NRR-PMDAPEm Resource

From: Poole, Justin
Sent: Friday, May 05, 2017 9:40 AM
To: Browne, Kenneth
Subject: DRAFT - Request for Additional Information Regarding ASR Amendment Request
Attachments: DRAFT - MF8260 RAIs.pdf

Ken,

By letter dated August 1, 2016, as supplemented by letter dated September 30, 2016, 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 has developed the attached DRAFT request for additional information (RAI). Please review to ensure that the RAI 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. If further clarification is needed, and you would like to discuss the questions in a conference call, let me know. This email does not convey a formal NRC staff position, and it does not formally request for additional information.

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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-16082, dated September 30, 2016, from Ralph A. Dodds III, NextEra Energy Seabrook to USNRC regarding the Supplement to Request to Adopt a Methodology for Analysis of Seismic Category I Structures with Concrete Affected by Alkali-Silica Reaction (ADAMS Accession No. ML16279A048).

3. ACI 318-71, "Building Code Requirements for Reinforced Concrete," American Concrete Institute, 1971.

Monitoring RAI-1

Regulatory Requirement

10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, Quality Standards and Records, requires structures be designed 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. The Seabrook seismic Category I 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 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.

Discussion

Section 3.2.3 of the LAR notes that adjustments to Seabrook design code methodologies are unnecessary if ASR through-thickness expansion levels remain below limits established during the MPR Associates / Ferguson Structural Engineering Laboratory (MPR/FSEL) structural testing. These expansion limits are identified for flexure, reinforcement anchorage, shear, and structural attachments in Tables two and four of the LAR, and revised Table 3.8-18 of the Seabrook UFSAR, which references Section 2.1 of MPR-4288, "Seabrook Station: Impact of Alkali-Silica Reaction on the Structural Design Evaluations" (Seabrook FP# 101020).

The limits identified in Table 4 do not match the limits identified in Tables 2 and 3.8-18. In addition, it is not clear if margin from the MPR/FSEL limits was factored into the proposed expansion limits for use at Seabrook to account for the variability between the testing and Seabrook structures.

Proposed UFSAR Section 3.8.4.7.2 notes that all locations meeting Tier 3 criteria will be monitored for CCI on a ½ year inspection frequency and will be added to the through-thickness expansion monitoring via extensometers; however, it is not clearly stated how often through-thickness measurements will be taken.

Because the proposed methodology to analyze ASR affected structures assumes through-thickness expansion remains below the identified limits, the staff needs to understand what the limits are, how they were developed, and how frequently they will be monitored.

Questions

1. Identify the through-thickness limits that will be used for monitoring and referenced in the UFSAR.

2. Explain whether or not margin was added to the monitoring limits as compared to the MPR/FSEL limits. Include the combined cracking index (CCI) limit for structural attachments in this discussion. If margin was not added explain why this is appropriate considering the MPR/FSEL testing is unique and does not exactly simulate Seabrook structures.

3. State the interval at which through-thickness measurements will be taken and provide a justification for the interval.

Monitoring RAI-2

Regulatory Requirement

GDC 1, Quality Standards and Records, requires structures be designed 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. The Seabrook seismic Category I 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 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

Discussion

Section 3.2.3 of the LAR notes that adjustments to Seabrook design code methodologies are unnecessary if ASR through-thickness expansion levels remain below limits established during the MPR/FSEL structural testing. All of the limits are based on through-thickness expansion which was selected as the monitoring parameter based on the performance of the specimens in

the MPR/FSEL structural testing. Section 5.1.4 of MPR-4288 notes that "a limit on in-plane expansion is not necessary, as expansion [in the testing] is predominately in the through-thickness direction."

This statement in MPR-4288 assumes the structures at Seabrook behave in a similar fashion to the test specimens, although no actions have been taken to date to validate or corroborate this hypothesis on Seabrook structures. ASR is a volumetric expansion phenomenon that can preferentially occur in any direction. During testing, the in-plane expansion plateaued, but expansion continued in the through-thickness direction. Although the beam test specimens were designed to be "as representative as practical" of Seabrook two-way reinforced structural walls; there is no guarantee similar behavior will occur in Seabrook structural systems.

The proposed methodology to analyze ASR affected structures assumes the parameter being monitored properly captures ASR degradation. Therefore, the staff needs additional information on how the through-thickness expansion was chosen as the parameter to be monitored, and what actions will be taken to validate that selection.

Questions

1. Explain how the hypothesis that ASR expansion in Seabrook structures will behave similarly to the test specimens (i.e., in-plane expansion will plateau and through-thickness expansion will dominate, and overall ASR behavior is similar) will be periodically validated or corroborated through the service life of the plant.

2. Identify quantitative limits, along with technical justification, for in-plane and volumetric expansion that can be considered bounding or comparable to that observed in the large-scale testing with regard to structural limits states (flexure/rebar anchorage and shear) or provide a technical justification for why limits on these parameters are unnecessary.

3. If additional parameters and limits are identified, provide the monitoring interval for corroborating the parameters, along with a technical justification for the adequacy of the interval.

Monitoring RAI-3

Regulatory Requirement

GDC 1, Quality Standards and Records, requires structures be designed 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. The Seabrook seismic Category I 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 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

Discussion

Section 3.2.3 of the LAR notes that adjustments to Seabrook design code methodologies are unnecessary if ASR through-thickness expansion levels remain below limits established during the MPR/FSEL structural testing. Section 3.5.1 notes that extensometers will be installed to monitor expansion moving forward but that the expansion prior to extensometer installation must be estimated. To estimate prior through-thickness expansion, an empirical correlation will be used that was developed based on data from the MPR/FSEL structural testing. The correlation relates reduction in concrete elastic modulus measurements with through-thickness expansion to date. This correlation is an empirical, first-of-a-kind correlation that has not been corroborated with data from Seabrook structures or other ASR-affected structures in the field.

In the December 23, 2016, response to license renewal RAI B.2.1.31A-A4, the licensee noted that the correlation will be corroborated at least 2 years prior to the period of extended operation (PEO) by taking cores in the vicinity of three extensometers. However, no technical justification is provided for the adequacy of three locations or for corroborating the correlation with only one point in time.

Questions

1. Provide technical basis for the adequacy of taking only three measurements at Seabrook, at only a single point in time, to corroborate the correlating curve derived from large-scale test specimens.

2. Explain how it will be determined whether the data taken for Seabrook structures correlates to the curve derived from large-scale test specimens.

3. Provide a technical justification that the timing of the corroboration activity (and number of times it will be performed) is sufficient to demonstrate that an adequate validation exists today and will be ensured through the life of the plant.

Deformation RAI 1

Regulatory Requirement

GDC 1, Quality Standards and Records, requires that structures important to safety shall be designed 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. GDC 2 requires, in part, that structures important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes considering appropriate combinations of the effects of normal and accident conditions with the effects of natural phenomena. GDC 4 requires these structures to be designed to accommodate the effects of environmental conditions associated with normal operation and postulated accidents, and appropriately protected against associated dynamic effects.

10 CFR Part 50, Appendix B, Criterion III “Design Control” requires, in part, that the design control 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.

Discussion

LAR Section 1.0 proposes to revise the UFSAR to include methods for analyzing seismic Category 1 structures with concrete affected by ASR. LAR Section 1.0 also identifies that the Seabrook seismic Category I 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.

ACI 318-71, Section 8.6, includes provisions for moment redistribution of negative moments calculated by elastic theory at the supports of continuous flexural members. This code section specifies a moment redistribution limit as a function of the tension reinforcement ratio and reinforcement ratio producing balanced conditions, subject to an upper limit of 20 percent. Further, ACI 318-71 allows the use of such moment redistribution only when the section at which the moment is reduced is so designed that the tension reinforcement ratio is equal to or less than 0.5 times the reinforcement ratio producing balanced conditions as defined in Section 10.3.3 of the code (i.e., the section design has sufficient ductility). Chapter 19 of ACI 318-71 considers use of other code provisions not specifically excluded or in conflict as applicable for thin shell concrete structures. However, Section 19.3.1 of the code states that elastic behavior shall be the accepted basis for determining internal forces, displacement and stability of thin shells. Equilibrium checks of internal forces and external loads shall be made to insure consistency of results.

LAR Section 3.3.2, on page 20 of 34 of Enclosure 1, under the subsection titled "Stage Three: Detailed Evaluation" states, in part: "The structure is evaluated using strength acceptance criteria in ACI 318-71 for reinforced concrete consistent with UFSAR Section 3.8.4.5. In the Stage Three evaluation, consideration is given to cracked section properties, self-limiting stresses, and the **redistribution of structural demands** when sufficient ductility is available" (emphasis added).

As indicated in Section 6.2.2 of Enclosure 2 of the LAR supplement dated September 30, 2016, (Containment Enclosure Building (CEB) evaluation report, SG&H 150252-CA-02, Revision 0, Seabrook FP#100985), moment redistribution is performed for certain elements in the finite element model that have axial-flexure (PM) interaction demands that exceed their code capacity. As discussed in Section 7.6.2 of the CEB report, when exceedances are identified in certain regions based on the initial analysis, the bending moment in excess of the PM interaction capacity is redistributed, resulting in changes to the bending moments, and possibly membrane forces, in adjacent regions of the structure. The moment redistribution approach in the LAR is based on iterative linear elastic analysis which simulates the redistribution of moments that would occur when localized flexural plasticity occurs at certain locations. When moments at other locations rise above their capacity, the iterative procedure is continued, to redistribute the moments in the model, until the PM demands throughout the structure meet the code capacities of the individual elements, as shown in the presented PM diagrams. From the staff review of the CEB Evaluation Report, it is not clear how the moment redistribution approach described in the report meets the criteria in ACI 318-71.

Also, the redistribution of moments ["structural demands"] calculated based on "elastic analysis" is a deviation from the method of evaluation described in the UFSAR to determine the structural response under design loads including ASR load in the proposed Stage Three evaluation methodology; however, there is no description of the process of redistribution of moments in the main body of the LAR nor any associated change indicated in the UFSAR markup in the LAR.

Questions

1. Demonstrate how the moment redistribution approach used in Stage Three of the LAR proposed method of evaluation for analyzing ASR-affected concrete structures is consistent with specific criteria in ACI 318-71. Alternatively, provide the technical basis for the acceptability of the approach implemented consistent with an NRC staff position for safety-related nuclear structures (e.g., RG 1.142, SRP 3.7.2 & 3.8.4) or an applicable consensus standard provision with regard to redistribution of moments calculated by linear-elastic analysis of concrete structures.

2. Update UFSAR section markups, as applicable, consistent with the response.

Deformation RAI 2

Regulatory Requirement

GDC 2 requires that structures important to safety be designed to withstand the effects of natural phenomena combined with those of normal and accident conditions. GDC 4 requires these structures to be designed to accommodate the effects of environmental conditions associated with normal operation and postulated accidents, and appropriately protected against associated dynamic effects.

NUREG-0800, Standard Review Plan (SRP), provides acceptable load combinations to address the requirement. SRP Section 3.8.4 II.3 "Loads and Load Combinations" item A, notes that analysis of structures should include site-related or plant-related loads applicable to Category I structures. The inclusion of these loads and the related load combinations are reviewed on a case-by-case basis.

Discussion

In LAR Section 3.3.2, the licensee notes that original design loads will be combined with the self-straining loads from ASR expansion and a three-stage process is proposed for analyzing ASR-affected structures. In this discussion a "threshold limit" is introduced for monitoring elements that are developed for each structure. The threshold limit is the value for each monitoring element at which the factored self-straining load equals the design limit when combined with the factored design basis loads. In a Stage One analysis an acceptance limit of 90 percent is placed upon the threshold limit, in a Stage Two analysis a limit of 95 percent is used, while in a Stage Three a limit of 100 percent is used.

For Stage One and Two analyses, existing design basis analysis methods are used and the threshold limit represents the margin remaining between the code allowable limits and the design basis loading plus the self-straining loads from ASR.

In Stage Three, additional analysis methods are employed (100-40-40, cracked section properties, moment redistribution), and a threshold factor is applied to account for future ASR expansion. Section 7.3 of the CEB evaluation report states "the threshold factor is selected to be the largest factor in which the structure meets evaluation criteria using the approaches described in this calculation," and a threshold factor of 1.2 is reported for the CEB. However, as discussed in Section 7.6.2 of the CEB evaluation report, Stage Three analysis uses an iterative process that allows moments to be redistributed until demands meet code capacities.

Since the demands upon the structure are being modified in Stage Three analyses, it is not clear what exactly the threshold factor represents, or how it will be selected in future Stage 3 analyses.

Questions

1. Clarify what the threshold factor represents in Stage 3 analyses and how the factor will be determined for future analyses (i.e., is the factor always set at 1.2 or does it depend on each analysis).

2. Explain if there is a limit imposed on the extent of moment redistribution that can be applied to a structure, and if this impacts the specification of the threshold factor. Provide a technical justification for the adequacy of the limit, or justification for the lack of a limit.