

## **NRR-DMPSPEm Resource**

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**From:** Poole, Justin  
**Sent:** Tuesday, May 1, 2018 1:35 PM  
**To:** Browne, Kenneth  
**Cc:** Thomas, Christine; Danna, James; Wittick, Brian; Oesterle, Eric  
**Subject:** Request for Additional Information Regarding ASR Amendment Request  
**Attachments:** MF8260 Followup RAIs.pdf

Ken

By letter dated August 1, 2016, as supplemented by letters dated September 30, 2016; October 3, 2017; and December 11, 2017, NextEra Energy Seabrook, LLC (NextEra) submitted a license amendment request for Seabrook Station, Unit No. 1. The proposed amendment would revise the current licensing basis to adopt a methodology for the analysis of seismic category I structures with concrete affected by alkali-silica reaction. In reviewing NextEra's application, the NRC staff had developed a DRAFT request for additional information (RAI).

On April 18, 2018, the NRC staff sent NextEra the DRAFT RAIs to ensure that the questions are understandable, the regulatory basis is clear, there is no proprietary information contained in the RAI, and to determine if the information was previously docketed. On May 1, 2018, the NRC and NextEra held a clarifying call where some minor editorial changes were made to provide clarity to the questions. The attached contains the final version of the RAIs. During the call NextEra requested a response date of June 1, 2018. The NRC staff informed NextEra that this date is acceptable. These RAIs will be put in ADAMS as a publicly available document.

*Justin C. Poole  
Project Manager  
NRR/DORL/LPL I  
U.S. Nuclear Regulatory Commission  
(301)415-2048*

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**From:** Poole, Justin

**Created By:** Justin.Poole@nrc.gov

**Recipients:**

"Thomas, Christine" <Christine.Thomas@nexteraenergy.com>  
Tracking Status: None  
"Danna, James" <James.Danna@nrc.gov>  
Tracking Status: None  
"Wittick, Brian" <Brian.Wittick@nrc.gov>  
Tracking Status: None  
"Oesterle, Eric" <Eric.Oesterle@nrc.gov>  
Tracking Status: None  
"Browne, Kenneth" <Kenneth.J.Browne@nexteraenergy.com>  
Tracking Status: None

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**REQUEST FOR ADDITIONAL INFORMATION (RAI)**  
**REGARDING LICENSE AMENDMENT REQUEST (LAR) 16-03 TO REVISE CURRENT**  
**LICENSING BASIS TO ADOPT A METHODOLOGY FOR THE ANALYSIS OF SEISMIC**  
**CATEGORY I STRUCTURES WITH CONCRETE AFFECTED BY**  
**ALKALI-SILICA REACTION,**  
**NEXTERA ENERGY SEABROOK, LLC,**  
**SEABROOK STATION**  
**DOCKET NO. 50-443**

**References:**

1. Letter SBK-L-16071, dated August 1, 2016, from Ralph A. Dodds III, NextEra Energy Seabrook to USNRC regarding the Request to Adopt a Methodology for Analysis of Seismic Category I Structures with Concrete Affected by Alkali-Silica Reaction (ADAMS Accession No. ML16216A240).
2. Letter SBK-L-17156, dated October 3, 2017, from Eric McCartney, NextEra Energy Seabrook to USNRC regarding the Response to Request for Additional Information Regarding License Amendment Request 16-03 Related to Alkali-Silica Reaction (CAC MF8260) (ADAMS Accession No. ML17277A337).
3. Letter SBK-L-17204, dated December 11, 2017, from Eric McCartney, NextEra Energy Seabrook to USNRC regarding the Response to Request for Additional Information Regarding License Amendment Request Related to Alkali-Silica Reaction (CAC MF8260; EPID L-2016-LLA-0007) (ADAMS Accession No. ML17345A641).

**Regulatory Requirement**

The regulatory requirements below apply generically to all RAIs. Additional regulatory requirements specific to an RAI are stated in the Background Section of the RAI.

Section 3.1 of the Seabrook Station UFSAR discusses how the principal design features for plant structures, systems and components important to safety meet the NRC General Design Criteria (GDC) for Nuclear Power Plants, specified in Appendix A to 10 CFR Part 50 and identifies any exceptions that are taken. This section indicates, in part, that the principal design features for Seabrook structures did include, among others, meeting the requirements of General Design Criteria (GDC) 1, 2 and 4 of 10 CFR 50, Appendix A.

10 CFR Part 50, Appendix A, GDC 1, Quality Standards and Records, requires, in part, structures be designed and tested to quality standards commensurate with the importance of the safety functions to be performed. Where generally recognized codes and standards are used, they shall be evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified as necessary to assure a quality product in keeping with the required safety function. Based on the LAR and UFSAR Section 3.8, the Seabrook seismic Category I concrete structures, other than containment, were designed in accordance with ACI 318-71, while the containment was designed in accordance with ASME Section III, Division 2, 1975 Edition.

10 CFR Part 50, Appendix B, Criterion III "Design Control" requires, in part, that the design control measures shall assure that applicable regulatory requirements and the design basis, as defined in 10 CFR 50.2 and as specified in the license application, for applicable structures are correctly translated into specifications, drawings, procedures and instructions. These measures shall include provisions to assure that appropriate quality standards are specified and included in design documents and that deviations from such standards are controlled. Design changes,

including field changes, shall be subject to design control measures commensurate with those applied to the original design.

### **RAI-D10 (Follow-up to RAI-D2)**

#### **Background**

Supplement 4 in the response to RAI-D2 (Reference 3), and Section 5.6 of the Methodology Document, states, “the ratio of cracked over uncracked moment of inertia for flexural behavior can be calculated using ACI 318-71 equation 9-4 or it is acceptable to define the cracked moment of inertia as 50% of the gross moment of inertia.” In the basis for Supplement 4, the licensee states that the ratio of cracked to uncracked (gross) moment of inertia of 0.5 is consistent with the provisions of ACI 318-14 Section 6.6.3.1.2, ASCE 43-05 Table 3-1, and ASCE 4-16 Table 3-2. The staff notes that these cited document sources did not consider ASR-affected concrete. Supplement 5 states, “axial and shear cracking reduces the corresponding stiffness of a structural member. The effect of cracking on reducing the axial and shear stiffness of structural components may be considered in analysis.”

Section 4.4.5 and Appendix A of the Methodology Document describe equations for calculating reduced flexural rigidity, axial rigidity and shear rigidity, respectively, based on (1) effective moment of inertia ( $I_e$ ) using ACI 318-71 equation 9-4 and the cracking moment ( $M_{cr}$ ) using the ACI 318-71 code equations 9-4 and 9-5 with modulus of rupture  $f_r = 7.5\sqrt{f'_c}$ ; (2) the cracking strain  $\epsilon_{cr} = f_t/E_c$ , where  $f_t = 5\sqrt{f'_c}$ , and (3) shear strain using Reference A6 therein; all of which are from sources that do not consider ASR-affected concrete.

#### **Issue**

Reports MPR-4288 and MPR-4273 (Enclosures 5 and 6 of the August 2016 LAR submittal) describe the plant-specific MPR/FSEL Large Scale Test Program (LSTP). The Reinforcement Anchorage Test Program and the Shear Test Program of the LSTP described in Reports MPR-4273 (Section 5.2 and 5.3) and MPR-4288 generated experimental data that provides insights on stiffness (flexural and shear) of ASR-affected test specimens. The results of the LSTP appear to indicate that the stiffness of ASR-affected test specimens is higher than the control specimen and show an increasing trend in stiffness and a delay in the onset of flexural cracking, with an increasing level of ASR-expansion. This behavior is attributed to the ASR-induced prestress effect in the test specimens.

Section 6.3.5 “ASR Effects on Flexural Stiffness” of Report MPR-4288 states, in part: “Results from the tests of ASR-affected specimens demonstrated that the flexural rigidity increases with the severity of ASR. The increased rigidity could be viewed as an improvement for the seismic response.” Section 5.3.4 of Report MPR-4273 states, in part: “Figure 5-10 shows that the stiffness in ASR-affected test specimens is clearly greater than the control specimen and there is an increasing trend with respect to through-thickness expansion.” Figures 5-5 and 5-7 of the report also provide insights on shear stiffness and flexural stiffness in ASR-affected test specimens.

It appears that results and data from the LSTP was not considered in the proposed procedure for developing cracked section properties in the method of evaluation of Seabrook ASR-affected structures. No technical justification is provided for the applicability and validity of supplements 4 and 5 for ASR-affected concrete. The ‘internal prestressing’ effect noted in the LSTP would result in the observed increase in stiffness (flexural, shear) and delay in the onset of flexural

cracking. This is considered in the procedure when developing the ASR load (demand),  $S_a$ , in the proposed method of evaluation for ASR-affected concrete; however, it appears that there has been no consideration of the ASR prestressing effect in the proposed procedure for determining reduction in axial, shear and/or flexural rigidity (stiffness) for implementing cracked section properties.

### **Request:**

With regard to ASR effects on stiffness and the implementation of cracked section properties, explain how the relevant experimental data obtained on LSTP specimens are considered in the procedure in the Methodology Document (Section 4.4.5 and Appendix A, and supplements 4 and 5 in Section 5.6) for determining reduced stiffness (flexural, shear, and axial) in implementing cracked section properties. Explain whether and how the ASR prestressing effect is applied to the calculation of cracking moment, cracking strain, and shear strain for ASR-affected members, and provide supporting technical basis.

### **RAI-D11 (Follow-up to RAI-D8)**

#### **Background**

- 1) 10 CFR Part 50.9, "Completeness and accuracy of information," requires, in part, that "information provided to the Commission by an applicant for a license or by a licensee ... shall be complete and accurate in all material aspects." Calculation results submitted in support of the RAI-D8 response (Tables 1 and 2 of Attachment 2 of Reference 3) included footnotes stating "preliminary results, may change during checking and approval," and "calculation pending final review."
- 2) Parametric Study 1, in response to RAI-D8 (Reference 3), in part concludes, "stresses and strains in steel rebar are less than the elastic limits at service load conditions, provided that ASR strain is less than 2 mm/m." The staff notes that this is consistent with the approximate strain level at which rebar is expected to yield (i.e.,  $f_y/E_s = 60 \text{ ksi}/29000 \text{ ksi} = 0.0021 \text{ mm/mm}$  or 2.1 mm/m). ASR in-plane expansion exceeding this magnitude could be indicative of rebar yielding or slip due to loss of bond between concrete and steel reinforcement. Potential yielding or slip of the reinforcement could be indicative of marked change in behavioral response of a structure, could impact structural capacity, or could render assumptions of linear elastic behavior in the structural analyses incorrect (including UFSAR Section 3.7 seismic analysis).

#### **Issue**

- 1) It is not clear that the calculations submitted in support of RAI-D8 are finalized and thus are "complete and accurate in all material aspects."
- 2) ASR in-plane expansion could increase with ASR progression under service conditions, and based on field monitoring, a structure may enter or include ASR Severity Zone 4 (CI greater than 2 mm/m). There is no criteria or upper limit of in-plane expansion in the method of evaluation that would trigger an action for evaluation of the implications of potential rebar yielding or slip under service conditions if field monitoring indicates a structure has entered Severity Zone 4. It is not clear if and how a structure will be evaluated for rebar yielding or slip if field monitoring data indicates a structure is in ASR Severity Zone 4.

## **Request**

- 1) Confirm that the information provided in support of RAI-D8 is complete, final and accurate, or provide a finalized version of the supporting information.
- 2) Explain how a structure will be evaluated in the proposed method of evaluation for the implications of rebar yielding or slip under service conditions (as discussed in the background) if field monitoring data indicates a structure has entered, or includes, ASR Severity Zone 4 (CI greater than 2 mm/m) or provide a technical justification if no evaluation is planned.

## **RAI-D12**

### **Background**

Supplement 3 in the response to RAI-D2 (Reference 3) and Section 5.6 of the Methodology Document state, “the shear-friction capacity for members subjected to net compression can be calculated using procedures defined in Building Code Requirements for Structural Concrete (ACI 318-83 Section 11.7.7).”

With regard to use of portions of subsequent code editions or addenda, as a regulatory example, 10 CFR 50.55a(g)(4)(iv) requires that portions of editions or addenda may be used, provided all related requirements of the respective editions or addenda are met.

### **Issue**

Code subsections often include caveats or related requirements that may impact other subsections within the same broader section. The technical basis for Supplement 3 compares ACI 318-83 Section 11.7.7 to the equivalent requirement in ACI 318-71 (Section 11.15); however, the basis does not address other portions of Section 11.7 or explain why Section 11.7 does not need to be used in its entirety.

### **Request**

Provide a technical justification for the use of Section 11.7.7 that addresses why additional related requirements in 11.7 do not need to be included in Supplement 3, or update Supplement 3 to reference ACI 318-83 Section 11.7 in its entirety.

## **RAI-D13**

### **Background**

During a site audit the week of March 19, 2018, the staff reviewed calculation SGH 170443-CA-01, Rev. 0 (Seabrook FP# 101166), which implements the guidance in the “Methodology Document” (MD) for a portion of the Electric Tunnel structure. The calculation determined that the structure (embedded wall against concrete backfill with no field observed signs of distress) is adequate for operability; however, when applying the procedure outlined in the MD to account for potential ASR expansion effects of concrete backfill in areas with no observed signs of ASR

distress, the structure will not meet the ACI 318-71 code requirements. It appears either the structure needs to be modified to meet code requirements, or the MD needs to be revised to address cases with structures against concrete backfill that show no signs of distress.

### **Issue**

It is unclear from reviewing the calculation if this will result in a change to the proposed method of evaluation related to structures against concrete backfill. It is also unclear if this situation is unique to the Electric Tunnel structure, or if other calculations concluded that the associated structures did not meet code requirements when analyzed with the proposed methodology to account for potential ASR expansion of concrete backfill for embedded structure segments with no observed signs of distress.

### **Request**

Explain if the results of this calculation will result in a revision to the MD. If the MD will be revised, provide the revision with an explanation of the technical basis of the changes. Also, explain whether applicability of the revised proposed methodology is specific to the electrical tunnel structure, or whether it is generically applicable to any structure with embedded walls against concrete backfill with no observed signs of distress.

### **RAI-D14**

#### **Background**

10 CFR Part 50.34(b), "Final safety analysis report," describes what a licensee must include in a final safety analysis report. This includes "a description and analysis of the structures, systems and components of the facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which such requirements have been established, and the evaluations required to show that safety function will be accomplished."

10 CFR Part 50.71(e), "Maintenance of records, making of reports," requires, in part, that licensees shall submit updates to the final safety analysis report (FSAR) to include "all the changes necessary to reflect information and analyses submitted to the Commission by the applicant or licensee ... since the last update to the FSAR."

- 1) The response to RAI-M2, Request 1, and RAI-M3, including Appendix B of the response (Reference 2), summarizes (i) corroboration studies of the correlation methodology in MPR-4153, and (ii) periodic assessment of ASR expansion behavior that will be conducted in the future to confirm that ASR expansion behavior in Seabrook structures is similar to that observed in the MPR/FSEL LSTP specimens.
- 2) The response to RAI-D2 (Reference 3) references a Methodology Document that defines the analysis and evaluation procedures for the analysis described in the original LAR. Sections 3.1, 4.2, 4.3 and 4.4 of the Methodology Document describe how the proposed ASR load is developed and Section 5.6 of identifies five 'supplements,' which are described as "deviations to the codes of record."

### **Issue**

- 1) Verifying similar ASR expansion behavior between the MPR/FSEL LSTP specimens and Seabrook structures is part of the technical justification for the expansion limits and acceptance criteria developed in the MPR/FSEL LSTP. The future actions associated with the corroboration study and the periodic assessment of ASR behavior appear to be key aspects of this justification; however, these supporting actions are not described in the FSAR update markup for the LAR.
- 2) The codes of record, and any supplements or deviations, explain how structures are analyzed and how their safety functions will be accomplished and form an important part of the changes to the method of evaluation described in the FSAR; however, the development of the proposed ASR load and the 'supplements' to the Seabrook code of record are not described in the FSAR update markup for the LAR.

### **Request**

- 1) Provide an UFSAR markup that includes a summary description of the proposed corroboration study and the periodic behavior assessment, including timeline, or explain why it is unnecessary to identify these items in the UFSAR as part of the proposed method of evaluation.
- 2) Provide an UFSAR markup that includes a summary description of how the ASR load, including the load due to expansion of concrete backfill, is determined and a complete description of the code 'supplements' identified in response to RAI-D2. Alternatively, explain why it is unnecessary to explain how this Seabrook unique load is developed and to identify the code deviations in the UFSAR as part of the proposed method of evaluation.