UNITED STATES
NUCLEAR REGULATORY COMMISSION
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Mr. Richard D. Bologna
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SUBJECT: BEAVER VALLEY POWER STATION, 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. MG0096 AND MG0097; EPID L-2017-JLD-0027)

Dear Mr. Bologna:

The purpose of this letter is to document the staff's evaluation of the Beaver Valley Power Station, Units 1 and 2 (Beaver Valley) 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 no further response or regulatory actions associated with NTTF Recommendation 2.1 "Seismic" are required for Beaver Valley.

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* Section 50.54(f) (hereafter referred to as the 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 50.54(f) letter requested that licensees reevaluate seismic hazards at their sites using present-day methodologies and guidance. Enclosure 1, Item 8, of the 50.54(f) letter requested that certain licensees complete a 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 July 27, 2017 (ADAMS Accession No. ML17213A014), FirstEnergy Nuclear Operating Company (FENOC, the licensee), provided its SPRA report in response to Enclosure 1, Item (8) of the 50.54(f) letter, for Beaver Valley. The NRC staff assessed the licensee's implementation of the Electric Power Research Institute'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 Beaver Valley's SPRA report meets the intent of the SPID guidance and that the results and risk insights provided by the SPRA support the NRC's determination that no further response or regulatory actions associated with NTTF Recommendation 2.1 "Seismic" are required.

BACKGROUND

The 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 50.54(f) letters to all operating power reactor 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 important to safety) to provide additional protection against the updated hazards.

By letter dated March 31, 2014 (ADAMS Accession No. ML14090A143), FENOC submitted the reevaluated seismic hazard information for the Beaver Valley site. 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 regulatory guidance and methodologies, 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, 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. These seismic evaluations were expected to be submitted to the NRC by September 30, 2017, and December 31, 2016, respectively.

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

In its July 27, 2017, letter, FENOC provided the SPRA report that initiated the NRC's Phase 2 decisionmaking process for Beaver Valley. 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 results 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 Beaver Valley is described below.

EVALUATION

Upon receipt of the licensee's July 27, 2017, SPRA report, a technical team of staff 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. On October 11, 2017, the technical team determined that sufficient information was available to perform the detailed technical review in support of the Phase 2 decision.

As described in the 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 50.54(f) letter. As stated in its July 27, 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 Addenda B, 2013. Section A.10 of the licensee's submittal provided a summary of the SPRA peer review team's facts and observations (F&O's) classified as findings. The findings from the licensee's internal events PRA were not provided in the submittal, but had been previously docketed (ADAMS Accession No. ML14051A499). Section A.10 included the licensee's dispositions of the SPRA peer review team's findings and a status of the dispositions. The staff reviewed each of the licensee's dispositions of the findings and evaluated whether they were adequately addressed such that the technical adequacy of the SPRA could be judged to be sufficient for the purposes of supporting the regulatory decisionmaking associated with Phase 2.

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 list

of applicable licensees in Enclosure 1 of the July 6, 2017, letter included FENOC as the licensee for Beaver Valley. The staff exercised the audit process through the use of two clarification calls that took place on October 11, 2017, and January 31, 2018, and by reviewing licensee documents via an electronic reading room (online portal) as documented in Enclosure 2 to this letter. In preparation for the clarification 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. ML18024B364) were sent to the licensee in advance of the calls to facilitate clear communication and to ensure that the appropriate FENOC staff were available to answer questions in various technical areas. After the call, the licensee voluntarily added three documents to an online portal in response to the clarification questions. At the conclusion of the clarification calls and following the review of the supporting documents, the staff had no further questions and determined that no additional documentation or information was needed to supplement Beaver Valley's docketed SPRA report. Consequently, the staff determined that the docketed SPRA report was sufficient to support regulatory decisionmaking associated with Phase 2 of the 50.54(f) letter. Based on the staff's review of the licensee's submittal, including the disposition of the peer review findings as described above, 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 50.54(f) letter.

Following the staff's conclusion on the SPRA's technical adequacy, the staff reviewed the risk and safety insights contained in the Beaver Valley SPRA report. 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 to Beaver Valley's submittal. As documented in the checklist, the staff concluded that the Beaver Valley SPRA met the intent of the SPID. The staff further concluded that the peer review findings have been addressed and the analyses used by the licensee in addressing these findings are 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 Beaver Valley 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 Beaver Valley SPRA report demonstrated that the plant SCDF for Unit 1 was not below the initial screening values in the August 29, 2017, staff memorandum. However, the SLERF for Units 1 and 2 and the SCDF for Unit 2 were sufficiently low such that no further review is warranted under NTTF Recommendation 2.1: Seismic. As a result, the NRC staff utilized the Beaver Valley SPRA report and other available information to complete a detailed screening with respect to SCDF for Unit 1. A discussion of the detailed screening evaluation completed by the NRC staff is provided in Enclosure 3 to this letter.

Based on its review, the technical team determined that recommending Beaver Valley be classified as a Group 1 site was appropriate and 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 Beaver Valley review to the TRB with the Phase 2 recommendation that Beaver Valley 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 Beaver Valley.

Subsequently, the technical team met with the SMRP and presented the results of the review including the recommendation for Beaver Valley 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 Beaver Valley 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 Beaver Valley audit included two clarification calls that took place on October 11, 2017, and January 31, 2018, and the review of licensee documents through an electronic reading room. An audit summary document is included as Enclosure 2 to this letter.

CONCLUSION

Based on the staff's review of the Beaver Valley submittal against the endorsed SPID guidance, the NRC staff concludes that the licensee responded appropriately to Enclosure 1, Item (8) of the 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 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 review 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 Brett Titus at (301) 415-3075 or via e-mail at Brett.Titus@nrc.gov.

Sincerely,

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

Docket Nos. 50-334 and 50-412

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

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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/ANS Standard to the relevant guidance in the SPID. For most SRs, the SPID guidance does not differ from the requirement in the ASME/ANS Standard. However, because the guidance of the SPID and the criteria of the ASME/ANS 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/ANS 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/ANS 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/ANS Standard.

(iii) The SPID has some requirements that are not in the ASME/ANS 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/ANS 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 Safe Shutdown Earthquake (SSE) to Ground Motion Response Spectrum (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, In-Structure Response Spectra (ISRS), and Fragilities
- Topic 8: Screening by Capacity to Select Structures, Systems, and Components (SSCs) for Seismic Fragility Analysis (SPID Section 6.4.3)
- Topic 9: Use of the Conservative Deterministic Failure Margin (CDFM)/HybridMethodology 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 Seismic Large Early Release Frequency (SLERF) (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 Analysis (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 Foundation Input Response Spectra (FIRS) developed by the licensee for the SPRA differs from the GMRS and represents an update to the previously reviewed PSHA. Differences in spectra are primarily due to a reduction in damping values used in calculating site response and corrections to the PSHA software used by the licensee. The updated hazard represents a more realistic representation of the geologic structure beneath the site. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): N/A	
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 Probabilistic Seismic Hazards Analysis (SHA) requirements in the ASME/ANS Standard, as well as to the requirements in the SPID.	Yes
• Although some peer review findings have not been resolved, the analysis is acceptable on another justified basis.	N/A
• 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.	N/A

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
Notes from staff reviewer: None. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): N/A	
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 SHA-E1 and E2 in the ASME/ANS Standard, as well as to the requirements in the SPID.	Yes
• Although some peer review findings 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 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 issue is establishing the control point where the 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 comparison:	
A) If the SSE control point(s) is defined in the final safety analysis report (FSAR), it should be used as defined.	Yes
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.	N/A
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.	No
If yes, the control point can be used in the SPRA and the NRC staff's earlier acceptance governs.	
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.	Yes
Notes from staff reviewer: Licensee developed FIRS consistent with NRC guidance. The FIRS elevations are different from the GMRS elevation discussed in the staffs review of the licensee's PSHA and represent the seismic demand at the foundation of evaluated structures discussed in Topic 7 of this checklist. Deviation(s) or deficiency(ies) and Resolution: None.	

Consequence(s): N/A	
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 requirements in the SPID. No requirements in the ASME/ANS Standard specifically address this topic.	Yes
• Although some peer review findings 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.	No
• 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.	Yes

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	No
Used an enhancement of an existing model	No
Used an entirely new model	Yes
Criteria 1 through 7 (SPID Section 6.3.1) are all met.	Yes

Notes from staff reviewer:

The Beaver Valley SPRA submittal indicated that entirely new finite element structural models were developed. Section 4.3 of the SPRA submittal documents the soil-structure interaction (SSI) model, evaluation of existing lumped mass models and subsequent development of all new finite element models, plus material properties of concrete, steel, and soil.

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

Consequence(s): N/A

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 Seismic Fragility Analysis (SFR)-C1 through C6 in the ASME/ANS Standard, as well as to the requirements in the SPID.	Yes
• Although some peer review findings 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."	No
If no, this issue is moot.	
If yes, on which structure(s)? Structure #1 name: Structure #2 name:	
Structure #1:	
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.	N/A
Notes from staff reviewer: The Beaver Valley SPRA submittal indicated that no structure was analyzed using a fixed based methodology; Beaver Valley is characterized as a soil site. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): N/A	
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 requirements in the SPID. No requirements in the ASME/ANS Standard specifically address this topic.	N/A
• Although some peer review findings 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.	N/A
• 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.	N/A

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

Seismic response scaling was used.	No
Potential Staff Findings:	
If a new uniform hazard spectra or review level earthquake is used, the shape is approximately similar to the spectral shape previously used for ISRS generation.	N/A
If the shape is not similar, the justification for seismic response scaling is adequate.	N/A
Consideration of non-linear effects is adequate.	N/A
Notes from staff reviewer: The Beaver Valley SPRA submittal indicated that completely new finite element models and SSI analyses were performed. Therefore, no scaling was necessary.	
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 SR SFR-C3 in the ASME/ANS Standard, as well as to the requirements in the SPID.	N/A
• Although some peer review findings have not been resolved, the analysis is acceptable on another justified basis.	N/A
• The licensee's use of seismic response scaling adequately meets the intent of the SPID guidance.	N/A
• 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 ASME/ANS 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: Beaver Valley Reactor Buildings	Yes
Structure #2 name: Beaver Valley Diesel Generator Building	Yes
Structure #3 name: Beaver Valley Fuel Handling/ Decontamination and Safeguards Building	Yes
Structure #4 name: Beaver Valley Auxiliary Buildings, Service Buildings, and Main Steam Cable Vaults	Yes
Structure #5 name: Beaver Valley Shared Intake Structure	Yes
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 SSI analysis capable of capturing uncertainties and realistic?	Yes

• Is the probabilistic response analysis capable of providing the full distribution of the responses?	Yes

Notes from staff reviewer:

The Beaver Valley SPRA submittal indicated that FIRS were calculated according to NRC guidance for all relevant structures.

The submittal justifies the adequacy of existing seismic response analyses so that new response analysis was not needed.

Section 3.1.1.2 of the submittal, explains that "representative foundation elevations" were selected for site response analysis and the acceleration response spectra were mapped to structures by their foundation elevation. Uncertainty was considered by developing a FIRS for lower-bound, best-estimate, and upper-bound soil shear velocities.

Though Section 3.1 explains that acceleration response spectra were mapped to structures by their foundation elevation, it was not clear from the information provided in the submittal how consideration of the impact of soil condition was factored into the site response mapping.

The staff utilized the audit process to review licensee provided documents which described the mapping between the structure foundation elevation groups, soil interaction groups, and the plant structures considered in the SPRA. This mapping adequately described how the impact of soil condition was factored into the site response mapping.

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

Consequence(s): N/A

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-C2, C4, C5, and C6 in the ASME/ANS Standard, as well as to the requirements in the SPID.	Yes
• Although some peer review findings have not been resolved, the analysis is acceptable on another justified basis.	N/A
• The licensee's FIRS modeling is consistent with the prior NRC review of the GMRS and soil velocity information.	Yes

• The licensee's structural model meets the intent of the SPID guidance and the ASME/ANS Standard's requirements.	Yes
• The response analysis accounts for uncertainties in accordance with the SPID guidance and the ASME/ANS Standard's requirements.	Yes
• 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.	Yes
• The licensee's structural model does not meet the intent of the SPID guidance and the ASME/ANS Standard's requirements, but is acceptable on another justified basis.	N/A

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

The selection of 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 ASME/ANS 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: None. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): N/A	

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-B1 and B2 in the ASME/ANS Standard, as well as to the requirements in the SPID.	Yes
• Although some peer review findings 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:	Yes
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.	Yes
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.	Yes
C) An alternative method has been used appropriately for developing full seismic fragility curves.	N/A

Notes from staff reviewer:

The Beaver Valley SPRA submittal, Tables 5.9 and 5.14 for Units 1 and 2, respectively, list which SSCs used the CDFM or separation of variables (SOV) methods to calculate the fragility.

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

Consequence(s): N/A

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 requirements in the SPID. No requirements in the ASME/ANS Standard specifically address this Topic.	Yes
• Although some peer review findings have not been resolved, the analysis is acceptable on another justified basis.	N/A
• The licensee's use of the CDFM/Hybrid method for seismic fragility analysis meets the intent of the SPID guidance.	Yes
• 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

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. 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. The flow chart in Figure 6-7 of the SPID was followed. The flow chart was not followed but the analysis is acceptable on another justified basis.	 Yes No Yes
Notes from staff reviewer: The Beaver Valley SPRA submittal Section 5.1.3 states that relays and non-relay contact devices identified to be susceptible to high frequency motion were evaluated per EPRI Phase 2 testing. Use of SPID Figure 6-7 flow chart was not needed because the capacities calculated for all unscreened components susceptible to high frequency were calculated as high frequency. 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 SR SFR-F3 in the ASME/ANS Standard, as well as to the requirements in the SPID. • Although some peer review findings have not been resolved, the analysis is acceptable on another justified basis.	 Yes 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 ASME/ANS 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: The Beaver Valley SPRA submittal Section 5.1.3 indicates that circuit analysis was performed to understand the impact of failure of a relay or contact device on the function of a credited SSC. When circuit analysis showed that there was no impact, then the device was screened out. The licensee did not credit operator actions in response to	

seismic induced relay failure. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): N/A	
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 Seismic Plant Response Analysis (SPR)-B6 (Addendum A) or SPR-B4 (Addendum B) in the ASME/ANS Standard, as well as to the requirements in the SPID.	Yes
• Although some peer review findings 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 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 SOV 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:

The Beaver Valley SPRA submittal indicated that the fragility of structures included in the SPRA analysis was calculated using the SOV method. Section 4.4.2.16 of the submittal explains that a fragility refinement process was used to remove conservatism for other SSCs. In this process, the CDFM approach for calculating SSC fragility using generic equipment ruggedness spectra (GERS) was first used to determine the seismic core damage frequency (SCDF) and SLERF values. For cases in which the level of risk was not acceptably low, refinements were made to the fragility analysis by:

- Creating a new component groups and selecting representative components
- Refining the seismic demand through development of computer models
- Inclusion of a ductility factor
- Performing a new fragility calculation using the separation of variables approach

Section A.10 of Appendix A and B of the submittal explains that, in practice, use of the SOV method was not needed. The NRC staff utilized the audit process to further understand the fragility refinement process that was implemented by the licensee. The licensee explained that the refinement process described in Section 4.4.2.16 of the

submittal was performed on several SSCs until an acceptable SCDF/SLERF was reached (e.g., the SCDF was less than 1E-06). The licensee explained that the EPRI SPRA Implementation Guide (EPRI 3002000709) was used to provide guidance on the non-SOV refinement options. Use of ductility factors is a way to account for the fact that many SSCs are capable of absorbing energy beyond yield without loss of function. The NRC staff notes that the EPRI SPRA Implementation Guide defines the term "ductility factor" and provides guidance on how to apply them. Likewise, the NRC staff notes that EPRI SPRA Implementation Guide provides guidance on using computer simulation to refine aspects of SPRA quantification including the combining of fragilities over increments of seismic ground motion. As for the other refinement option, the NRC staff notes that creating new component groups and enhancing the groupings is, in general, a conventional approach and an appropriate way to refine the fragility analysis. The fragilities assigned to a component group are typically bounded by the fragility of the weakest component. Therefore, refinements to the groupings, such as adding more groups, tends to decrease conservatism.

The approach taken by the licensee appears to meet the recommendations in Section 6.4.1 of the SPID in that additional SSCs have not been selected for SOV fragility analysis because doing so would not make a significant difference in the SPRA results.

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

Consequence(s): N/A

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 requirements in the SPID. No requirements in the ASME/ANS Standard specifically address this Topic.	Yes
• Although some peer review findings 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 SOV 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 SOV methodology does not meet the intent of the SPID guidance, but is acceptable on another justified basis.	N/A

TOPIC 13: Evaluation of SLERF (SPID Section 6.5.1)

The NRC staff review of the SPRA's analysis of SLERF finds an acceptable demonstration of its adequacy.	Yes
Potential Staff Findings:	
A) The analysis follows each of the elements of guidance for SLERF analysis in Section 6.5.1 of the SPID, including in Table 6-3.	Yes
B) The SLERF analysis does not follow the guidance in Table 6-3 but the analysis is acceptable on another justified basis.	NA
Notes from staff reviewer: None. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): N/A	
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 SRs SFR-F4, SPR-E1, SPR-E2, and SPR-E6 (Addendum B only) in the ASME/ANS Standard, as well as to the requirements in the SPID.	Yes
• Although some peer review findings have not been resolved, the analysis is acceptable on another justified basis.	N/A
• The licensee's analysis of SLERF meets the intent of the SPID guidance.	Yes
• The licensee's analysis of SLERF 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 SPRA's peer review findings, observations, and their resolution finds an acceptable demonstration of the peer review's adequacy. Potential Staff Findings:	Yes
A) The analysis follows each of the elements of the peer review guidance in Section 6.7 of the SPID.	Yes
B) The composition of the peer review team meets the SPID guidance.	Yes
C) The peer reviewers focusing on seismic response and fragility analysis have successfully completed the Seismic Qualifications Utility Group 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).	Yes
D) The "in process" peer-review process followed the 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 three bullets. These three 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.	N/A
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). F) The peer-review process does not follow the guidance in the SPID but is acceptable on another justified basis. G) The licensee peer-review findings were satisfactorily resolved or were determined not to be significant to the SPRA conclusions for this evaluation.	 Yes N/A Yes
Notes from staff reviewer: None. Deviation(s) or deficiency(ies) and Resolution: None. Consequence(s): N/A	
The NRC staff concludes that: • The licensee's peer-review process meets the intent of the SPID guidance. • The licensee's peer-review process does not meet the intent of the SPID guidance but is acceptable on another justified basis.	 Yes 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.	Yes
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.	No

Notes from staff reviewer:

The Beaver Valley SPRA submittal does not provide open internal event probabilistic risk assessment (IEPRA) findings, but indicates in Section A.7 that the IEPRA that may affect the SPRA model have been addressed.

The NRC staff requested clarification of this statement as part of the audit process. In a telephone call with FirstEnergy Nuclear Operating Company (FENOC, the licensee) on October 11, 2017, FENOC explained that a compilation of open IEPRA F&Os and gap assessment findings along with dispositions relevant to the version of the IEPRA model, which was used as the basis for the SPRA was previously submitted to the NRC on the docket in a letter dated February 14, 2014 (ADAMS Accession No. ML14051A499), for its National Fire Protection Association 805 licensing amendment request. The NRC staff reviewed the IEPRA finding dispositions provided in the February 14, 2015, letter and determined that the findings appeared to be resolved for the purposes of this SPRA evaluation.

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

Consequence(s): N/A

The NRC staff concludes that:	
• The licensee's documentation meets the intent of the SPID guidance. The documentation requirements in the ASME/ANS Standard can be found in HLR-SHA-J, HLR-SFR-G, and HLR-SPR-F.	Yes
• The licensee's documentation does not meet the intent of the SPID guidance but is acceptable on another justified basis.	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: The Beaver Valley SPRA submittal indicates that the mean SCDF is 1.3E-5 and 8.78E-6 per year for Units 1 and 2, respectively; the mean SLERF is 6.14E-7 and 2.66E-7 per year for Units 1 and 2, respectively. The NRC staff compared these values against the review guidance dated August 29, 2017 (ADAMS Accession No. ML17146A200), and found that the SCDF for Unit 1 exceeded the initial screening value of 1E-5 per year. Therefore, a detailed screening was performed for Unit 1 with respect to SCDF. The detailed screening, which is discussed in Enclosure 3, indicated that no further regulatory action is warranted because: • A potential cost-justified substantial safety improvement was not identified based on the estimated achievable reduction in SCDF and/or SLERF, • Additional consideration of containment performance, as described in NUREG/BR-0058 does not identify a modification that would result in a cost-justified substantial safety improvement, and • The staff did not identify a potential modification necessary for adequate protection or compliance with existing requirements. Deviation(s) or Deficiency(ies), and Resolution: None.	
The NRC staff concludes that: • The licensee identified plant modifications necessary to achieve the appropriate risk profile.	N/A

• The licensee provided a schedule to implement the modifications (if any) with appropriate consideration of plant risk and outage scheduling.	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

NEI, 2012: NEI 12-13 "External Hazards PRA Peer Review Process Guidelines," Nuclear Energy Institute, August 2012

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

AUDIT SUMMARY BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED TO BEAVER VALLEY POWER STATION, 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. MG0096 AND MG0097; EPID L-2017-JLD-0027)

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 pursuant to 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 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. (Note: Some plant-specific changes regarding whether an 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 letter issued pursuant to Title 10 CFR Part 50, Section 50.54(f). The list of applicable licensees in Enclosure 1 to the July 6, 2017, letter included FirstEnergy Nuclear Operating Company (FENOC, the licensee) as the licensee for Beaver Valley Power Station, Units 1 and 2 (Beaver Valley).

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 Beaver Valley audit took place at the NRC Headquarters in Rockville, MD, beginning on July 6, 2017. Personnel from FENOC participated remotely, via telephone and electronic reading room, from their respective offices. A list of the licensee staff, NRC staff, and contract

support personnel that participated in the audit is contained in the table below.

NRC and Contract Support Personnel		**Licensee Personnel**	
Name	Title	Name	Title
Sara Lyons	Project Manager	Kathleen Nevins	Fleet Licensing
Courtney St. Peters	Risk Analyst	K. Raymond Fine	Probabilistic Risk Assessment (PRA) Supervisor
David Heeszel	Geophysicist	Douglas Rapp	PRA Engineer
Ian Tseng	Mechanical Engineer	Robert Drsek	PRA Engineer
Bernard Grenier	Contracting Officer's Representative	Mohammed Alvi	Project Manager
Steve Short	Risk Analyst (Pacific Northwest National Laboratory)	Phil Lashley	Licensing Supervisor
Nathan Barrett	Engineer (Pacific Northwest National Laboratory)	Nish Vaidya	Consultant (Rizzo Associates)
Garill Coles	Risk Analyst (Pacific Northwest National Laboratory)	Eddie Guerra	Consultant (Rizzo Associates)
		Thomas Roche	Consultant (ABSG Consulting)

The NRC staff and the licensee participated in two clarification calls that took place on October 11, 2017, and January 31, 2018. 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. ML18024B364) were sent to the licensee in advance of the call to facilitate clear communication and to ensure that the appropriate FENOC staff were available to answer questions in various technical areas.

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

- component and structural fragilities
- how plant response for various scenarios was modeled in the SPRA
- the accuracy of calculated SPRA importance measures

The licensee's response to the questions aided in the staff's understanding of the Beaver Valley SPRA docketed submittal. After the calls, 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 no additional documentation or information was needed to supplement Beaver Valley's docketed SPRA report. The staff determined additional docketed information was not necessary because the licensee's docketed submittal, including the documentation of the licensee's SRPA review team's facts and observations classified as findings, was sufficient to support NRC's regulatory decisionmaking associated with Phase 2 of the 50.54(f) letter.

DOCUMENTS AUDITED

- ABSG Consulting Report 2734294-R-005 Revision 2, Rizzo Associates Report R7 12-4735, "Building Seismic Analysis Beaver Valley Nuclear Power Station, Unit 1, Seismic Probabilistic Risk Assessment Project," July 19, 2016.
- ABSG Consulting Report 2734294-R-005 Revision 3, Rizzo Associates Report R7 12-4735, "Building Seismic Analysis Beaver Valley Power Station, Unit 1, Seismic Probabilistic Risk Assessment Project," November 10, 2017.
- ABSG Consulting Report 2734294-R-003 Revision 5, Rizzo Associates Report R3 12-4735, "Probabilistic Seismic Hazard Analysis and Foundation Input Response Spectra, Beaver Valley Nuclear Power Station Seismic Probabilistic Risk Assessment Project," November 10, 2017.

OPEN ITEMS AND REQUEST FOR INFORMATION

Following the clarification calls, there were no open items identified by the NRC staff that required proposed closure paths and there were no requests for information discussed or planned to be issued based on the audit.

DEVIATIONS FROM AUDIT PLAN

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

AUDIT CONCLUSION

The issuance of this document, containing the staff's review of the SPRA submittal, concludes the SPRA audit process for Beaver Valley.

NRC Staff SPRA Submittal Detailed Screening Evaluation

Introduction

After concluding that the submitted Beaver Valley Power Station, Units 1 and 2 (Beaver Valley) seismic probabilistic risk assessments (SPRAs) are technically adequate for the purposes of this evaluation, the U.S. Nuclear Regulatory Commission (NRC) staff reviewed the risk and safety insights contained in the SPRA reports. The staff used the screening criteria described in the review guidance documented 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" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17146A200) to determine in which group the technical team would recommend placing Beaver Valley to the Senior Management Review Panel (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 Beaver Valley SPRA submittal indicates that the mean seismic core damage frequency (SCDF) is 1.3E-5 and 8.78E-6 per year for Units 1 and 2, respectively; the mean seismic large early release frequency (SLERF) is 6.14E-7 and 2.66E-7 per year for Units 1 and 2, respectively. The NRC staff compared these values against the review guidance and found that the SCDF for Unit 1 exceeded the initial screening value of 1E-5 per year, while the SCDF for Unit 2 and the SLERF for Units 1 and 2 were below the initial screening values. Therefore, a detailed screening evaluation was performed for Unit 1 with respect to SCDF and no further review was performed with respect to SCDF for Unit 2 and SLERF for Units 1 and 2.

Detailed Screening of Unit 1 SCDF

The detailed screening uses information provided in the SPRA submittal to establish risk reduction worth (RRW) threshold and target values that are used to identify areas where potential cost-justified and substantial improvements, respectively, may be identified. In the case of Beaver Valley, Unit 1, an RRW threshold value of 1.005 was used. This value was determined by the staff to be appropriate or conservative by estimating the associated maximum averted cost-risk (MACR) and comparing it with assumed minimum cost of $100,000 for a potential modification. The MACR data used for the severe accident mitigation alternatives (SAMA) analysis provided in NUREG-1437 Supplement 36, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 36, Regarding Beaver Valley Power Station, Units 1 and 2" (ADAMS Accession No. ML091260011) was used for this assessment.

Table 5-9 of the submittal provides the Fussell-Vesely (FV) SCDF importance measure results for significant seismically failed structures, systems, and components (SSCs) (by Fragility Group). Table 5-10 of the submittal provides the FV for significant non-seismically failed (i.e., randomly failed) SSCs (by Basic Event) in terms of SCDF. The NRC staff converted the FV importance measures to RRW importance measures. The results are provided in Table 1 for the SCDF contributors which have a RRW greater than or equal to 1.005. In addition, the licensee provided in Table 5-19 the results of a sensitivity study that shows the change-in-risk if

all Human Error Probabilities (HEPs) and Common Cause Factors (CCFs) in the PRA are set to their 95th and 5th percentile.

Table 1 of this document provides the following information by column: (1) Fragility Group or Basic Event name, (2) Description of the fragility group or basic event, (3) Failure Mode if applicable, (4) Unit 1 RRW, (5) Unit 1 maximum SCDF reduction (MCR) from completely eliminating the failure.

If all the contributors to SCDF shown in Table 1 were eliminated, the possible reduction in SCDF is less than 1E-05/year (based upon conservatively summing the MCRs for the contributors arithmetically to yield 8.8E-06/year). The staff reviewed this information using the guidance documented in NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," (ADAMS Accession No. ML042820192) and determined that a potential cost-justified substantial safety improvement was not identified based on the estimated achievable reduction in SCDF.

Conclusions

The initial and detailed screening results indicated that no further regulatory action is warranted because:

- a potential cost-justified substantial safety improvement was not identified based on the estimated achievable reduction in SCDF and/or SLERF,
- additional consideration of containment performance, as described in NUREG/BR-0058 does not identify a modification that would result in a cost-justified substantial safety improvement, and
- the staff did not identify a potential modification necessary for adequate protection or compliance with existing requirements.

Table 1 Importance Analysis Results of Top Contributors to SCDF

Fragility Group/Event	Description	Failure Mode	Unit 1	
			RRW	MCR (/rx-yr)
SSC Fragility Groups – Seismically Failed				
EQ07	Off-site Grid Transformers	Ceramic insulators	1.195	2.10E-06
EQ55	VSLOCA	Pipe/vessel breaks	1.116	1.34E-06
EQ14	PPDWST (WT-TK-10)	Anchor bolt chair	1.085	1.01E-06
EQ13	RWST (QS-TK-1)	Tank shell rupture near anchor bolt chairs at base	1.067	8.13E-07
EQ08	4KV-480V-XMFR	Excess sliding displacement of coils within housing	1.060	7.35E-07
EQ37	All River Water Pumps	Anchor bolt shear tension interaction	1.054	6.58E-07
EQ81	Block Walls in SRVD	Structural failure	1.032	4.00E-07
EQ57	Recirculation Spray HX 1B&1D	Concrete breakout anchor bolt	1.029	3.61E-07
EQ96	Turbine Building	Gap between Turbine and Service Buildings	1.029	3.61E-07
EQ111	Unit 2 DWST	Tank overturning	1.019	2.45E-07
EQ113	Intake Structure Contactors	Contactor chatter	1.010	1.29E-07
EQ43	Fuel Oil Tanks TK-1A/1B	Tank shell rupture near nozzle	1.010	1.29E-07
EQ102	MCC-1E10	Interaction with adjacent concrete wall	1.007	9.03E-08
EQ79	EDG Air Start Receivers	Tank sliding	1.007	9.03E-08
EQ56	Small LOCA	Pipe/vessel breaks	1.006	7.74E-08
EQ97	PZR PORV Pressure Reducing Valves	Shaft Binding	1.005	6.45E-08
TOTAL				8.8E-06
Randomly failed SSCs				
Basic Event				
BV-1EE-EG-1	EDG No. 1	N/A	1.027	3.35E-07
BV-LS-1EE-201-1	EE-EG-1 Day Tank Level (Pump Control) Level switch	N/A	1.019	2.45E-07
BV-PNL-DG-SEQ-1	EDG Automatic Sequence Relay Panel	N/A	1.005	6.45E-08
BV-1VS-F-22A	EDG Building Direct Drive Fan	N/A	1.002	2.58E-08
Human Failure Events and Common Cause Failures				
HRA	HFEs 5th Percentile		1.039	5.07E-07
HRA	HFEs 95th Percentile			increase
CCF	CCFs 5th Percentile		1.002	1.94E-08
CCF	CCFs 95th Percentile			increase

SUBJECT: BEAVER VALLEY POWER STATION, 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. MG0096 AND MG0097; EPID L-2017-JLD-0027) DATED JUNE 6, 2018

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OFFICE	NRR/DRA/APLB/PM	NRR/DLP/PBMB/LA	OGC (NLO)	NRR/DLP/PBMB/BC
NAME	SLyons	SLent	MYoung	EBowman
DATE	4/2/18	4/2/18	5/1/18	5/2/18
OFFICE	NRR/DORL/D	NRR/DRA/D	NRR/DLP/D	
NAME	JGiitter	MFranovich	LLund	
DATE	5/30/18	5/29/18	6/6/18	

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