



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

September 7, 2018

Mr. Richard D. Bologna  
Site Vice President  
FirstEnergy Nuclear Operating Company  
Beaver Valley Power Station  
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SUBJECT: BEAVER VALLEY POWER STATION, UNITS 1 AND 2 – SEISMIC HAZARD  
MITIGATION STRATEGIES ASSESSMENT (CAC NOS. MF7800 AND MF7801;  
EPID NO. L-2016-JLD-0006)

Dear Mr. Bologna:

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, pursuant to 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 October 11, 2017 (ADAMS Accession No. ML17285A015), FirstEnergy Nuclear Operating Company (FENOC, the licensee), submitted its seismic mitigation strategies assessment (MSA) for the Beaver Valley Power Station, Units 1 and 2 (Beaver Valley). 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 Beaver Valley MSA.


The NRC staff has concluded that the Beaver Valley 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 the NEI dated February 8, 2017 (ADAMS Accession No. ML17034A286), the NRC staff stated that Japan Lessons-Learned Division (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. MF7800 and MF7801.

If you have any questions, please contact me at 301-415-1617 or via e-mail at [Frankie.Vega@nrc.gov](mailto:Frankie.Vega@nrc.gov).

Sincerely,



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

Docket Nos. 50-334 and 50-412

Enclosure:  
Staff Assessment Related to the  
Mitigating Strategies for Beaver Valley

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION  
RELATED TO MITIGATION STRATEGIES FOR  
BEAVER VALLEY POWER STATION, UNITS 1 AND 2  
AS A RESULT OF THE REEVALUATED SEISMIC HAZARD  
NEAR-TERM TASK FORCE RECOMMENDATION 2.1 – SEISMIC  
(CAC NOS. MF7800 AND MF7801)

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

2.0 BACKGROUND

By letter dated March 31, 2014 (ADAMS Accession No. ML14090A143), FirstEnergy Nuclear Operating Company (FENOC, the licensee) submitted the reevaluated seismic hazard

information for Beaver Valley Power Station, Units 1 and 2 (Beaver Valley). The NRC performed a staff assessment of the submittal and issued a response letter on October 5, 2015, (ADAMS Accession No. ML15274A307). 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, Beaver Valley 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 September 29, 2017, and December 31, 2016, respectively.

By letter dated November 7, 2016 (ADAMS Accession No. ML16312A311), FENOC provided its SFP evaluation report for Beaver Valley. The NRC staff assessed the licensee's evaluation and documented its review by letter dated January 6, 2017 (ADAMS Accession No. ML16349A042).

By letter dated July 27, 2017 (ADAMS Accession No. ML17213A014), FENOC provided its SPRA report for Beaver Valley. 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 Beaver Valley'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 June 6, 2018 (ADAMS Accession No. ML18092A837).

By letter dated October 11, 2017 (ADAMS Accession No. ML17285A015), the licensee submitted its seismic mitigation strategies assessment (MSA) for Beaver Valley.

### 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 alternate mitigation strategies (AMS) at Beaver Valley are reasonably protected against the reevaluated seismic hazard. As specified in NEI 12-06, Beaver Valley's SPRA was peer reviewed in accordance with the expectations described in the Electric Power Research Institute's (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 letter dated July 27, 2017, 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 Beaver Valley, Units 1 and 2 in the July 27, 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 AMS are reasonably protected against the reevaluated seismic hazard, and no further evaluation of the maintenance of core cooling or containment integrity is necessary.

Regarding maintenance of spent fuel pool (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.

As described in the FIP and stated in the MSA, the Beaver Valley SFP FLEX cooling and makeup capability relies on using a diesel-driven FLEX makeup pump taking suction from the unit's refueling water storage tank (RWST) or the plant's ultimate heat sink (i.e. the Ohio River) and discharging through a flexible hose which can be connected to SFP emergency make-up piping or discharge directly into the SFP. Hoses are also routed to spray nozzles on the operating deck to spray the spent fuel if necessary.

The licensee stated that permanently installed equipment relied on for the SFP cooling FLEX strategy has been designed to the SSE loading conditions and was installed, or evaluated in accordance with the plant design basis. The licensee also referred to its SFP integrity evaluation (ADAMS Accession No. ML16312A311). As part of this evaluation, the licensee demonstrated that the SFP structure and interfacing plant equipment can withstand ground motions with peak spectral acceleration less than or equal to 0.8g.

The licensee also evaluated the seismic capacities of the FLEX storage building, FLEX equipment, and FLEX deployment paths to ensure availability of the FLEX SFP make-up strategy. As documented in licensee calculation, "Converting C<sub>1%</sub> HCLPFs to C<sub>10%</sub> Capacities," PRA-BV3-17-001-R00, dated March 14, 2017, the licensee calculated C<sub>10%</sub> capacities and compared these values to the GMRS. Since the C<sub>10%</sub> values were greater than the GMRS, the licensee concluded that the FLEX storage building, SFP make-up pump tie down, and the RWST have adequate capacity to withstand the GMRS. The licensee also performed a slope stability analysis of a specific section of the south deployment path and obtained a C<sub>10%</sub> capacity greater than the GMRS. In addition, the licensee evaluated the potential collapse of the Unit 2 cooling tower and the transmission towers in the switchyard and the potential effects on the availability of the deployment paths. In summary, the licensee concluded that the deployment paths would not be affected by these potential interaction concerns.

To confirm the conclusions above, the NRC staff exercised the audit process described in a letter dated December 5, 2016 (ADAMS Accession No. ML16259A189), by requesting supporting information from the licensee. The following documents were made available in the electronic Portal for staff review:

- FirstEnergy Nuclear Operating Company, Beaver Valley Power Station Analysis Assessment, "Converting C<sub>1%</sub> HCLPFs to C<sub>10%</sub> Capacities," PRA-BV3-17-001-R00, dated March 14, 2017.
- ABS Consulting/Rizzo Associates Report, "Seismic Walkdown of Beaver Valley Nuclear Power Station Unit 1," ABS 2734294-R-004/RIZZO R6 12-4735, Revision 2, dated August 3, 2016.
- ABS Consulting/Rizzo Associates Report, "Seismic Walkdown of Beaver Valley Nuclear Power Station Unit 2," ABS 2734294-R-011/RIZZO R6 12-4736, Revision 2, dated June 20, 2016.

The NRC staff reviewed the licensee's calculation "Converting C<sub>1%</sub> HCLPFs to C<sub>10%</sub> Capacities," PRA-BV3-17-001-R00, dated March 14, 2017. The NRC staff noted that the C<sub>10%</sub> capacity

values used in the MSA were derived from the high confidence of low probability of failure (HCLPF) capacities developed for the Beaver Valley seismic probabilistic risk assessment (SPRA). The NRC staff confirmed that the C<sub>10%</sub> capacity values obtained for the FLEX storage building, the RWST, and SFP make-up pump tie down were greater than the GMRS. Therefore, based on this evaluation, these structures, systems, and components are expected to be available following a seismic event at least the magnitude of the reevaluated seismic hazard. The NRC staff also confirmed that the approach used to calculate these C<sub>10%</sub> seismic capacities followed the guidance in NEI 12-06, Revision 4.

The NRC staff reviewed the information provided in ABS Consulting/Rizzo Associates Report, "Seismic Walkdown of Beaver Valley Nuclear Power Station Unit 1 and 2," regarding the evaluation performed to address the availability of the deployments paths for Units 1 and 2 considering a site-specific seismic event. These seismic walkdowns supported the SPRA project for Beaver Valley. The NRC staff confirmed that the C<sub>10%</sub> value obtained from the slope stability analysis was greater than the GMRS, and therefore, the deployment paths are not expected to be affected by potential slope instability and should be available following the site-specific seismic event. In addition, the NRC staff reviewed the information provided regarding the potential seismic interactions along the FLEX deployment pathways and concludes that sufficient information is provided in these seismic walkdown reports to support the statements made in the MSA regarding the FLEX deployment paths.

Therefore, the NRC staff concludes that the licensee has demonstrated that the strategy to maintain SFP cooling is reasonably protected against the reevaluated seismic hazard in accordance with NEI 12-06, Revision 4, and ISG-2012-01, Revision 2.

#### 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 5, 2016, letter.

#### 5.0 CONCLUSION

The NRC staff has reviewed the information presented by the licensee in its MSA for Beaver Valley and finds that the licensee's seismic hazard MSA was performed consistent with the guidance in Appendix H of NEI 12-06, Revision 4. Based on the NRC's assessment of the technical adequacy of the licensee's SPRA and the 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, the NRC staff concludes that the licensee has demonstrated that the alternate mitigation strategies at Beaver Valley exhibit reasonable protection against the reevaluated seismic hazard.

SUBJECT: BEAVER VALLEY POWER STATION, UNITS 1 AND 2 – SEISMIC HAZARD MITIGATION STRATEGIES ASSESSMENT DATED September 7, 2018

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