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

January 30, 2018

Mr. William R. Gideon
Site Vice President
Brunswick Steam Electric Plant
8470 River Rd. SE (M/C BNP001)
Southport, NC 28461

SUBJECT: BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2 – STAFF REVIEW OF MITIGATING STRATEGIES ASSESSMENT REPORT OF THE IMPACT OF THE REEVALUATED SEISMIC HAZARD DEVELOPED IN RESPONSE TO THE MARCH 12, 2012, 50.54(f) LETTER (CAC NOS. MF7807 AND MF7808; EPID L-2016-JLD-0006)

Dear Mr. Gideon:

The purpose of this letter is to provide the U.S. Nuclear Regulatory Commission's (NRC) assessment of the seismic hazard mitigating strategies assessment (MSA), as described in the August 17, 2017, letter (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17229B504), submitted by Duke Energy Progress, LLC (Duke, the licensee) for Brunswick Steam Electric Plant, Units 1 and 2 (Brunswick). The NRC staff evaluated the Brunswick strategies developed under Order EA-12-049 and described in Duke's Final Integrated Plan (FIP) for Brunswick (ADAMS Accession No. ML16146A604). The staff's review of Brunswick's mitigating strategies was documented in a safety evaluation dated December 14, 2016 (ADAMS Accession No. ML16335A031). The purpose of the safety evaluation is to ensure that the licensee has developed guidance and proposed designs which, if implemented appropriately, should adequately address the requirements of Order EA-12-049. An inspection will confirm compliance with the order and is currently scheduled for the week of January 29, 2018. The following NRC staff review confirms that the licensee has adequately addressed the reevaluated seismic hazard within Brunswick's mitigation strategies for beyond-design-basis external events.

BACKGROUND

By letter dated March 12, 2012 (ADAMS Accession No. ML12053A340), the 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). The 50.54(f) letter 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 the seismic hazard using present-day methodologies and guidance.

Concurrent with the reevaluation of seismic hazards, the NRC issued Order EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML12054A736). The order requires holders of operating power reactor licenses and construction permits issued under 10 CFR Part 50 to develop, implement, and maintain guidance and strategies to maintain or restore

core cooling, containment, and spent fuel pool cooling following a beyond-design-basis external event. In order to proceed with the implementation of Order EA-12-049, licensees used the current design basis flood and seismic hazard or the most recent flood and seismic hazard information, which may not be based on present-day methodologies and guidance, in developing their mitigation strategies.

On December 10, 2015 (ADAMS Accession No. ML16005A621), the Nuclear Energy Institute (NEI) submitted Revision 2 to NEI 12-06, including guidance for conducting MSAs using the reevaluated hazard information. The NRC subsequently endorsed NEI 12-06, Revision 2, with exceptions, clarifications, and additions, in Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-01, Revision 1, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML15357A163).

MITIGATION STRATEGIES ASSESSMENT

By letter dated March 1, 2016 (ADAMS Accession No. ML16041A435), the NRC staff documented its review of the licensee's reevaluated seismic hazard, also referred to as the mitigation strategies seismic hazard information (MSSHI). The NRC staff concluded that the licensee demonstrated that the Individual Plant Examination of External Events High Confidence of Low Probability of Failure Spectrum (IHS) could be used for comparison with the GMRS for the screening decision. The staff found that a portion of the Brunswick Ground Motion Response Spectrum (GMRS) above 10 Hertz (Hz) exceeds both the IHS and Safe Shutdown Earthquake (SSE), meriting a high frequency (HF) confirmation. Furthermore, because the GMRS exceeds the SSE between 1 and 10 Hz, Brunswick screens in to perform a spent fuel pool (SFP) evaluation. In addition, the staff concluded that the GMRS determined by the licensee adequately characterizes the reevaluated seismic hazard for the Brunswick site.

By letters dated December 15, 2015 (ADAMS Accession Nos. ML16365A023 and ML16365A024, respectively), Duke stated that they completed the relay chatter review and submitted a HF confirmation report for Brunswick. By letter dated April 20, 2017 (ADAMS Accession No. ML17107A277), the NRC staff concluded, based on its review, that the licensee correctly implemented the guidance in conducting the HF confirmation for Brunswick.

By letter dated August 10, 2017 (ADAMS Accession No. ML17233A167), Duke submitted the seismic MSA report for Brunswick. The licensee stated that the Brunswick MSA was performed consistent with Appendix H of NEI 12-06, Revision 2, which describes acceptable methods for demonstrating that the reevaluated seismic hazard is addressed within the Brunswick mitigation strategies for beyond-design-basis external events. Guidance document NEI 12-06, Revision 2 was endorsed by NRC staff document JLD-ISG-2012-01, Revision 1. Therefore, the methodology used by the licensee is acceptable to perform an assessment of the mitigation strategies that addresses the reevaluated seismic hazard.

The NRC staff found that Duke's Path 4 approach for Brunswick is not consistent with the guidance. Duke's use of NEI guidance document, "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), Section 3.2.1.2 for narrow band exceedance does not comport with the intent of that section to be used only where the GMRS exceeds the SSE in narrow frequency bands. The Brunswick GMRS exceeds the SSE for all frequencies above 7 Hz.

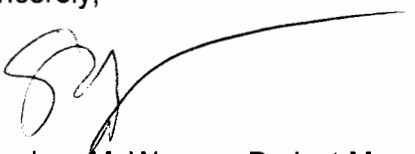
Regarding the appropriate MSA path for Brunswick, industry guidance NEI 12-06, Revision 2, Section H.4.4 states that licensees who determine that a plant GMRS described in Section H.2 has spectral ordinates greater than the SSE, but no more than 2 times the SSE anywhere in the 1 to 10 Hz frequency range may use Path 4. No exceptions are stated in the NEI 12-06 guidance. However, the NRC staff found that the alternative guidance in NEI 12-06 Revision 4 Section H.4.5.2 "Deterministic Assessment", using Path 5 was applicable. Given that the guidance in H.4.4 and H.4.5.2 are consistent, the NRC staff used Section H.4.5.2 provisions in its review.

The NRC staff performed a checklist review of the seismic hazard MSA for Brunswick using the alternative guidance in NEI 12-06 Revision 4 Section H.4.5.2. The checklist is provided as an enclosure to this letter. The NRC staff found that Brunswick met the intent of the guidance. The staff did not identify any deficiencies using the Path 5 approach. All evaluated components demonstrated adequate seismic capacity and no component modifications were required.

The NRC staff completed its review of the seismic hazard MSA for Brunswick and concluded that sufficient information has been provided to demonstrate that the licensee's plans for the development and implementation of guidance and strategies under Order EA-12-049 appropriately address the reevaluated seismic hazard information stemming from the 50.54(f) letter.

If you have any questions, please contact me at (301) 415-3041 or via e-mail at Stephen.Wyman@nrc.gov.

Sincerely,



Stephen M. Wyman, Project Manager
Beyond-Design-Basis Engineering Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket Nos. 50-325 and 50-324

Enclosure:
Technical Review Checklist

cc w/encl: Distribution via Listserv

TECHNICAL REVIEW CHECKLIST
BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO PATH FOUR MITIGATING STRATEGY ASSESSMENT
BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2
DOCKET NOS. 50-325 AND 50-324

The NRC staff performed the following checklist review based on the Enclosure of the August 17, 2017, letter (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17229B504) for Brunswick Steam Electric Plant, Units 1 and 2 (Brunswick). Deviations, deficiencies, and conclusions are noted at the end of each section and an overall conclusion is provided at the end of the checklist.

I. Background and Assessment to Mitigation Strategies Seismic Hazard Information (MSSHI)

This section establishes basic background and assessment to MSSHI criteria in Nuclear Energy Institute (NEI) 12-06, Appendix H.	
Licensee approach to mitigating strategies assessment (MSA):	
Was the MSA conducted in accordance with NEI 12-06, Revision 2 as endorsed by the staff?	~~Yes~~ / No
Was the MSA conducted using an alternate method?	Yes / ~~No~~
Status of Order EA-12-049 Flexible Mitigation Strategy at the time of this review:	
Has the licensee submitted a Final Integrated Plan?	Yes / ~~No~~
Has the NRC staff completed a safety evaluation for the mitigation strategy?	Yes / ~~No~~
Has the NRC staff confirmed compliance with Order EA-12-049 by successfully completing the temporary instruction (TI)-191 inspection?	~~Yes~~ / No
Status of MSSHI	
Did the licensee use the Ground Motion Response Spectra (GMRS) and Uniform Hazard Response Spectra (UHRS) as submitted in response to the 50.54(f) request for information and reviewed by the NRC staff?	Yes / ~~No~~

Has the plant equipment relied on for FLEX strategies previously been evaluated as seismically robust to the plant safe shutdown earthquake (SSE) levels?	Yes / ~~No / NA~~
Is the maximum ratio of GMRS/SSE in the range of 1-10 Hertz (Hz) less than 2?	~~Yes~~ / No
Did the licensee meet the seismic evaluation criteria described in NEI 12-06, Section H.5?	Yes / ~~No~~
Notes from staff reviewer: The GMRS/SSE ratio is approximately 2.19 at 10 Hz. Path 4 is limited to less than 2 times SSE. The narrow band argument suggested by Duke is not applicable for the MSA. Alternative guidance in NEI 12-06, Rev 4, Section H.4.5.2 (Path 5 deterministic assessment) is applicable and consistent with Path 4 when evaluated to the GMRS. Deviation(s) or deficiency(ies) and Resolution: Licensee performed assessment under NEI 12-06 Rev 2 using Path 4. The NRC staff found that following the provisions of Path 5 of NEI 12-06, Revision 4, with the exceptions, clarifications, and additions contained in JLD-ISG-2012-01, Revision 2, is an acceptable alternative to NEI 12-06, Revision 2 at Brunswick. The NRC staff reviewed using alternative guidance in NEI 12-06, Rev 4, Section H.4.5.2. Consequence(s): None	
The NRC staff concludes: • The licensee meets the background and assessment to MSSHI criteria in NEI 12-06, Appendix H.	Yes / ~~No~~

II. Expedited Seismic Evaluation Process (ESEP) Equipment

Equipment used in support of the FLEX strategies has been evaluated to demonstrate seismic adequacy following the guidance in Section 5 of NEI 12-06. As stated in Appendix H of NEI 12-06, previous seismic evaluations should be credited to the extent that they apply for the assessment of the MSSHI, including the ESEP evaluations performed in accordance with EPRI Report 3002000704. "Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic." (ADAMS Accession No. ML13102A142)	

Licensees may reference a previous ESEP submittal, submit a new or updated ESEP report, or provide other adequate justification or evaluation.	
Did the licensee previously perform an ESEP?	Yes / ~~No~~
Did the licensee provide a new or updated ESEP report with the MSA?	~~Yes~~ / No
If the licensee did not perform ESEP, did they provide adequate justification that the expedited seismic equipment list structures, systems, and components (SSCs) are acceptable in accordance with the original guidance and in accordance with NEI 12-06 Section H.5 $C_{10\%}$ capacity criteria?	~~Yes / No~~ / NA
If the licensee did not perform the ESEP, did they perform an evaluation consistent with the guidance in NEI 12-06, Section H.4.4, Steps 2 and 3, including the evaluation of FLEX components that were not previously evaluated to GMRS or 2 times the SSE?	~~Yes / No~~ / NA

Notes from staff reviewer: FLEX items previously evaluated in the Brunswick ESEP had HCLPF capacities evaluated to 2 x SSE. However, the NRC found that the NEI 12-06 Section H.5 $C_{10\%}$ capacity of those SSCs safely exceeds the Brunswick GMRS demand based on the most conservative realistic lower bound case $C_{10\%}$ / $C_{1\%}$ ratio of 1.36. $C_{10\%}$ Capacity = 2xSSE x 1.36 = 2.72xSSE compared to demand GMRS/$SSE_{MAX\ 1\text{-}10Hz}$ = 2.19. The licensee stated that FLEX items not included in the ESEP were evaluated for the Brunswick MSSHI. The licensee performed an analysis in accordance with NEI 12-06 Section H.5 and concluded that these items have adequate capacity.

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

Consequence(s): None

The NRC staff concludes: • The licensee has evaluated seismic adequacy of equipment used in support of FLEX strategy consistent with the NEI 12-06, Appendix H guidance.	Yes / ~~No~~

III. Inherently / Sufficiently Rugged Equipment

Appendix H, Section 4.4 of NEI 12-06, Revision 2 documents the process and justification for inherently and sufficiently rugged SSCs. The licensee: Documented the inherently and sufficiently rugged SSCs consistent with the NEI 12-06 Appendix H guidance.	Yes / ~~No~~
Notes from staff reviewer: The process to identify inherently rugged items is documented in Section 2.3 of the Brunswick MSA report dated August 17, 2017. The licensee stated that a qualitative assessment was available for audit in Stevenson & Associates Report 16C4425-RPT-002 Rev 0. Deviation(s) or deficiency(ies) and Resolution: None Consequence(s): None	
The NRC staff concludes: • The licensee's assessment of inherently and sufficiently rugged SSCs met the intent of the NEI 12-06, Appendix H guidance.	Yes / ~~No~~

IV. Evaluation of Components Not Covered by ESEP

The ESEP specifically excluded the evaluation of certain components of the FLEX strategy in an effort to provide stakeholders with near-term confidence in a plant's seismic capacity. However, licensees will be required to complete those evaluations as part of the Path 5 Deterministic Assessment MSA to demonstrate compliance with the impending rule. Were the following components, not evaluated in the ESEP, evaluated as part of the MSA? :	
• FLEX Storage Building	Yes / ~~No~~
• Non-seismic CAT I structures	Yes / ~~No / NA~~
• Operator Pathways credited in FLEX strategy	Yes / ~~No~~

• Tie down of FLEX portable equipment	Yes / ~~No~~
• Seismic interactions	
o Masonry block wall	Yes / ~~No~~
o Piping attached to tanks	Yes / ~~No~~
o Flooding from non-seismically robust tanks	Yes / ~~No~~
o Distributed systems (Piping/conduit/raceways/cable trays)	Yes / ~~No~~
o Other potential areas of interaction	Yes / ~~No~~
• FLEX equipment haul paths	Yes / ~~No~~
• Other equipment (list in Staff Reviewer Notes)	~~Yes / No /~~ NA
Did the licensee provide adequate description/documentation of the evaluation?	Yes / ~~No~~

Notes from staff reviewer: The licensee stated no piping attached to buried tanks exist within the FLEX strategy. The staff also reviewed referenced documents 16C4425-RPT-002, 16C4425-RPT-003, 16C4425-CAL-001 and 16C4425-CAL-002 from Stevenson & Associates to confirm the MSA submittal statements regarding FLEX buildings and block wall seismic capacity in Section 2.4 of the Brunswick MSA Report.

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

Consequence(s): None

The NRC staff concludes:	
• The licensee followed the NEI 12-06, Appendix H guidance in evaluating SSCs not deemed inherently rugged.	Yes / ~~No~~

V. Spent Fuel Pool (SFP) Cooling

Per NEI 12-06, Appendix H, Section 4.4, licensees need to evaluate the adequacy of SFP cooling equipment to the GMRS. Most plants include the Order EA-12-051 SFP Level Instrument as part of the strategy.	
The licensee:	
• Clearly identified the SSCs and locations of the equipment that is part of the final FLEX SFP cooling strategy.	Yes / ~~No~~

• Clearly stated the seismic design basis (e.g. SSE) of the equipment used in the strategy. • Provided adequate description or documentation of the SFP cooling equipment's evaluation to the GMRS. Portable equipment and flexible hoses do not need to be evaluated.	Yes / ~~No~~ Yes / ~~No~~
Notes from staff reviewer: The NRC staff confirmed that the SFP cooling equipment described in the licensee's FIP was reevaluated to the GMRS as documented in Stevenson & Associates Report 16C4425-RPT-002 and NRC letter dated February 2, 2017 (ADAMS Accession No. ML17031A001). Deviation(s) or deficiency(ies) and Resolution: None Consequence(s): None	
The NRC staff concludes: • The licensee followed the NEI 12-06, Appendix H guidance in evaluating SFP cooling.	Yes / ~~No~~

VI. High Frequency (HF)

Per NEI 12-06, Appendix H, Section 4.4, licensees with GMRS exceedance of the SSE above 10 Hz need to evaluate bi-stable components such as relays using the methodology described in NEI 12-06, Section H.4.2. The HF evaluation may have been submitted under separate letter or may be sent as an attachment to the MSA Report. The staff review checklist is included as an attachment to this report.	
The licensee: • GMRS exceeds the SSE above 10 Hz.	Yes / ~~No~~
• Provided a HF evaluation as described in NEI 12-06, Section H.4.2.	Yes / ~~No / NA~~
• Appeared to follow the guidance for the HF evaluation.	Yes / ~~No / NA~~
• Provided results of demand vs. capacity with identification of resolutions as needed.	~~Yes /~~ ~~No /~~ NA

Notes from staff reviewer: The selection process for high frequency evaluation is described in detail in Stevenson & Associates Report 16C4425-RPT-005. The NRC staff confirmed that no FLEX related components were identified for HF evaluation. No modifications were required. The staff notes that it did not complete a full HF checklist review because the licensee did not identify any components for evaluation. Deviation(s) or deficiency(ies) and Resolution: None Consequence(s): None	
The NRC staff concludes: • The licensee's component capacity evaluation met the intent of the HF guidance.	Yes / ~~No~~

VII. Conclusions:

The NRC staff assessed the licensee's implementation of the MSA guidance for Brunswick. Based on its review, the NRC staff concludes that the licensee's implementation of the MSA meets the intent of the guidance. The staff concludes that through the implementation of the MSA guidance, the licensee identified and evaluated the seismic capacity of the mitigating strategies equipment to ensure functionality will be maintained following a seismic event up to the GMRS. As noted in the review checklist, the staff identified one deviation and no exceptions taken from the guidance and the licensee did not identify any necessary equipment modifications or changes to the strategy.

In summary, the NRC staff has reviewed the seismic hazard MSA for Brunswick. The NRC staff concludes that sufficient information has been provided to demonstrate that the licensee's plans for the development and implementation of guidance and strategies under Order EA-12-049 appropriately address the reevaluated seismic hazard information stemming from the 50.54(f) letter.

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