



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

July 12, 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 – SEISMIC HAZARD  
MITIGATION STRATEGIES ASSESSMENT (CAC NOS. MF7891 AND MF7892;  
EPID L-2016-JLD-0006)

Dear Mr. Shea:

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 to all power reactor licensees and holders of construction permits in active or deferred status, under Title 10 of the *Code of Federal Regulations*, Section 50.54(f), "Conditions of Licenses" (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force report (ADAMS Accession No. ML111861807).

Enclosure 1 to the 50.54(f) letter requested that licensees reevaluate seismic hazards for their site(s) using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses. Concurrent with the reevaluation of seismic hazards, licensees were required to develop and implement mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML12054A735). In order to proceed with implementation of Order EA-12-049, licensees used the current licensing basis seismic hazard or the most recent seismic hazard information, which may not have been based on present-day methodologies and guidance, in the development of their mitigating strategies.

By letter dated December 21, 2017 (ADAMS Accession No. ML17355A362), the Tennessee Valley Authority (the licensee) submitted its seismic mitigation strategies assessment (MSA) for Watts Bar Nuclear Plant, Units 1 and 2 (WBN, Watts Bar). The MSA is intended to confirm that licensees have adequately addressed the reevaluated seismic hazards within their mitigating strategies for beyond-design-basis external events. The purpose of this letter is to provide the NRC's assessment of the WBN MSA.

The NRC staff has concluded that the Watts Bar MSA was performed consistent with the guidance described in Appendix H of Nuclear Energy Institute (NEI) guidance document NEI 12-06, Revision 4. The guidance in NEI 12-06, Revision 4, and Appendix H in particular, supports the proposed Mitigation of Beyond-Design-Basis Events rulemaking. In a letter to NEI

dated February 8, 2017 (ADAMS Accession No. ML17034A286), the NRC staff stated that Japan Lessons-Learned Directorate (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-01, Revision 2 (ADAMS Package Accession No. ML17005A182) had been issued and had been made publicly available. This ISG revision endorsed NEI 12-06, Revision 4, with exceptions, clarifications and additions.

In addition, the licensee has demonstrated that the alternate mitigation strategies, if appropriately implemented, are reasonably protected from reevaluated seismic hazard conditions for beyond-design-basis external events. This closes out the NRC's efforts associated with CAC Nos. MF7891 and MF7892.

If you have any questions, please contact me at 301-415-2864 or at Milton.Valentin@nrc.gov.

Sincerely,

A handwritten signature in black ink, appearing to read 'M Valentin', written in a cursive style.

Milton Valentin, Project Manager  
Beyond-Design-Basis Management Branch  
Division of Licensing Projects  
Office of Nuclear Reactor Regulation

Docket Nos. 50-390 and 50-391

Enclosure:  
Staff Assessment Related to the  
Mitigating Strategies for Watts Bar

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION  
RELATED TO MITIGATION STRATEGIES FOR  
WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2  
AS A RESULT OF THE REEVALUATED SEISMIC HAZARD  
NEAR-TERM TASK FORCE RECOMMENDATION 2.1 – SEISMIC  
(CAC NOS. MF7891 AND MF7892)

1.0 INTRODUCTION

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 to all power reactor licensees and holders of construction permits in active or deferred status, under Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f), “Conditions of Licenses” (hereafter referred to as the “50.54(f) letter”). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant as documented in the NRC’s Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807).

Enclosure 1 to the 50.54(f) letter requested that licensees reevaluate seismic hazards for their respective site(s) using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses. Concurrent with the reevaluation of seismic hazards, licensees were required to develop and implement mitigating strategies in accordance with NRC Order EA-12-049, “Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events” (ADAMS Accession No. ML12054A735). That order requires holders of operating reactor licenses and construction permits issued under 10 CFR Part 50 to modify the plants to provide additional capabilities and defense-in-depth for responding to beyond-design-basis external events, and to submit to the NRC for review a final integrated plan that describes how compliance with the requirements of Attachment 2 of the order was achieved. In order to proceed with implementation of Order EA-12-049, licensees used the current licensing basis seismic hazard or the most recent seismic hazard information, which may not have been based on present-day methodologies and guidance, in the development of their mitigating strategies.

The NRC staff and industry recognized the difficulty in developing and implementing mitigating strategies before completing the reevaluation of external hazards. To address this issue, Nuclear Energy Institute (NEI) guidance document NEI 12-06, Revision 4, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide” (ADAMS Accession No. ML16354B421) was written as an appropriate methodology for licensees to perform assessments of the mitigating strategies against the reevaluated seismic hazards developed in response to the March 12, 2012, 50.54(f) letter. The guidance in NEI 12-06, Revision 4, and Appendix H in particular, supports the proposed Mitigation of Beyond-Design-Basis Events rulemaking. In a letter to NEI dated February 8, 2017 (ADAMS Accession No. ML17034A286), the NRC staff stated that Japan Lessons-Learned Directorate (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-01, Revision 2 (ADAMS Package Accession No. ML17005A182) had been issued and had been made publicly available. This ISG revision endorsed NEI 12-06, Revision 4, with exceptions, clarifications and additions, as published in the *Federal Register* (83 FR 18089).

## 2.0 BACKGROUND

By letter dated March 31, 2014 (ADAMS Accession No. ML14098A478), the Tennessee Valley Authority (TVA, the licensee) submitted its reevaluated seismic hazard information for Watts Bar Nuclear Plant, Units 1 and 2 (WBN, Watts Bar). 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) a seismic probabilistic risk assessment (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.

By letter dated June 30, 2017 (ADAMS Accession No. ML17181A485), and supplemental information in letter dated April 10, 2018 (ADAMS Accession No. ML18100A966), TVA provided its SPRA report for WBN. The NRC staff assessed the licensee's submittal and 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 and that the risk and safety insights provided by WBN's SPRA report support the NRC's determination that no further response or regulatory action is required in response to the reevaluated seismic hazard. The NRC's staff assessment documenting this decision was issued on July 10, 2018 (ADAMS Accession No. ML18115A138).

By letter dated December 22, 2016 (ADAMS Accession No. ML16357A578), the licensee provided its limited-scope evaluation of the SFP for WBN. The NRC staff assessed the licensee's submittal and concluded that the licensee's implementation of the SFP integrity evaluation met the criteria of the SFP Evaluation Guidance Report Electric Power Research Institute (EPRI) Report No. 3002007148 entitled, "Seismic Evaluation Guidance: Spent Fuel Pool Integrity Evaluation" (ADAMS Accession No. ML16055A017) for WBN. The NRC's staff assessment documenting this decision was issued on March 7, 2017 (ADAMS Accession No. ML17062A681).

By letter dated December 21, 2017 (ADAMS Accession No. ML17355A362), the licensee submitted its seismic mitigation strategies assessment (MSA) for WBN. The following section provides the NRC's evaluation of the MSA.

## 3.0 TECHNICAL EVALUATION

Section H.4.5.3 of NEI 12-06, Revision 4, describes a method that the staff finds acceptable to demonstrate that the mitigation strategies at WBN are reasonably protected against the reevaluated seismic hazard. As specified in NEI 12-06, WBN's SPRA was peer reviewed in accordance with the expectations described in the EPRI's Seismic Evaluation Guidance Report 1025287, "Screening, Prioritization, and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic" (ADAMS Accession No.

ML12333A170). The NRC staff reviewed the licensee's SPRA information submitted by letters dated June 30, 2017 and April 10, 2018, and determined that its technical adequacy was sufficient to support regulatory decisionmaking associated with the reevaluated seismic hazard. The seismic core damage frequency (SCDF) and seismic large early release frequency (SLERF) values reported for WBN in the June 30, 2017, letter are less than the  $5 \times 10^{-5}/\text{yr}$  (SCDF) and  $5 \times 10^{-6}/\text{yr}$  (SLERF) screening values described in Section H.4.5.3 of NEI 12-06, Revision 4. These base SPRA results demonstrate a high likelihood that the alternate mitigation strategies are reasonably protected against the reevaluated seismic hazard, and no further evaluation of the maintenance of core cooling or containment integrity is necessary.

Regarding the capability for SFP cooling, Section H.4.5.6 of NEI 12-06, Revision 4, states that licensees following Path 5 need to ensure the SFP cooling mitigating strategies are maintained. Specifically, licensees will ensure that SFP makeup capability needed to accomplish the SFP cooling strategies is evaluated for seismic adequacy against the reevaluated seismic hazard.

The WBN SFP cooling strategy relies on the use of low pressure FLEX pumps to pressurize the Essential Raw Cooling Water (ERCW) headers which can then be used for makeup to the SFP. The source of makeup water is the Chickamauga reservoir. The primary SFP makeup flow method is from the ERCW header connections through a hose(s) to the SFP. The secondary SFP makeup method is the FLEX connection at the SFP Demineralized Water System makeup line. Supply to this FLEX connection could come from an available clean water source via transfer pump or an ERCW FLEX connection. This secondary makeup capability provides makeup control when the refueling floor is not accessible. The pre-staged 6.9 kilovolt (kV) FLEX diesel generators will energize the SFP cooling pumps to restore SFP cooling capability. The SFP cooling strategies were previously evaluated and found acceptable in the NRC staff safety evaluation for the implementation of mitigations strategies related to Order EA-12-049 (ADAMS Accession No. ML15078A193).

In its letter dated December 21, 2017, the licensee stated that the portable FLEX equipment availability, including its storage and deployment pathways, needed to accomplish SFP cooling has subsequently been evaluated considering a site-specific seismic event. To confirm these statements, the NRC staff exercised the audit process described in letter dated December 5, 2016 (ADAMS Accession No. ML16259A189), by requesting supporting information from TVA. The licensee made available supporting information in their electronic Portal for the audit. In document CDN 000 360 2014 00498, "Seismic Margin Assessment of WBN Fukushima FLEX Equipment Storage Building (FESB)," dated May 5, 2014, the licensee stated that the FESB has sufficient seismic capacity to withstand the reevaluated seismic hazard. The licensee also made available Calculation No. 12-4869-F-35, "Seismic HCLPF Capacity for Distribution Systems at WBNP," dated June, 23, 2015, where piping similar to that of the ERCW and SFP Demineralized Water Systems is evaluated against the reevaluated hazard. In addition, the licensee stated that the low pressure FLEX pumps are stored in the FESB. Lastly, the licensee stated that the ERCW headers and SFP Demineralized Water System makeup components were evaluated for the SPRA and no vulnerabilities associated with these systems were identified.

To assess the licensee's ability for implementing the SFP makeup strategy after the reevaluated seismic event, the NRC staff assessed the storage conditions of the FLEX equipment and the licensee's ability for deployment. The NRC staff audited document CDN 000 360 2014 00498 to confirm that the licensee considered seismic loads equivalent to the reevaluated seismic hazard. In its evaluation, the licensee evaluated the seismic capacity of the FESB by calculating the high-confidence-low-probability-of-failure (HCLPF) capacity of the FESB and

demonstrating that there is margin between the FESB capacity and the reevaluated seismic hazard. The NRC staff reviewed this calculation and confirmed that the seismic loads used in the analysis are the same as those generated by the reevaluated seismic hazard. When auditing calculation 12-4869-F-65, the NRC staff confirmed that a similar approach was followed to demonstrate that distribution piping has sufficient capacity to withstand the reevaluated seismic hazard. The NRC staff also confirmed that the licensee's approach is consistent with the guidance in EPRI Report No. NP-6041-SL, Revision 1, "A Methodology for Assessment of Nuclear Power Plant Seismic Margin. This approach was found acceptable by the NRC staff in Interim Staff Guidance JLD-ISG-2012-04, Revision 0, "Guidance on Performing a Seismic Margin Assessment in Response to the March 2012 Request for Information Letter," dated November 16, 2012. For those reasons, the NRC staff concluded that the licensee's analysis provides sufficient information to support the statements made in the MSA regarding evaluating equipment needed for the SFP makeup strategy against the reevaluated seismic hazard. Regarding the storage conditions inside the FESB, the NRC inspectors confirmed, during the FLEX audit at WBN held the week of March 12, 2014 (ADAMS Accession No. ML14128A129), that the FLEX equipment was spaced out and tied down to prevent spatial interaction during a seismic event. As documented in NEI 12-06, Revision 4, the FLEX pumps and other FLEX equipment (i.e. pumps and hoses) are considered inherently rugged and capable of withstanding the reevaluated hazard. For these reasons, the NRC staff concludes that the FESB and storage conditions of the FLEX pumps needed for the SFP makeup strategy should be reasonably protected against the reevaluated seismic hazard.

The licensee also stated, in its December 21, 2017, letter, that possible liquefaction along the FLEX deployment routes is mitigated through use of hauling equipment capable of handling a 9" terrain drop or rise. To confirm this, the NRC staff requested the licensee to make available the liquefaction analysis completed for WBN. The licensee made available Document W50140715008, "Liquefaction Induces Settlement of Haul Roads," dated June 19, 2014. In this document, the licensee stated to have identified a silty sand layer, estimated between 3 and 10 feet thick that might be susceptible to liquefaction. In its analysis, the licensee reported to have assessed a liquefiable zone 20 feet thick using the 10,000 year earthquake event. The licensee's assessment determined a terrain rise or drop of 9 inches. The NRC staff evaluated this information to determine that the use of a 20 feet thick layer is a conservative approach, given that the silty sand layer is estimated to be between 3 to 10 feet thick. The NRC staff also considered that, by definition, the reevaluated seismic hazard is developed using spectral hazard curves that represent the 1,000 year and 10,000 year earthquakes. The NRC staff confirmed that this information is documented in the licensee's seismic hazard evaluation dated March 31, 2014 (ADAMS Accession No. ML14098A478), where Table 2.4-1 for WBN shows that the 10,000 year earthquake is stronger than the reevaluated seismic hazard. The NRC staff documented its assessment of this seismic hazard reevaluation in letters dated October 5, 2015 for Unit 1 (ADAMS Accession No. ML15055A543), and Unit 2 (ADAMS Accession No. ML15111A377). For these reasons, the NRC staff concludes that the use of vehicles that can cope with 9-inch terrain rise or drop should be sufficient to handle possible soil liquefaction along the FLEX deployment routes at WBN.

Therefore, the NRC staff concludes that the licensee has developed the ability to deploy its mitigation strategies, as described above, against postulated beyond-design-basis seismic events, in accordance with NEI 12-06, Revision 4.

#### 4.0 AUDIT REPORT

The NRC staff previously issued a generic audit plan dated December 5, 2016 (ADAMS Accession No. ML16259A189), that described the NRC staff's intention to conduct audits related to MSAs and issue an audit report that summarizes and documents the NRC's regulatory audit of the licensee's MSA. The NRC staff activities have been limited to performing the reviews described above. Because this staff assessment appropriately summarizes the results of those reviews, the NRC staff concludes that a separate audit summary report is not necessary, and that this document serves as the final audit report described in the December 21, 2016, letter.

#### 5.0 CONCLUSION

The NRC staff has reviewed the information presented by the licensee in the MSA for WBN and finds that the licensee's seismic hazard MSA was performed consistent with the guidance in Appendix H of NEI 12-06, Revision 4. As discussed in this letter, the NRC staff concludes that following the provisions of NEI 12-06, Revision 4, with the exceptions, clarifications, and additions contained in JLD-ISG-2012-01, Revision 2, is acceptable. Based on the NRC's assessment of the technical adequacy of the licensee's SPRA, the SPRA results compared to the screening criteria of Section H.4.5.3 of NEI 12-06, Revision 4, and the evaluation of the SFP cooling strategy against the reevaluated seismic hazard, the NRC staff concludes that the licensee has demonstrated that the alternate mitigation strategies at WBN exhibit reasonable protection against the reevaluated seismic hazard.

WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2- SEISMIC HAZARD MITIGATION STRATEGIES ASSESSMENT DATED JULY 12, 2018.

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