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SEABROOK

September 30, 2016
10 CFR 50.90

SBK-L-16153
Docket No. 50-443

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Seabrook Station

Supplement to License Amendment Request 16-03
Revise Current Licensing Basis to Adopt a Methodology for the Analysis of
Seismic Category I Structures with Concrete Affected by Alkali-Silica Reaction

References:

1. NextEra Energy Seabrook, LLC letter SBK-L-16071, "License Amendment Request 16-03, Revise Current Licensing Basis to Adopt a Methodology for the Analysis of Seismic Category I Structures with Concrete Affected by Alkali-Silica Reaction," August 1, 2016 (ML16216A240)

2. NRC letter "Seabrook Station, Unit No. 1 - Supplemental Information Needed for Acceptance of Requested Licensing Action Re: Alkali-Silica Reaction (CAC MF8260)," September 19, 2016 (ML16258A022)

In Reference 1, NextEra Energy Seabrook, LLC (NextEra) submitted a license amendment request (LAR) to revise the Seabrook Updated Final Safety Analysis Report (UFSAR) to include methods for analyzing Seismic Category I structures with concrete affected by an alkali-silica reaction (ASR). Approval of this proposed change will allow NextEra to proceed in an optimum, safe and effective manner toward a long-term solution for ASR degradation at Seabrook Station. The proposed methodology changes are necessary to reconcile the design basis of the containment building and other Seismic Category I structures that are affected by ASR.

In Reference 2, the NRC staff determined that supplemental information is necessary to enable the staff to make an independent assessment regarding the acceptability of the proposed amendment in terms of regulatory requirements and the protection of public health and safety and the environment. The Enclosures to this letter provide the necessary supplemental information.

ADD 1
NRR

Enclosure 5 to this letter contains information proprietary to NextEra and is supported by an affidavit in Enclosure 4 signed by NextEra, the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR 2.390. Accordingly, it is requested that the information that is proprietary to NextEra be withheld from public disclosure in accordance with 10 CFR 2.390.

This supplement does not alter the conclusion in Reference 1 that the change does not involve a significant hazards consideration pursuant to 10 CFR 50.92, and there are no significant environmental impacts associated with this change.

No new or revised commitments are included in this letter.

Should you have any questions regarding this letter, please contact Mr. Kenneth Browne, Licensing Manager, at (603) 773-7932.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on September 30, 2016.

Sincerely,

R Dodds, III

Ralph A. Dodds III
Plant General Manager
NextEra Energy Seabrook, LLC

Enclosures:

Enclosure 1 Supplement to License Amendment Request 16-03, Revise Current Licensing Basis to Adopt a Methodology for the Analysis of Seismic Category I Structures with Concrete Affected by Alkali-Silica Reaction

Enclosure 2 Simpson Gumpertz & Heger, Inc., "Evaluation and Design Confirmation of As-Deformed CEB, 150252-CA-02," Revision 0, July 2016 (Seabrook FP#100985)

Enclosure 3 MPR-4153, Revision 2, "Seabrook Station – Approach for Determining Through-Thickness Expansion from Alkali-Silica Reaction," July 2016 (Seabrook FP# 100918); (Non-proprietary)

Enclosure 4 Affidavit in Support of Application for Withholding Proprietary Information from Public Disclosure

Enclosure 5 MPR-4153, Revision 2, "Seabrook Station – Approach for Determining Through-Thickness Expansion from Alkali-Silica Reaction," July 2016 (Seabrook FP# 100918); (Proprietary)

cc: NRC Region I Administrator
NRC Project Manager
NRC Senior Resident Inspector

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Enclosure 1 to SBK-L-16153

Supplement to License Amendment Request 16-03
Revise Current Licensing Basis to Adopt a Methodology for the Analysis of Seismic Category I Structures with Concrete Affected by Alkali-Silica Reaction

Enclosure 1
Supplement to License Amendment Request 16-03
Revise Current Licensing Basis to Adopt a Methodology for the Analysis of Seismic Category I Structures with Concrete Affected by Alkali-Silica Reaction

Background

By letter dated August 1, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16216A240), NextEra Energy Seabrook, LLC (NextEra) submitted a license amendment request (LAR) to revise their current licensing basis to adopt a methodology for the analysis of Seismic Category I structures with concrete affected by alkali-silica reaction (ASR). The proposed amendment would revise the Seabrook Updated Final Safety Analysis Report (UFSAR) to include new methods for analyzing Seismic Category I structures with concrete affected by Alkali-Silica Reaction (ASR).

As discussed in Section 4.3.8.2 of NEI 96-07, Revision 1, "Guidelines for 10 CFR 50.59 Implementation," as endorsed by NRC Regulatory Guide (RG) 1.187, when a licensee is requesting approval of a specific analysis for a specific application, "a thorough understanding of the terms, conditions, and limitations relating to the application of the methodology is essential. This information is usually documented in the original license application or license amendment request...."

The NRC staff has reviewed the LAR and concluded that the following information is necessary to enable the staff to make an independent assessment regarding the acceptability of the proposed amendment and methodology in terms of regulatory requirements and the protection of public health and safety and the environment.

Item 1

Section 3.5.1 of Enclosure 1 notes that NextEra will use an empirical correlation developed via testing to correlate concrete elastic modulus measurements with the through-thickness expansion to date. This correlation is a unique, first-of-a-kind approach and is necessary for the proposed monitoring program to be effective. The staff needs additional information on the technical basis for the correlation.

Provide the technical basis for the correlation between concrete elastic modulus and through-thickness expansion. Include enough data from the testing for the staff to make a decision on the adequacy of the correlation.

NextEra Response

The process and technical basis for correlating modulus and expansion is described in MPR-4153, "Seabrook Station – Approach for Determining Through-Thickness Expansion from Alkali-Silica Reaction," Revision 2. A previous version of the report (Revision 1), which used the data available up through early 2015, was submitted to the NRC on 6/30/2015. A revision to this document was recently completed that updates the correlation using the complete set of data from the MPR/FSEL testing. Revision 2 of MPR-4153, "Seabrook Station – Approach for Determining Through-Thickness Expansion from Alkali-Silica Reaction," July 2016 is included as Enclosure 5.

Item 2

Section 3.3 of Enclosure 1 proposes a "building deformation assessment" process to evaluate ASR impacts on each of the Seismic Category I structures listed in UFSAR Section 3.8.4.1. This method is a first-of-a-kind, complex analysis, that has not been previously reviewed by the NRC or by a consensus industry group. Therefore, in order to have a thorough understanding of the methodology, the staff needs to review at least one detailed demonstration of the process to provide reasonable assurance that the approach is appropriate and repeatable.

Provide a demonstration of the building deformation assessment process being applied to a structure affected by ASR. The demonstration should include a structure that has gone through the entire process (i.e., through Stage Three).

NextEra Response

A demonstration of the building deformation assessment process for the Containment Enclosure Building (CEB) is provided in Simpson Gumpertz & Heger, Inc., "Evaluation and Design Confirmation of As-Deformed CEB, 150252-CA-02," Revision 0, July 2016 (Enclosure 2).

This evaluation is a Stage 3 Deformation Evaluation which is the most complex of the 3 evaluation stages. The process is consistent with the defined process for evaluating all Seismic Category I structures as further outlined in the response to Item 5.

The process of evaluating each structure at Seabrook Station for deformation is ongoing. The process has initially focused on evaluating the structures with higher levels of observed deformation, higher ASR expansion measurements, and structures with low margin to structural design code acceptance limits. Because the process of analyzing all structures is ongoing, examples of structures that have been dispositioned using only a Stage One Screening Evaluation are not currently available.

Item 3

Section 3.3 of Enclosure 1 notes that the concrete backfill may apply pressure to adjacent structures; however, no explanation is provided regarding how this pressure will be estimated.

Explain how the pressure from concrete backfill is determined. Also include an explanation of how external pressure due to concrete expansion will be determined for the case of two adjacent concrete structures.

NextEra Response

The concrete backfill at Seabrook Station used the same slow-reacting coarse aggregate as was used in the structures at the site, and is therefore susceptible to ASR. Since the concrete backfill at Seabrook Station is not reinforced, uniform expansion will occur until an external restraining force prevents further expansion in a particular direction. If concrete backfill is in contact with a structural wall and expanding from ASR, the backfill will exert a pressure on the wall. The lateral pressure force will increase with higher levels of ASR expansion until the pressure force equals the minimum force that acts on the backfill from other directions. The restraining forces on the backfill may come from the weight of overburden on top of the backfill and other structures, soil, or bedrock that abuts the backfill. The lateral pressure from backfill expanding from ASR will not exceed the downward pressure force exerted on backfill by the weight of the overburden, because once these forces are equal, additional expansion of the backfill will be in the vertical direction or in some other direction of lower restraint.

The fact that ASR expansion occurs in the direction(s) with the least restraint was observed in the reinforced concrete specimens used in the large-scale test program conducted by MPR/FSEL for NextEra. The test specimens had two-dimensional reinforcement mats, but no reinforcement in the through-thickness direction. Expansion in the test specimens plateaued in the reinforced directions but continued to expand in the unreinforced direction. The reinforcement in the test specimens applied an internal restraining force much like the external restraining forces discussed above for concrete backfill.

Estimation of the external pressure due to ASR expansion of the concrete backfill on a structure is specific to each structure due to building configuration, contour of excavated bedrock, layout of surrounding concrete backfill, adjacent structures, and the weight of overburden. As described above, ASR expansion of the concrete backfill occurs in the direction of least resistance. The pressure exerted on the structure by adjacent ASR-affected concrete backfill is estimated based on the constraints that inhibit expansion of the concrete backfill on its perimeter which is proportional to the overburdened pressure. These constraints are unique for each structure.

Simpson Gumpertz & Heger, Inc., "Evaluation and Design Confirmation of As-Deformed CEB, 150252-CA-02," Revision 0, July 2016 provides an explanation on how concrete backfill pressure is estimated for the CEB to simulate the field measurements of deformation and structural strain. (Reference Enclosure 2 section 6.3.1 "Self-Straining Loads" in the sub section titled "ASR Expansion of Concrete Fill"). The approach described in the calculation is typical of the methodology that will be applied in the evaluations of other ASR-affected structures.

Structures that are designed to be connected or in contact with each other are evaluated for forces transmitted between the structures, which may include forces due to ASR. The transfer of these forces is evaluated in a way that is consistent with original design calculations.

Item 4

It's not clear to the NRC staff whether you are requesting approval to change your licensing basis to Regulatory Guide (RG) 1.92 "Combining Modal Responses and Spatial Components in Seismic Response Analysis," Revision 3, specifically changing from the square-root of sum-of-squares method to use the alternate 100-40-40 approach. If so, provide a detailed explanation, or example, demonstrating how you are meeting the guidance in RG 1.92, Revision 3.

NextEra Response

NextEra is requesting approval for use of Regulatory Guide (RG) 1.92 "Combining Modal Responses and Spatial Components in Seismic Response Analysis," Revision 3, in order to gain additional margin when combining ASR loads with seismic loads. Building deformation analyses will combine seismic loads on structures using either the response spectra method in Section 2.1 of RG 1.92, Revision 3, or the square-root-sum-of-squares (SRSS) method which is in the Current Licensing Basis. The SRSS procedure for combining components of seismic loads will continue to be used for all other applications.

Simpson Gumpertz & Heger, Inc., "Evaluation and Design Confirmation of As-Deformed CEB, 150252-CA-02," provides an example of how the guidance in RG 1.92, Revision 3 is utlized in the evaluation of the CEB. (Reference: Enclosure 2 Section 6.3.2 "Original SD-66 Loads" in the section titled "Seismic Loads.")

Item 5

Minimal information is provided about the ASR deformation program, especially how the status of the existing structures will be quantified. Section 3.3.2 notes that existing data will be reviewed but no explanation is provided regarding how much data is necessary to determine whether a structure is impacted by ASR deformation (e.g. how many locations will be monitored, how recent the inspection data will be, what specific indications will be looked for when reviewing existing data).

Provide a more detailed summary of the ASR deformation program. Include a detailed discussion of what will be looked at during the field data review and how deformations and strains will be conservatively estimated. The discussion should explain how monitoring elements will be determined, how it will be determined that existing data is representative of the structure, and how it will be determined that enough data has been collected to properly estimate the demands on the structure. In addition, an example of applying the initial screening process to an existing structure should be provided and the example should highlight the generic portions of the process and explain how they will be repeated for other structures.

NextEra Response

The ASR deformation program was developed to qualify Seabrook structures for deformation attributed to the cumulative effects of concrete ASR expansion. All Category I structures at Seabrook Station that are affected by ASR will be analyzed for deformation. The detailed steps for gathering deformation measurements and analyzing each structure for ASR effects are building-specific, but the defined process is outlined below. The amount of field data used and the level of detail required in the analysis vary depending on the stage of analysis for each building. The three stages of analysis are defined in Section 3.3.2 of the LAR.

<u>Review, Acquisition, and Assessment of Deformation Data</u> - The initial step in the deformation analysis process involves reviewing existing data and performing additional field surveys of structures. Since ASR was initially identified at Seabrook in 2009, NextEra has gathered visual inspection data and obtained ASR expansion measurement data for each structure through the Structures Monitoring Program. MPR-4153, Revision 2, "Seabrook Station – Approach for Determining Through-Thickness Expansion from Alkali-Silica Reaction," July 2016 (Enclosure 5) provides a description of the process for obtaining ASR strain measurements. Data also were collected in walkdowns to identify potential interactions between deformed structures and plant components. Recently, seismic gap measurements were obtained for building deformation. Collectively, the ASR expansion and building deformation measurement data can be used to analytically determine the deformed shape of each structure.

NextEra will initially review the data obtained for each structure to determine if additional measurements are needed to characterize the deformed shape of the structure. A review of the structure and associated data determines which of the three stages is appropriate to analyze each structure. The stage of analysis and the amount of field data required for each building depends on the following considerations:

- The design margins of the undeformed structure when design basis loads are applied;
- The locations where design margins are a minimum;
- The magnitude of ASR expansion and deformation measured in the structure;
- The orientation and complexity of deformation measurements, and;
- The complexity of the structure.

The review of data assesses that there is sufficient data to characterize structure deformation corresponding to the stage of analysis used to evaluate the structure. If the data assessment concludes that more data are necessary, then additional data will be obtained in the form of Crack Index (CI) measurements in ASR affected areas, measurements between points on the structure, and/or measurements relative to adjacent structures (e.g., seismic gap measurements). The duration of acceptability of the data for each stage of analysis are based on the monitoring frequencies in Tables 5 and 6 of the LAR (Reference 1).

The amount of data needed for the analysis increases with the stage of analysis (as described in LAR Section 3.3.2) being performed to qualify each structure. The Stage One analysis is based on maximum ASR strain measured by Crack Index (CI) measurements performed at locations with most pattern cracking based on visual inspection for a structure or a region of the structure. The amount of CI data that are needed increases when a structure is evaluated for a higher stage of analysis. A Stage Three analysis includes a sufficient number of CI measurements to accurately calculate the mean ASR strain in a region of a structure. The number of CI measurements for a region will be determined through one of the following approaches:

- For large regions, a number of CI measurements are selected such that additional CI measurements would not cause a significant change to the computed mean ASR strain.
- For small regions, the number of CI measurement grids will be based on the ratio of measured area to the total area.

Alternatively, the mean ASR strain can be computed using a smaller number of CI measurements if close-up visual inspection of the region affirm that the collected measurements are representative of the region. A Stage Two analysis uses a quantity of data that is between those described for Stages One and Three. Other data such as seismic gap measurements, displacement, deformations, width of structural cracks (if any), and overall expansion for structure are used with graded approach based on the stage of analysis.

<u>Quantify ASR Demands</u> – A finite element model (FEM) will be developed for Stage Two or Three analyses in ANSYS that represents the undeformed shape of each structure. The dimensions of the model will be based on design drawings. The model will include all relevant portions of the structure and its foundation.

ASR expansion is simulated in the FEM by expanding (i.e., straining) the modeled concrete material at locations where evidence of ASR is observed in the actual structure. The magnitude and distribution of the ASR expansion applied to the FEM is selected to match field measurements and observations. Creep, shrinkage, and swelling that have occurred since each structure was erected could also affect building long term deformation. Although the deformation caused by these long-term conditions is small, these mechanisms are considered in each analysis to more accurately quantify the deformation caused by ASR and long-term loadings. Once the creep, shrinkage, swelling, and ASR expansion are applied to the FEM along with the static deadweight of the structure as a body force, a deformed shape is produced. The deformed shape determined from FEM is compared to the various measurements of the actual deformed shape obtained in the Review, Acquisition and Assessment phase.

Because of inhomogeneity of concrete in structures and the level of detail used to model ASR-affected regions, it may be necessary to adjust the concrete expansion imposed in the ASR-affected regions of the model or make refinements to the shape of ASR regions, while remaining consistent with field measurements, to correlate the predicted shape and extent of deformation with the actual measurements from the structure. If the actual deformed shape of a structure differs from the shape simulated by the FEM, then there may be additional loads on the structure that account for the differences. If the deformed structure cannot be accurately predicted using the FEM and the available measurements, additional measurements will be obtained and the process of verifying the deformation analysis model will be repeated.

Analysis of ASR-Impacted Structure – The overall objective of the deformation analysis is to assess each structure's capacity to withstand design basis loads in conjunction with the ASR expansion loads. Once the FEM is verified by comparing the simulated deformations and strains to measurements of the actual structure, the magnitude of ASR expansion in the affected areas of the structure is amplified by a factor to account for potential future ASR expansion. Then the original design load demands are added to ASR load demands based on the load combinations specified in Seabrook UFSAR Tables 3.8-1, 3.8-14, and 3.8-16. In Stage Three evaluations, the original design demands are recomputed by applying the associated loads to the FEM. In other stages, the original design demands are generally taken from original design calculations. The results from these analyses are compared to ACI 318-71 or ASME Section III acceptance criteria, as appropriate.

Establish Monitoring Threshold Limits – The specific locations where ASR exists in each structure and the critical areas where the margin to Licensing Basis structural design code and design basis acceptance criteria are most limiting influence the locations and types of measurements that are used to monitor each structure. The results from the deformed structure analysis will be reviewed to identify the critical areas for meeting the structural acceptance and seismic gap criteria and the ASR regions that influence the calculated results in the critical areas. Monitoring parameters will be identified and their locations specified based on the review. The number of monitoring locations and the types of measurements taken will be influenced by the sensitivity of the results to the level of expansion or deformation in these regions as well as the size and shape of ASR-affected areas in the structure.

As described in the LAR 16-03 (Reference 1), the building deformation analysis process includes three stages – a Stage One Screening Evaluation, a Stage Two Analytical Evaluation, and a Stage Three Detailed Evaluation. However, all structures may not be analyzed using the three stages in sequence. The process is designed to address increasing levels of structure deformation which may require more accuracy and precision in the analysis method to demonstrate that structural acceptance criteria are satisfied. The evaluation for a structure may begin at a more advanced stage (e.g., Stage Two) when structural margins may be challenged. The decision to proceed directly to Stage Two or Stage Three is based on a review of the available design margin, the magnitude of ASR expansion measured in the structure, and the complexity of the structure.

The process of evaluating each structure at Seabrook Station for deformation is ongoing. The process has initially focused on evaluating the structures with higher levels of observed deformation, higher ASR expansion measurements, and structures with low margin to structural design code acceptance limits. Because the process of analyzing all structures is ongoing, examples of structures that have been dispositioned using only a Stage One Screening Evaluation are not currently available.

Simpson Gumpertz & Heger, Inc., "Evaluation and Design Confirmation of As-Deformed CEB, 150252-CA-02," Revision 0, July 2016 (Enclosure 2) provides an example of a Stage Three evaluation for the CEB per the process discussed above. Specific questions noted above in Item 5 have been addressed in sections of the report as noted below:

- Method for using field data to simulate strain in the FEA model and how it was determined that the data are representative of the structure is provided in Section 6.3.1 "Self-Straining Loads" in the subsection titled "ASR Expansion of the CEB Wall"

- Determination that sufficient data have been collected to properly estimate the demands on the structure is provided in Section 6.4.1 "Comparison of ASR Strains and Crack Index Measurements" and Section 6.4.2 "Comparison of Simulated Deformations and Field Measurements"

- A discussion on how monitoring elements were determined is provided in Section 8 "Establish Threshold Measurements for Condition Monitoring"

Enclosure 4 to SBK-L-16153

Affidavit in Support of Application for Withholding Proprietary Information from Public Disclosure

NextEra Energy Seabrook, LLC

AFFIDAVIT IN SUPPORT OF APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

County of Rockingham)
)
State of New Hampshire)

I, Ralph A. Dodds III, being duly sworn according to law, depose and state the following:

(1) I am the Plant General Manager of NextEra Energy Seabrook, LLC (NextEra Energy Seabrook), and have been delegated the function of reviewing the information described in paragraph (3) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) I am making this Affidavit in conjunction with NextEra Energy Seabrook's "Application for Withholding Proprietary Information from Public Disclosure" accompanying this Affidavit and in conformance with the provisions of 10 CFR Section 2.390.

(3) The information sought to be withheld is contained in Enclosures 5 to this letter, "MPR-4153, Revision 2, "Seabrook Station – Approach for Determining Through-Thickness Expansion from Alkali-Silica Reaction," July 2016 (Seabrook FP# 100918) (Proprietary). The NextEra Energy Seabrook proprietary information in Enclosure 5 is identified by enclosing boxes (**[__]**).

(4) The information sought to be withheld is considered to be proprietary and confidential commercial information because alkali-silica reaction (ASR) is a newly-identified phenomenon at domestic nuclear plants. The information requested to be withheld is the result of several years of intensive NextEra Energy Seabrook effort and the expenditure of a considerable sum of money. This information may be marketable in the event nuclear facilities or other regulated facilities identify the presence of ASR. In order for potential customers to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended. The extent to which this information is available to potential customers diminishes NextEra Energy Seabrook's ability to sell products and services involving the use of the information. Thus, public disclosure of the information sought to be withheld is likely to cause substantial harm to NextEra Energy Seabrook's competitive position and NextEra Energy Seabrook has a rational basis for considering this information to be confidential commercial information.

(5) The information sought to be withheld is being submitted to the NRC in confidence.

(6) The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by NextEra Energy Seabrook, has not been disclosed publicly, and not been made available in public sources.

(7) The information is of a sort customarily held in confidence by NextEra Energy Seabrook, and is in fact so held.

(8) All disclosures to third parties, including any required transmittals to the NRC, have been or will be pursuant to regulatory provisions and/or confidentiality agreements that provide for maintaining the information in confidence.

I declare that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief. Further, the affiant sayeth naught.

Ralph A. Dodds III
Plant General Manager
NextEra Energy Seabrook, LLC
626 Lafayette Road
Seabrook, New Hampshire 03874

Subscribed and sworn to before me
this 30 day of September, 2016

Notary Public
My commission expires January 14, 2020

SHIRLEY SWEENEY MY COMMISSION EXPIRES JAN. 14, 2020 NOTARY PUBLIC NEW HAMPSHIRE