil (single time history), DGB SSI is based on five sets of time histories, and RWST lumped mass single time history (equivalent static seismic load). Probabilistic response analysis was not used. WBN SPRA Table A-1: Some F&Os are identified as Not-met category under SRs SFR-C4 and C6. However, these had been resolved in the Appendix X Independent Review Report. The staff review of these F&Os did not generate questions.	

For buildings on rock, a single time history was used. For DGB on soil, the SSI analyses were performed with time histories using strain compatible soil properties to account for input motion uncertainties. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): None.	
The NRC staff concludes: • The peer review findings have been addressed and the analysis approach has been accepted by the peer reviewers. The peer review findings referred to relate to the SRs SFR-C2, C4, C5, and C6 in the Standard, as well as to the requirements in the SPID. • Although some peer review findings and observations have not been resolved, the analysis is acceptable on another justified basis. • The licensee's FIRS modeling is consistent with the prior NRC review of the GMRS and soil velocity information. • The licensee's structural model meets the intent of the SPID guidance and the standard's requirements. • The response analysis accounts for uncertainties in accordance with the SPID guidance and the standard's requirements. • The NRC staff concludes that an acceptable consistency has been achieved among the various analysis pieces of the overall analysis of site response and structural response. • The licensee's structural model does not meet the intent of the SPID guidance and the standard's requirements, but is acceptable on another justified basis.	Yes N/A Yes Yes Yes Yes N/A

TOPIC 8: Screening by Capacity to Select SSCs for Seismic Fragility Analysis (SPID Section 6.4.3)

The selection of structures, systems, and components (SSCs) for seismic fragility analysis used a screening approach by capacity following Section 6.4.3 of the SPID. If no, see items D and E. If yes, see items A, B, and C. Potential Staff Findings:	Yes
A) The recommendations in Section 6.4.3 of the SPID were followed for the screening aspect of the analysis, using the screening criteria therein.	Yes
B) The approach for retaining certain SSCs in the model with a screening-level seismic capacity follows the recommendations in Section 6.4.3 of the SPID and has been appropriately justified.	Yes
C) The approach for screening out certain SSCs from the model based on their inherent seismic ruggedness follows the recommendations in Section 6.4.3 of the SPID and has been appropriately justified.	Yes
D) The Standard has been followed.	N/A
E) An alternative method has been used and its use has been appropriately justified.	N/A
Notes from staff reviewer: There are no peer-review findings in WBN SPRA Table A-1 associated with SRs SFR B1 and B2. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): None.	
The NRC staff concludes: • The peer review findings have been addressed and the analysis approach has been accepted by the peer reviewers. The peer review findings referred to relate to the SRs SFR-B1 and B2 in the Standard, as well as to the requirements in the SPID.	N/A

• Although some peer review findings and observations have not been resolved, the analysis is acceptable on another justified basis.	N/A
• The licensee's use of a screening approach for selecting SSCs for fragility analysis meets the intent of the SPID guidance.	Yes
• The licensee's use of a screening approach for selecting SSCs for fragility analysis does not meet the intent of the SPID guidance, but is acceptable on another justified basis.	N/A

TOPIC 9: Use of the CDFM/Hybrid Methodology for Fragility Analysis (SPID Section 6.4.1)

The Conservative Deterministic Failure Margin (CDFM)/Hybrid method was used for seismic fragility analysis. If no, See item C) below and next issue. If yes: Potential Staff Findings: A) The recommendations in Section 6.4.1 of the SPID were followed appropriately for developing the CDFM High Confidence Low Probability of Failure capacities. B) The Hybrid methodology in Section 6.4.1 and Table 6-2 of the SPID was used appropriately for developing the full seismic fragility curves. C) An alternative method has been used appropriately for developing full seismic fragility curves.	Yes Yes Yes N/A
Notes from staff reviewer: The CDFM approach is based on EPRI NP-6041 and EPRI 01019200 consistent with SPID Section 6.4.1. There were no Peer Review comments on this subject. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): None.	
The NRC staff concludes that: • The peer review findings have been addressed and the analysis approach has been accepted by the peer reviewers. The peer review findings referred to relate to the requirements in the SPID. No requirements in the Standard specifically address this Topic. • Although some peer review findings and observations have not been resolved, the analysis is acceptable on another justified basis. • The licensee's use of the CDFM/Hybrid method for seismic fragility analysis meets the intent of the SPID guidance. • The licensee's use of the CDFM/Hybrid method for seismic fragility analysis does not meet the intent of the SPID guidance, but is acceptable on another justified basis.	N/A N/A Yes N/A

TOPIC 10: Capacities of SSCs Sensitive to High-Frequencies (SPID Section 6.4.2)

The SPID requires that certain SSCs that are sensitive to high-frequency seismic motion must be analyzed in the SPRA for their seismic fragility using a methodology described in Section 6.4.2 of the SPID.	Yes
Potential Staff Findings:	
The NRC staff review of the SPRA's fragility analysis of SSCs sensitive to high frequency seismic motion finds that the analysis is acceptable.	Yes
The flow chart in Figure 6-7 of the SPID was followed.	Yes
The flow chart was not followed but the analysis is acceptable on another justified basis.	N/A
Notes from staff reviewer: Relay and Circuit Breaker chatters caused by high frequency ground motions were considered in the WBN SPRA. There are no peer-review findings in Table A-1 for the WBN SPRA submittal associated with requirement SFR-F3. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): None.	
The NRC staff concludes that:	
• The peer review findings have been addressed and the analysis approach has been accepted by the peer reviewers. The peer review findings referred to relate to requirement SFR-F3 in the Standard, as well as to the requirements in the SPID.	N/A
• Although some peer review findings and observations have not been resolved, the analysis is acceptable on another justified basis.	N/A
• The licensee's fragility analysis of SSCs sensitive to high frequency seismic motion meets the intent of the SPID guidance.	Yes
• The licensee's fragility analysis of SSCs sensitive to high-frequency motion does not meet the intent of the SPID guidance, but is acceptable on another justified basis.	N/A

TOPIC 11: Capacities of Relays Sensitive to High-Frequencies (SPID Section 6.4.2)

The SPID requires that certain relays and related devices (generically, "relays") that are sensitive to high-frequency seismic motion must be analyzed in the SPRA for their seismic fragility. Although following the Standard is generally acceptable for the fragility analysis of these components, the SPID (Section 6.4.2) contains additional guidance when either circuit analysis or operator-action analysis is used as part of the SPRA to understand a given relay's role in plant safety. When one or both of these are used, the NRC reviewer should use the following elements of the checklist.	
i) Circuit analysis: The seismic relay-chatter analysis of some relays relies on circuit analysis to assure that safety is maintained. (A) If no, then (B) is moot. (B) If yes: Potential Staff Finding: The approach to circuit analysis for maintaining safety after seismic relay chatter is acceptable.	Yes Yes
ii) Operator actions: The relay-chatter analysis of some relays relies on operator actions to assure that safety is maintained. (A) If no, then (B) is moot. (B) If yes: Potential Staff Finding: The approach to analyzing operator actions for maintaining safety after seismic relay chatter is acceptable.	No N/A
Notes from staff reviewer: In its supplement (ADAMS Accession No. ML18100A966), TVA clarified that the circuit analysis was performed in accordance with the requirements in the ASME/ANS SPRA Standard and that operator actions were not credited in the SPRA. There are no peer-review findings in WBN SPRA Table A-1 associated with SRs SFR-B6 or B4. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): None.	
The NRC staff concludes that: • the peer review findings have been addressed and the analysis approach has been accepted by the staff for the purposes of this evaluation. The peer review findings referred	N/A

to relate to the SRs SPR-B6 (Addendum A) or SPR-B4 (Addendum B) in the Standard, as well as to the requirements in the SPID.	
• although some peer review findings and observations have not been resolved, the analysis is acceptable on another justified basis.	N/A
• the licensee's analysis of seismic relay-chatter effects meets the intent of the SPID guidance.	Yes
• the licensee's analysis of seismic relay-chatter effects does not meet the intent of the SPID guidance, but is acceptable on another justified basis.	N/A

TOPIC 12: Selection of Dominant Risk Contributors that Require Fragility Analysis Using the Separation of Variables Methodology (SPID Section 6.4.1)

The CDFM methodology has been used in the SPRA for analysis of the bulk of the SSCs requiring seismic fragility analysis. If no, the staff review will concentrate on how the fragility analysis was performed, to support one or the other of the "potential staff findings" noted just below.	Yes
If yes, significant risk contributors for which use of separation of variables (SOV) fragility calculations would make a significant difference in the SPRA results have been selected for SOV calculations.	Yes
Potential Staff Findings:	
A) The recommendations in Section 6.4.1 of the SPID were followed concerning the selection of the "dominant risk contributors" that require additional seismic fragility analysis using the separation-of-variables methodology.	Yes
B) The recommendations in Section 6.4.1 were not followed, but the analysis is acceptable on another justified basis.	N/A

Notes from staff reviewer:

TVA confirmed in its supplement (ADAMS Accession No. ML18100A966) that the fragility analysis was based on test data and properly accounted for spectral bandwidth, single/dual/tri axial testing, multimode response, and seismic motion in three directions.

As stated in its supplement, TVA determined a component to be significant contributor if the Fussel-Vesely value was greater than 0.005. TVA made multiple iterations with refined fragility until the quantification showed no significant change in the number of components or ranking on the top contributor list.

For all WBN building structures, the CDFM was used for fragility evaluation. The CDFM was used for components in all structures except the DGB. A sensitivity study was performed on top contributors (relay logic panel, switchgear cabinet and block wall) that showed little difference in component fragility by the CDFM and the SOV method.

Detailed analysis was performed for the DGB and all of its components using SOV method. The DGB analysis showed that the fragility quantification remained the same or was slightly increased. Fragility of only Southern DG Block Wall was obtained using SOV (WBN SPRA Tables 5.4-4, 5.5-3 and 5.5-4).

There are no peer-review findings in WBN SPRA Table A-1 associated with SRs SFR-B1 and B2.

Deviation(s) or deficiency(ies) and Resolution: None.

Consequence(s): None.	
The NRC staff concludes:	
• the peer review findings have been addressed and the analysis approach has been accepted by the peer reviewers. The peer review findings referred to relate to the requirements in the SPID. No requirements in the Standard specifically address this Topic.	N/A
• although some peer review findings and observations have not been resolved, the analysis is acceptable on another justified basis.	N/A
• the licensee's method for selecting the "dominant risk contributors" for further seismic fragilities analysis using the separation-of-variables methodology meets the intent of the SPID guidance.	Yes
• the licensee's method for selecting the "dominant risk contributors" for further seismic fragilities analysis using the separation-of-variables methodology does not meet the intent of the SPID guidance, but is acceptable on another justified basis.	N/A

TOPIC 13: Evaluation of LERF (SPID Section 6.5.1)

The NRC staff review of the SPRA's analysis of large early release frequency (LERF) finds an acceptable demonstration of its adequacy.	Yes
Potential Staff Findings: A) The analysis follows each of the elements of guidance for LERF analysis in Section 6.5.1 of the SPID, including in Table 6-3.	Yes
B) The LERF analysis does not follow the guidance in Table 6-3 but the analysis is acceptable on another justified basis.	N/A
Notes from staff reviewer: In accordance with the SPID, the internal events probabilistic risk assessment (IEPRA) was adapted to include seismic-related basic events. The WBN IEPRA human reliability analysis was adjusted to account for response during and following a seismic event. Submittal Section 5.1.6 specifically describes the containment isolation failure modes evaluated in the SPRA model. The LERF contributors listed in Table 6-3 of the SPID either had no significant seismic-induced impact (per Table 6-3); were determined not to apply to a PWR; or were judged to be addressed at a general level in the report. The submittal does not discuss the impact of a seismic event on emergency plans, which is acceptable per the SPID for NTTF Recommendation 2.1. There were no LERF-related IEPRA peer review F&Os (i.e., F&Os associated with PRA standard supporting requirements from technical element "LE.") that remain unresolved for this application. (Resolution of F&Os is discussed in more detail under Topic #14). Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): None.	
The NRC staff concludes that:	
• the peer review findings have been addressed and the analysis approach has been accepted by the staff for the purposes of this evaluation. The peer review findings referred to relate to the SRs SFR-F4, SPR-E1, SPR-E2, and SPR-E6 (Addendum B only) in the Standard, as well as to the requirements in the SPID.	Yes
• although some peer review findings and observations have not been resolved, the analysis is acceptable on another justified basis.	N/A
• the licensee's analysis of LERF meets the intent of the SPID guidance.	Yes
• the licensee's analysis of LERF does not meet the intent of the SPID guidance but is acceptable on another justified basis	N/A

TOPIC 14: Peer Review of the SPRA, Accounting for NEI 12-13 (SPID Section 6.7)

The NRC staff review of the seismic PRA's peer review findings, observations, and their resolution finds an acceptable demonstration of the peer review's adequacy.	Yes
Potential Staff Findings: A) The analysis follows each of the elements of the peer review guidance in Section 6.7 of the SPID. B) The composition of the peer review team meets the SPID guidance. C) The peer reviewers focusing on seismic response and fragility analysis have successfully completed the Seismic Qualification Utility Group (SQUG) training course or equivalent (see SPID section 6.7). In what follows, a distinction is made between an "in-process" peer review and an "end-of-process" peer review of the completed SPRA report. If an in-process peer review is used, go to (D) and then skip (E). If an end-of-process peer review is used, skip (D) and go to (E). D) The "in process" peer-review process followed the "in process" peer review guidance in the SPID (Section 6.7), including the three "bullets" and the guidance related to NRC's additional input in the paragraph immediately following those 3 bullets. These 3 bullets are: • The SPRA findings should be based on a consensus process, and not based on a single peer review team member • A final review by the entire peer review team must occur after the completion of the SPRA project • An "in-process" peer review must assure that peer reviewers remain independent throughout the SPRA development activity. If no, go to (F). If yes, the "in process" peer review approach is acceptable. Go to (G). E) The "end-of-process" peer review process followed the peer review guidance in the SPID (Section 6.7). If no, go to (F). If yes, the "end-of-process" peer review approach is acceptable. Go to (G).	Yes Yes Yes N/A Yes

F) The peer-review process does not follow the guidance in the SPID, but is acceptable on another justified basis.	N/A
G) The licensee peer-review Findings and Observations were satisfactorily resolved or were determined not to be significant to the SPRA conclusions for this review application.	Yes

Notes from reviewer:

The submittal follows recommendations in Section 6.7 of the SPID. Submittal Section 5.2 and Appendix A describe the peer review process used to establish the technical adequacy of the SPRA and the IEPRA upon which the SPRA was based.

The IEPRA was peer reviewed in November 2009 in accordance with NEI 05-04, the ASME/ANS PRA standard and NRC Regulatory Guide 1.200, Revision 2, "An Approach For Determining The Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities." All elements of the standard were reviewed, resulting in 50 Finding-level F&Os. These 50 F&Os and their resolutions are provided in Table A-3 of the WBN SPRA submittal with sufficient information for detailed review. An F&O closure process in accordance with Appendix X of NEI 12-13 had been initiated at the time of the submittal, but was not yet complete (only one F&O remained open, but was technically addressed and in process of closure).

The WBN SPRA was peer reviewed in March 2016, in accordance with NEI 12-13, RG 1.200 Revision 2, and Capability Category II requirements PRA Standard ASME/ANS RA Sb-2013. The qualifications of each of the seven peer review members is described, one member was designated as the team leader. As part of the peer review, a walk-down of portions of WBN was performed by several members of the peer review team with the appropriate SQUG training. All elements of the SPRA were peer reviewed, including those identified in Section 6.7 of the SPID, and the results of the peer review (including 74 Finding-level F&Os) documented in a report. Subsequently, the SPRA model and documentation was updated to resolve the 74 F&Os.

In April 2017, an F&O closure review team performed an independent assessment to close-out the SPRA F&Os in accordance with Appendix X of NEI 12-13, an approach which has been accepted by the NRC (ADAMS Accession No. ML17079A427). The F&O closure team, consisting of six members and a dedicated team lead, determined that all of the F&Os except one had been resolved; this F&O and its resolution is provided in Table A-2 of the WBN SPRA submittal with sufficient information for detailed review. A process to ensure team member qualifications and independence in alignment with Appendix X guidance was established. Concurrence on the resolution of each Finding was based on a consensus process involving all members of the review team.

Deviation(s) or deficiency(ies) and Resolution:

The NRC staff reviewed TVA's dispositions to the IEPRA peer review Findings presented in the submittal and found that some dispositions seemed to be incomplete (i.e., the Finding did not seem to be resolved or there was not enough description in the disposition to conclude that the Finding was resolved.) In particular, dispositions for F&O 1-5, 1-8, 3-1, 3-6, 3-8, 5-1, 7-2, and 7-8 seemed incomplete.

Also, the submittal did not state whether any PRA upgrades performed to resolve IEPRA F&Os were identified, which would necessitate a focused-scope peer review per PRA Standard ASME/ANS RA-Sa-2009. Some updates seemed significant enough to meet the definition of a PRA upgrade such as the revision of common cause modeling and the flow rate and accumulation studies in support of the modeling of internal flooding.

Additionally, it was not clear whether the F&O closure review adhered fully to the guidance in Appendix X of NEI 12-13 and the two conditions spelled-out in the NRC acceptance letter dated May 3, 2017 (ADAMS Accession No. ML17079A427), on the Appendix X process. For example, based on the F&O closure report provided by the licensee on an ePortal the F&O closure review dispositions for certain F&Os (e.g., those pertaining to Standard SRs SFR-A2, SFR-F1, and SFR-G2) were identical to the original dispositions of the F&Os. As a result, the NRC staff could not confirm that the licensee was properly using the guidance in NEI Appendix X, as explained in the May 3, 2017, NRC staff acceptance letter.

In its supplement dated April 10, 2018 (ADAMS Accession No ML18100A966), the licensee explained that, since the date of the WBN SPRA submittal, the IEPRA F&Os presented in Appendix A for the submittal had been closed by the F&O closure review with one exception. The licensee explained that the F&O closure review was performed in accordance with the guidance in Appendix X of NEI 12-13, and that the PRA model that the F&O closure team reviewed was the same model used as the basis for the WBN SPRA. The licensee explained that the one F&O that remained open (i.e., F&O 3-6) concerning the state of knowledge correlation (SOKC) did not affect the seismic event risk. The licensee explained that this specific exclusion of SOKC only applied to valve failures in internal-seismic loss of coolant accident sequences and that similar components in fragility groupings are already completely correlated in the SPRA for these scenarios.

The licensee also explained, in its supplement letter, that no PRA upgrades as defined in the PRA standard ASME/ANS RA-Sa-2009 were made in the PRA to resolve F&Os (i.e., between the time of the 2009 IEPRA peer review and the version of the IEPRA which was used to develop the SPRA).

The licensee also confirmed in its supplement letter, that the independent F&O closure review adhered to the guidance in Appendix X of NEI 12-13 and the two conditions spelled-out in the NRC acceptance letter dated May 3, 2017. The licensee explained that, cases in which the F&O closure review assessment dispositions were identical to the original F&O dispositions, the F&O closure reviewers were in full agreement with the original F&O disposition. Based on the supplemental information, deficiencies in the submittal were resolved.

Consequence(s): None.

The NRC staff concludes:	
• The licensee's peer-review process meets the intent of the SPID guidance.	Yes
• The licensee's peer-review process does not meet the intent of the SPID guidance but is acceptable on another justified basis.	N/A

TOPIC 15: Documentation of the SPRA (SPID Section 6.8)

The NRC staff review of the SPRA's documentation as submitted finds an acceptable demonstration of its adequacy. The documentation should include all of the items of specific information contained in the 50.54(f) letter as described in Section 6.8 of the SPID.	Yes Yes
Notes from staff reviewer: The WBN SPRA submittal appears to follow the recommendations of Section 6.8 of the SPID. Tables 2.0-1 and 2.0-2 of the submittal provide a cross-reference of information required by the 50.54(f) letter and specified in Section 6.8 of the SPID to the sections of the submittal where the information can be found. The level-of-detail of the information provided appears to be generally consistent with that specified in Section 6.8 of the SPID. It is noted however that not all of the information identified in Section 6.8 of the SPID with regard to what was submitted for the individual plant evaluation of external events (IPEEE) program is included in the submittal (e.g., all functional/systemic event trees). However, the SPID only identifies this IPEEE information as guidance for consideration in the 50.54(f) response. All F&Os related to SPRA documentation (e.g., HLR_SHA-J, HLR-SPR-G, and HLR-SPR-F) have been closed by the F&O closure process. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): None.	
The NRC staff concludes: • The licensee's documentation meets the intent of the SPID guidance. The documentation requirements in the Standard can be found in HLR-SHA-J, HLR-SPR-G, and HLR-SPR-F. • The licensee's documentation does not meet the intent of the SPID guidance but is acceptable on another justified basis.	Yes N/A

Topic 16: Review of Plant Modifications and Licensee Actions, If Any

The licensee: • identified modifications necessary to achieve seismic risk improvements • provided a schedule to implement such modifications (if any), consistent with the intent of the guidance • provided Regulatory Commitment to complete modifications • provided Regulatory Commitment to report completion of modifications.	N/A N/A N/A N/A
Plant will: • complete modifications by • report completion of modifications by	N/A N/A
Notes from the Reviewer: Refer to Enclosure 2 for detailed evaluation. Deviation(s) or Deficiency(ies), and Resolution: Refer to Enclosure 2 for detailed evaluation. Consequences: None.	
The NRC staff concludes that the licensee: • identified plant modifications necessary to achieve the appropriate risk profile • provided a schedule to implement the modifications (if any) with appropriate consideration of plant risk and outage scheduling.	N/A N/A

REFERENCES

ASME/ANS Addendum A, 2009: Standard ASME/ANS RA-Sa-2009, Addenda A to ASME/ANS RA-S-2008, "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications," American Society of Mechanical Engineers and American Nuclear Society, 2009

ASME/ANS Addendum B, 2013: Standard ASME/ANS RA-Sb-2013, Addenda B to ASME/ANS RA-S-2008, "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications," American Society of Mechanical Engineers and American Nuclear Society, 2013

EPRI-SPID, 2012: "Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic," Electric Power Research Institute, EPRI report 1025287, November 2012, ADAMS Accession No. ML12333A170.

NEI, 2012: NEI 12-13 "External Hazards PRA Peer Review Process Guidelines," Nuclear Energy Institute, August 2012, ADAMS Accession No. ML12240A027.

NRC, 2012: "U.S. Nuclear Regulatory Commission Comments on NEI 12-13, 'External Hazards PRA Peer Review Process Guidelines' Dated August 2012," NRC letter to Nuclear Energy Institute, November 16, 2012, ADAMS Accession No. ML12321A280.

Executive Summary on Detailed Screening Evaluation

Introduction:

The Watts Bar Nuclear Plant, Units 1 and 2 (WBN, Watts Bar) Seismic Probabilistic Risk Assessment (SPRA) report (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17181A485) indicates that the mean seismic core damage frequency (SCDF) is 3.1E-06 /reactor-year (/rx-yr.) and the mean seismic large early release frequency (SLERF) is 2.2E-06 /rx-yr. for both Units 1 and 2. The NRC staff compared these values against the guidance in NRC staff memorandum dated August 29, 2017, titled, "Guidance for Determination of Appropriate Regulatory Action Based on Seismic Probabilistic Risk Assessment Submittals in Response to Near Term Task Force Recommendation 2.1: Seismic" (ADAMS Accession No. ML17146A200; hereafter SPRA Screening Guidance), which establishes a process the NRC staff uses to develop a recommendation on whether the plant should move forward as a Group 1, 2, 3 plant.[1]

The SPRA Screening Guidance is based on NUREG/BR-0058, Revision 4, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," (ADAMS Accession No. ML042820192), NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook," (ADAMS Accession No. ML050190193), and NUREG-1409, "Backfitting Guidelines," (ADAMS Accession No. ML032230247), as informed by Nuclear Energy Institute (NEI) 05-01, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document" (ADAMS Accession No. ML060530203). In order to determine the significance of proposed modifications in terms of safety improvement, NUREG/BR-0058 uses screening criteria based on the estimated reduction in core damage frequency, as well as the conditional probability of early containment failure or bypass. Per NUREG/BR-0058, the conditional probability of early containment failure or bypass is a measure of containment performance and the purpose of its inclusion in the screening criteria is to achieve a measure of balance between accident prevention and mitigation. The NUREG/BR-0058 uses a screening criteria of 0.1 or greater for conditional probability of early containment failure or bypass. In the context of the SPRA reviews, the staff guidance uses SCDF and SLERF as the screening criteria where SLERF is directly related to the conditional probability of early containment failure or bypass. Following NUREG/BR-0058, the threshold for the screening criterion in the staff guidance for SLERF is (1.0E-6/ rx-yr.), or 0.1 times the threshold for the screening criterion for SCDF (1.0E-5/ rx-yr.).

The NRC staff found that because the SCDF for WBN was below the initial screening value of 1.0E-5/ rx-yr., there were no potential modifications for the purpose of lowering core damage frequency identified that would be considered substantial safety improvements. However, as discussed above, the evaluation should also consider mitigation (i.e., containment performance, in this case measured as SLERF). The SLERF exceeded the initial screening value of 1.0E-6/ rx-yr. Therefore, a detailed screening following the SPRA Screening Guidance was performed.

[1] The groups are defined as follows: regulatory action not warranted (termed Group 1), regulatory action should be considered (termed Group 2), and more thorough analysis is needed to determine if regulatory action should be considered (termed Group 3).

The detailed screening shows that WBN should be considered a Group 1 plant because:

- Sufficient reductions in SCDF and SLERF cannot be achieved by potential modifications considered in this evaluation to constitute substantial safety improvements based upon importance measures, available information, and engineering judgement;

- Additional consideration of containment performance, as described in NUREG/BR-0058, does not identify a modification that would result in a substantial safety improvement; and

- The staff did not identify any potential modifications that would be appropriate to consider necessary for adequate protection or compliance with existing requirements.

As such, additional refined screening, or further evaluation, was not required.

Detailed Screening:

In its supplement letter dated April 10, 2018 (ADAMS Accession No. ML18100A966), the licensee explained that all cutsets across the seismic hazard level bins were merged and analyzed using the Electric Power Research Institute (EPRI) Advance Cutset Upper Bound Estimator (ACUBE) importance tool. Since all cutsets are treated together, there shouldn't be distortion in the results or inaccuracies in the importance values. The licensee further explained that:

- In conjunction with its Expedited Seismic Evaluation Program (ESEP), the licensee reviewed the seismic evaluation under Generic Letter (GL) 88-20, Supplement 4, "Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities," and refinements were made to increase the review level earthquake from 0.30g to 0.50g (ADAMS Accession No. ML15196A544) and to increase the high-confidence-low-probability-of-failure capacity from 0.38g to 0.85g after plant modifications associated with the 480V Shutdown Board transformers were made.

- Modeling of seismically-induced internal flooding was a collection of several uncorrelated fragility events modeled to initiate all internal flooding events and that, if bracing was improved at one or more locations, the seismic event would have the same effect unless all pipe bracing was improved.

- Results of the SPRA importance analysis were evaluated, but no single vulnerabilities were identified that would have a significant impact on seismic risk and any refinements in the fragility values of the top contributors would not be expected to have a significant impact on seismic risk.

The licensee concluded that no additional modifications beyond those made to support the ESEP were found to significantly improve plant seismic risk levels.

The licensee, in performing its seismic analysis in response to the Near-Term Task Force Recommendation 2.1, and the NRC in conducting its review, did not identify concerns that

would require licensee action above and beyond existing regulations to maintain the level of protection necessary to avoid undue risk to public health and safety. In addition, there were no issues identified as non-compliances with the WBN licenses, or the rules and orders of the Commission. For these reasons, the licensee and the staff did not identify a potential modification necessary for adequate protection or compliance with existing requirements.

The detailed screening uses information provided in the WBN SPRA submittal, particularly the importance measures, as well as other information described below to establish threshold and target values that are used to identify areas where potential cost-justified substantial safety improvements might be identified. The detailed screening process makes several simplifying assumptions, similar to a Phase 1 SAMA analysis (NEI 05-01, ADAMS Accession No. ML060530203) used for license renewal. To perform the detailed screening, the NRC staff referred to risk importance values defined in NUREG/CR-3385, "Measures of Risk Importance and Their Applications," (ADAMS Accession No. ML071690031). The NUREG/CR-3385 states that the risk reduction worth (RRW) importance value is useful for prioritizing feature improvements that can most reduce the risk. The maximum averted cost-risk (MACR) data used for the severe accident mitigation design alternatives (SAMDA) analysis provided in the Final Environmental Statement Related to the Operation of Watts Bar, Unit 2 (NUREG-0498, Supplement 2) was used to calculate the RRW threshold. For this analysis, NRC staff determined the RRW threshold from the SCDF-based MACR to be 1.045 (Unit 1) and 1.026 (Unit 2). The MACR calculation includes estimation of offsite exposures and offsite property damage, which captures the impact of SLERF. Therefore, separate SLERF-based MACR calculations were not performed. Table 1 includes those events that exceeded the RRW threshold for SCDF. Table 1 provides the following information: (first column) Fragility Group or Basic Event name, (second column) Description of the fragility group or basic event, and (third column) Failure Mode if applicable. The last columns have the RRW values and the respective risk reduction in SCDF from completely eliminating the corresponding failure in both Unit 1 and Unit 2. As previously mentioned, the NRC staff found that because the SCDF was below the initial screening value of 1.0E-5/ rx-yr., there were no potential modifications impacting core damage frequency identified that would be considered a substantial safety improvement.

As described previously, the evaluation also considered mitigation (i.e., containment performance), in this case measured as SLERF. Because only the SLERF exceeded the initial screening criterion, further evaluation only considers potential plant improvements that would reduce SLERF. Section 5.5 of the WBN SPRA submittal provides the Fussell-Vesely (FV) results for SLERF-significant structures, systems, and components (SSCs), human failure events (HFEs), and other types of basic events (e.g., Level 2 phenomenological events). The NRC staff estimated the RRW for each of these SSCs and the maximum large early release frequency reduction from completely eliminating the SSCs' failure. The results for SLERF are provided in Table 2 for those SSCs and basic events that exceeded the RRW thresholds. For SLERF, RRW thresholds of 1.045 (Unit 1) and 1.026 (Unit 2) were used assuming a remaining operating life of 18 years for Unit 1 and 38 years for Unit 2. Table 2 is equivalent to Table 1, with the difference of having the maximum SLERF reduction (MLR) for both Unit 1 and Unit 2.

The SPRA Screening Guidance recommends considering combinations of basic events. It is not the intent of that aspect of the guidance to aggregate several basic events that individually have RRW values close to the threshold. The NRC staff also considered potential plant modifications to address multiple basic events and combinations of multiple basic events. These types of modifications generally involve adding redundancy of alternating current/direct current (ac/dc) power and/or adding additional sources of cooling/makeup water. The NRC staff experience from SAMA analyses is that the cost of eliminating the seismic risk from these types

of plant improvements at the WBN units would substantially exceed the MACR.

In addition, the seismically-induced loss of offsite power initiating event frequency (SEIS_LOOP, or seismically-induced LOOP), is the highest seismic risk contributor. It is dependent on several factors, some of which are outside the plant's boundary. The state of knowledge is not sufficient to support apportionment of the SEIS_LOOP between the factors within and outside the plant's boundary. Further, mitigation of a SEIS_ LOOP is already being addressed by the addition of diverse and flexible mitigation strategies (FLEX), including installation of permanently-installed 480V FLEX diesel generators and 6.9kV (3 MW) FLEX diesel generators that are credited in the SPRA. As a result, the staff did not pursue potential improvements to SEIS_LOOP.

The licensee evaluated the three SPRA basic events or fragility groups listed as top SLERF contributors in the submittal after SEIS_LOOP (i.e., SEIS_HRAINSTR, SEIS_IF, and SEIS_0-25) associated with SSCs that could be potentially modified to increase their capacities. The licensee explained that, in each of the three cases, the basic events represent multiple sets of components (i.e., instruments, piping braces, and medium voltage breakers, respectively) and that upgrading the seismic fragility profile of "one or more" components associated with these sets would not significantly impact seismic risk. The NRC staff reviewed this information and notes that, even if all components associated with the three basic events were assumed not to fail as result of a seismic event, the reduction in calculated SLERF and related SCDF would not rise to a substantial safety improvement. Therefore, the staff did not pursue all the three basic events identified above for potential improvements.

After considering the information described above, and the analysis performed with the RRW and MLR values, the NRC staff concludes that no modifications are warranted in accordance with Title 10 of the Code of Federal Regulations (10 CFR) Section 50.109 to reduce SCDF and SLERF because a potential cost-justified substantial safety improvement was not identified.

The NRC staff also further evaluated accident sequences impacting the conditional probability of early containment failure or bypass given the seismic event and their associated cutsets to determine if any substantial safety improvements would reduce the SCDF and related SLERF of those sequences. The dominate LERF sequences are driven by loss of offsite power, which leads to core damage, and then operators failing to initiative backup containment isolation. The licensee confirmed in its submittal that containment isolation was a contributor for LERF.

These seismic accident sequences corresponded to peak ground acceleration greater than 2.0g and are defined in guidance from the Electric Power Research Institute Report 3002008093, "An Approach to Human Reliability Analysis for External Events with a Focus on Seismic," as guaranteed failure for all human failure events due to the conditions and potentially large uncertainties associated with the external event impact at this level. Given the large uncertainties in human reliability analysis and the conditions of the site during these large beyond design bases earthquakes, it was not feasible to request that the licensee to make modifications to reduce the contribution of these human actions to the conditional probability of early containment failure or bypass.

Based on the available information and engineering judgement, the NRC staff concluded that there were no further potential improvements to containment performance that would rise to the level of a substantial safety improvement or would warrant further regulatory analysis.

Additionally, the NRC staff reviewed the results of the IPEEE and SAMDA analyses previously completed for WBN to identify additional substantial safety improvements that would be cost-

justified. No other potential improvements were found based on this review.

Conclusion

Based on the analysis of the submittal and supplemental information, the NRC staff concludes that no modifications are warranted under 10 CFR Section 50.109 because:

- The staff did not identify a potential modification necessary for adequate protection or compliance with existing requirements;

- no potential cost-justified substantial safety improvement was identified based on the estimated achievable reduction in SCDF and SLERF; and

- additional consideration of containment performance, as described in NUREG/BR-0058 and assessed via SLERF, did not identify a modification that would result in a substantial safety improvement.

Table 1. WBN Unit 1 and Unit 2 Risk Significant SCDF Basic Events

Fragility Group/Event	Description	Failure Mode	Unit 1		Unit 2	
			RRW	MCR[2] (/rx-yr)	RRW	MCR (/rx-yr)
Fragility Groups						
SEIS_LOOP	LOOP INITIATING EVENT	Ceramic insulators	1.757	1.34E-06	1.828	1.41E-06
SEIS_IF	SEISMICALLY-INDUCED FLOODING EVENT	Anchorage	1.248	6.19E-07	1.307	7.31E-07
SEIS_3MWFLEXDG	3 megawatt (MW) FLEX Diesel Generator (DG)	Anchorage	1.159	4.26E-07	1.127	3.51E-07
SEIS_SSBO	SSBO INITIATING EVENT	Anchorage	1.115	3.20E-07	1.105	2.95E-07
SEIS_3-3	125V Vital Battery Charger	Functionality	1.105	2.95E-07	1.095	2.71E-07
SEIS_0-25	Breaker Chatter MVS	Breaker Chatter	1.092	2.61E-07	1.073	2.11E-07
SEIS_HRAINSTR	SEISMICALLY-INDUCED FAILURE OF HRA INSTRUMENTATION	Functionality and Anchorage	1.079	7E-07	1.060	1.77E-07
SEIS_5-1	6.9 Logic Relay Panel	Functionality	1.043*	1.28E-07	1.059	1.74E-07
SEIS_SSBI	SSBI INITIATING EVENT	Anchorage	1.041*	1.21E-07	1.044	1.31E-07
SEIS_0-24	Breaker Chatter LVS	Circuit Breaker Chatter	1.041*	1.21E-07	1.035	1.06E-07
SEIS_11-6	Aux Feedwater Pump	Anchorage	1.040*	1.18E-07	1.028	8.40E-08
SEIS_480VFLEXDG	480V FLEX DGs	Functionality	1.037*	1.12E-07	1.026	7.78E-08
SEIS_FLEXBUS	480 V FLEX Diesel Generator (DG) BUSES	Functionality	1.037*	1.12E-07	1.026	7.78E-08
Human Failure Events (HFEs)						
HAOS3	Start AFW (Reactor trip, no SI)	HFE	1.193	5.04E-07	1.215	5.50E-07
HAESBO3MW	Align 6.9 KV Diesel Generators	HFE	1.130	3.58E-07	1.099	2.80E-07
HAESBODG1	Align 225kVA 480V Diesel Generators	HFE	1.098	2.77E-07	1.013*	4.04E-08

[2] Risk reduction in SCDF from completely eliminating the corresponding failure

*Results are provided only because the other Unit RRW is greater than its respective threshold.

Table 2. WBN Unit 1 and Unit 2 Risk Significant SLERF Basic Events

Fragility Group/Event	Description	Failure Mode	Unit 1		Unit 2	
			RRW	MLR[3] (/rx-yr)	RRW	MLR (/rx-yr)
Fragility Groups						
SEIS_LOOP	LOOP INITIATING EVENT	Ceramic insulators	1.441	6.73E-07	1.637	8.56E-07
SEIS_HRAINSTR	SEISMICALLY-INDUCED FAILURE OF HRA INSTRUMENTATION	Functionality and Anchorage	1.292	4.97E-07	1.214	3.87E-07
SEIS_IF	SEISMICALLY-INDUCED FLOODING EVENT	Anchorage	1.179	3.34E-07	1.269	4.66E-07
SEIS_0-25	Breaker Chatter MVS (medium voltage switchgear)	Circuit Breaker Chatter	1.161	3.06E-07	1.121	2.38E-07
SEIS_DGBWSOUTH	Southern DG (diesel generator) Block Walls	Structure	1.094	1.89E-07	1.160	3.04E-07
SEIS_0-24	Breaker Chatter LVS (low voltage switchgear)	Circuit Breaker Chatter	1.085	1.72E-07	1.066	1.36E-07
SEIS_2-1	AUX Battery	Functionality	1.071	1.45E-07	1.066	1.36E-07
SEIS_20-1	HX-CCS (component cooling system heat exchanger)	Anchorage	1.067	1.39E-07	1.138	2.66E-07
SEIS_5-1	6.9 Logic Relay Panel	Functionality	1.063	1.30E-07	1.066	1.36E-07
SEIS_3MWFLEXDG	3 MW FLEX DGs	Anchorage	1.057	1.19E-07	1.089	1.80E-07
SEIS_FLEXTANK	FLEX Fuel Tanks	Functionality	NP	NP	1.062	1.28E-07
SEIS_480VFLEXDG	480V FLEX DGs	Functionality	NP	NP	1.054	1.12E-07
SEIS_FLEXBUS	480 V FLEX DG BUSES	Functionality	NP	NP	1.054	1.12E-07
Other Events (e.g., Level 2 Phenomenological)						
L2_NOTPISGTRNOSBO	NO PI-SGTR (NON-SBO SEQUENCE)	NA	1.100	2.00E-07	1.631	8.51E-07
L2_RCSDEPNOSBO	INTENTIONAL OR UNINTENTIONAL RHR DEPRESS PRE I-SGTR (NON-SBO SEQUENCE)	NA	1.100	2.00E-07	1.631	8.51E-07
FL-BATDEP	Battery Depleted FLAG	NA	NP	NP	1.316	5.28E-07

[3] Risk reduction in SLERF from completely eliminating the corresponding failure

*Results are provided only because the other Unit RRW is greater than its respective threshold.

NP – Not provided in the submittal, but is less than the RRW threshold of 1.045 used in the screening analysis.

NA – Not Applicable.

Table 2. WBN Unit 1 and Unit 2 Risk Significant SLERF Basic Events

Fragility Group/Event	Description	Failure Mode	Unit 1		Unit 2	
			RRW	MLR[3] (/rx-yr)	RRW	MLR (/rx-yr)
DGBW-COND1	Conditional probability DG block walls fall towards fans	NA	1.042*	8.80E-08	1.121	2.38E-07
Other Events (Continued)						
ICE-24HR	ICE CONDENSERS FAILS IN 24 HR (event actually is probability of containment failure at 24 hours given failure of containment heat removal but successful ice condenser operation)	NA	1.038*	8.14E-08	1.057	1.19E-07
L2_NOTDET	NO CONTAINMENT FAILS EARLY DUE TO H2 DETONATION	NA	1.033*	7.04E-08	1.172	3.23E-07
L2_NOTCFE5	NO CFE5 – LOW PRESSURE, VB, IGN AND ARFS SUCCESSFUL	NA	1.012*	2.64E-08	1.054	1.12E-07
Human Failure Events (HFEs)						
HACI1	Backup Containment Isolation, Given Loss of All AC Power	HFE	1.057	1.18E-07	1.081	1.65E-07

AUDIT SUMMARY BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED TO WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2 SUBMITTAL OF SEISMIC PROBABILISTIC RISK ASSESSMENT ASSOCIATED WITH REEVALUATED SEISMIC HAZARD IMPLEMENTATION OF THE NEAR-TERM TASK FORCE RECOMMENDATION 2.1: SEISMIC (CAC NOS. MF9879 AND MF9880; EPID L-2017-JLD-0044)

BACKGROUND AND AUDIT BASIS

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information under Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) (hereafter referred to as the 50.54(f) letter). Enclosure 1 to the 50.54(f) letter requested that licensees reevaluate the seismic hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses.

By letter dated October 27, 2015 (ADAMS Accession No. ML15194A015), the NRC made a determination of which licensees were to perform: (1) an SPRA [seismic probabilistic risk assessment], (2) limited scope evaluations, or (3) no further actions based on a comparison of the reevaluated seismic hazard and the site's design-basis earthquake. (Note: Some plant-specific changes regarding whether a seismic probabilistic risk assessment (SPRA) was needed or limited scope evaluations were needed at certain sites have occurred since the issuance of the October 27, 2015, letter.)

By letter dated July 6, 2017 (ADAMS Accession No. ML17177A446), the NRC issued a generic audit plan and entered into the audit process described in Office Instruction LIC-111, "Regulatory Audits", dated December 29, 2008 (ADAMS Accession No. ML082900195), to assist in the timely and efficient closure of activities associated with the 50.54(f) letter. The Watts Bar Nuclear Plant, Units 1 and 2 (WBN) was included in the list of applicable licensees. On June 30, 2017, the Tennessee Valley Authority (TVA, the licensee) submitted WBN's SPRA for NRC staff review (ADAMS Accession No. ML17181A485). The WBN's SPRA submittal was later supplemented with a letter dated April 10, 2018 (ADAMS Accession no. ML18100A966.)

REGULATORY AUDIT SCOPE AND METHODOLOGY

The areas of focus for the regulatory audit are the information contained in the SPRA submittal and all associated and relevant supporting documentation used in the development of the SPRA submittal including, but not limited to, methodology, process information, calculations, computer models, etc.

AUDIT ACTIVITIES

The WBN audit took place at the NRC Headquarters in Rockville, MD, beginning on July 31, 2017. Licensee personnel participated remotely, via telephone, from their respective offices. The following table provides a list of audit participants:

NRC and Contract Support Personnel		**Licensee Personnel**	
Name	**Title**	**Name**	**Title**
Milton Valentin	Project Manager	Russell Thompson	Licensing
Sara Lyons	Risk Analyst	Penny Selman	Engineering
Courtney St. Peters	Risk Analyst	Karl Nesmith	Projects
David Heeszel	Geophysicist	Roger Gish	Projects
Kaihwa Hsu	Mechanical Engineer	Dan Kearnaghan	Engineering
Antonios Zoulis	Risk Analyst	Steve Eder	Facility Risk Consultants
Mehdi Reisi Fard	Risk Analyst	Adam Helffrich Nish Vaidya Yigit Isbiliroglu	Rizzo Associates
Garill Cole Steve Short	Risk Analysts (Pacific Northwest National Laboratory)	Billy McNeely Barry Sloane Paul Amico	Jensen Hughes
Biswajit Dasgupta Daniel Pomerening	Engineering (Southwest Research Institute)		

The NRC staff and the licensee participated in one clarification calls that took place on November 20, 2017. In preparation for the calls, the staff developed questions to verify information in the licensee's submittal and to gain understanding of non-docketed information that supports the docketed SPRA report. The staff's clarification questions (ADAMS Accession No. ML17307A086) were sent to the licensee in advance of the call to facilitate clear communication and to ensure that the appropriate licensee personnel was available to answer questions in various technical areas.

During the call, the licensee provided clarifying information in the following areas:

- component and structural fragilities
- how plant response for various scenarios were modeled in the SPRA
- determination for no plant modifications
- closure of peer review findings

The licensee's response to the questions aided in the staff's understanding of the WBN SPRA docketed submittal. After the call, the licensee added supporting documents to an electronic reading room. Following the clarification call and review of the supporting documents, the staff had no further questions and determined that additional documentation or information was needed to supplement Watts Bar docketed SPRA report. The staff determined that additional information was necessary. The licensee supplemented the SPRA report with a letter dated April 10, 2018 (ADAMS Accession No. ML18100A966). The supplement information provided the information needed to support the regulatory decisionmaking associated with Phase 2 of the 50.54(f) letter.

DOCUMENTS AUDITED

The staff audited portions of the following supporting documents:

- Jensen Hughes Report 06044-RPT-01, "Watts Bar Nuclear Plant Seismic PRA Finding Level F&O Independent Technical Review," Revision R1, dated July 6, 2017
- Enercon Report TVACRP00050-REPT-001, "Watts Bar Unit 1 & 2 Internal Events Probabilistic Risk Assessment Peer Review Findings Closure," Revision 0, dated August 12, 2017
- Rizzo Associates Report R6 12-4869, "Watts Bar Bldg Seismic Analysis," Revisions 2 and 4, dated February 14, 2017
- Rizzo Associates Calculation No. 12-4869-F-10, "Seismic Fragility for Miscellaneous Components at WBNP," Revision 3, dated February 14, 2017
- Rizzo Associates Calculation No. 12-4869-F-44, "RCS Primary Loop Piping Fragility at WBNP," Revision 0, dated February 7, 2017
- Rizzo Associates Calculation No. 12-4869-F-37, "HCLPF Evaluation for Relays and Circuit Breakers at Watts Bar NPP," Revision 3, dated February 3, 2017
- Rizzo Associates Appendix E.23 to Calculation No. 12-4869-F-37, "Watts Bar Unit 1 & 2 Fragility Analysis M&E Equipment Fragility Calculations Relay and Breaker Chatter Evaluation," Revision 3, dated February 14, 2017
- Rizzo Associates Report R13 12-4869, "Fragility Analysis Report," Revision 1, dated February 15, 2017
- Addendum to Rizzo Associates Reports R13 and R06 12-4869, Revision 1, dated June 14, 2017
- Rizzo Associates Calculation No. 12-4869-F-39, "Equipment Fragilities Based on CDFM Versus Separation of Variables," Revision 2, dated February 1, 2017

OPEN ITEMS AND REQUEST FOR INFORMATION

During the audit period, the NRC staff generated audit questions for the licensee to address. All staff questions were responded during the audit period. Attachment 1 includes a question, and proposed answer from the licensee, handled during the audit. No open items or requests for information were generated during the audit.

DEVIATIONS FROM AUDIT PLAN

There were no deviations from the July 6, 2017, generic audit plan.

AUDIT CONCLUSION AND EXIT MEETING

The issuance of this document, containing the staff's review of the SPRA submittal, concludes the audit process for the Watts Bar SPRA associated to the 50.54(f) letter.

ATTACHMENT 1: WBN SPRA Audit Question and Response Summary

DESCRIPTION	LICENSEE RESPONSE
Median Capacities Section 4.1.1, "Relay Evaluation," of the WBN SPRA submittal summarized fragility analysis of relays and provided a list of relays in Table 4.1-1 along with the median capacities of those relays. The WBN SPRA submittal stated median capacities of the relays (except for one class of relays) exceeded 3.5g and thus relay chatter events were not considered in the seismic PRA for evaluating CDF and LERF. In response to NRC Audit Question 3, TVA provided Appendix E.23, "Watts Bar Unit 1 & 2 Fragility Analysis M&E Equipment Fragility Calculations Relay and Breaker Chatter Evaluation." Appendix E.23 includes the calculation of HCLPF values for relays at the Watts Bar nuclear power plant (Calculation 12-4869-F-37, Revision 3, 2017). The calculation provided the following data of the median capacity of relays (ACB stands for Auxiliary-Control Building): 1. Table 6.2-1 shows a list of Westinghouse Relays for Subgroup 2. The evaluated median capacity of this subgroup has been documented in Table 6.2-2 as 2.67g 2. Table 6.6-1shows a list of Gould Relays for Subgroup 6. The evaluated median capacity of this subgroup has been documented in Table 6.6-2 as 2.86g The NRC staff noticed that component IDs in Tables 6.2-1 and 6.6-1 seem to match the component IDs in Table 4.1-1 of the WBN SPRA submittal. The NRC staff also noticed that the median capacity A_m in WBN SPRA Table 4.1-1 is shown to be higher than 3.5g in the "disposition" column and are thus screened out from further evaluation. If these relays are the same, the documents seem to be contradictive. Please clarify: I. If components in Tables 6.2-1 and 6.6-1 are the same as those in Table 4.1-1. II. If the relays in questions are the same, and if fact have a capacity lower than the 3.5g cutoff limit, why these were excluded from further analysis. III. If the relays should have been further evaluated, explain any potential impact on seismic plant response analysis and on the SCDF and SLERF evaluations.	In response, the licensee stated that: The pages from Appendix E.23 previously provided were in response to questions No. 3 regarding beta values. The fragility values on those pages had been "superseded" as discussed below. Components 6.2-1 and 6.6-1 are the same as those in Table 4.1-1. However at the request of the SPRA quantification team, because the relays were in the top contributors, the fragility analysts were requested to look into the fragility calculations for these relays to determine if there was any conservatism in the fragility analysis. These relay fragilities were updated and the documentation was provided in an addendum to the fragility report. TVA failed to send this additional information to the NRC for review with the original relay calculation E.23. This information is now provided. These relays have Am values greater than 3.5g. Therefore, there is no impact to the SCDF and SLERF evaluations. The licensee facilitated Addendum A1 to the fragility calculation 12-4869-F37, reports R13 and R06 (Rizzo, 2017) where the refinements are captured. The NRC staff concluded that the licensee provided an adequate response to this question.

SUBJECT: WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2 – STAFF REVIEW OF SEISMIC PROBABILISTIC RISK ASSESSMENT ASSOCIATED WITH REEVALUATED SEISMIC HAZARD IMPLEMENTATION OF THE NEAR-TERM TASK FORCE RECOMMENDATION 2.1: SEISMIC (CAC NOS. MF9879 AND MF9880; EPID L-2017-JLD-0044) DATED JULY 10, 2018

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RidsACRS_MailCTR Resource

ADAMS Accession No.: ML18115A138 ***via email**

OFFICE	NRR/DLP/PBMB/PM	NRR/DLP/PBMB/LA*	OGC (NLO)*	NRR/DLP/PBMB/BC (A)
NAME	MValentin	SLent	JGillespie	BTitus
DATE	4/24/18	4/26/18	6/8/18	6/18/18
OFFICE	NRR/DORL/D	NRR/DRA/D	NRR/DLP/D	
NAME	JGiitter	MFranovich	LLund	
DATE	6/19/18	6/22/18	7/10/18	

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