NEXTera ENERGY SEABROOK

November 2, 2012

SBK-L-12217
Docket No. 50-443

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Seabrook Station
Response to Request for Additional Information
NextEra Energy Seabrook License Renewal Application
Request for Additional Information - Set 19

References:

1. NextEra Energy Seabrook, LLC letter SBK-L-10077, "Seabrook Station Application for Renewed Operating License," May 25, 2010. (Accession Number ML101590099)
2. NextEra Energy Seabrook, LLC letter SBK-L-12061, "Seabrook Station Response to Request for Additional Information, NextEra Energy Seabrook License Renewal Application – Supplemental Response - Alkali Silica Reaction (ASR)", March 30, 2012 (Accession Number ML12094A364).
3. NextEra Energy Seabrook, LLC letter SBK-L-12101, "Seabrook Station NextEra Energy Seabrook License Renewal Application Structures Monitoring Program Supplement-Alkali-Silica Reaction (ASR) Monitoring," May 16, 2012 (Accession Number ML12142A323).
4. NRC Letter, "Requests For Additional Information For The Review Of The Seabrook Station, License Renewal Application-Set 19," September 14, 2012. (Accession Number ML12250A707)
5. NextEra Energy Seabrook, LLC letter SBK-L-12084, "Seabrook Station Response to Request for Additional Information, NextEra Energy Seabrook License Renewal Application Supplemental Response – RAI B.2.1.11-2 and B.2.1.12-6," April 26, 2012 (Accession Number ML121220298).

In Reference 1, NextEra Energy Seabrook, LLC (NextEra) submitted an application for a renewed facility operating license for Seabrook Station Unit 1 in accordance with the Code of Federal Regulations, Title 10, Parts 50, 51, and 54.

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In Reference 2, NextEra provided supplemental responses to ASR-related RAIs B.2.1.28-3, B.2.1.31-1 and Follow-Up B.2.1.31-1 based on results of testing and analysis performed associated with ASR-affected structures, .

In Reference 3, NextEra provided changes to the License Renewal Application (LRA) associated with management of cracking due to expansion and reaction with aggregates in concrete structures. Included in this submittal is a plant specific Alkali-Silica Reaction (ASR) Monitoring Program, B.2.1.31A which augments the existing Structures Monitoring Program, B.2.1.31.

In Reference 4, the NRC requested additional information regarding the above previous submittals in order to complete its review of the License Renewal Application (LRA). Enclosure 1 provides NextEra's response to this latest request for additional information.

In Reference 5, NextEra provided a supplemental response to RAI B.2.1.11-2. Enclosure 2 contains an update to information provided in Reference 5.

Provided in this Supplement are changes to the License Renewal Application (LRA). To facilitate understanding, the changes are explained, and where appropriate, portions of the LRA are repeated with the change highlighted by strikethroughs for deleted text and bolded italics for inserted text.

There are no new or revised regulatory commitments contained in this letter.

If there are any questions or additional information is needed, please contact Mr. Richard R. Cliche, License Renewal Project Manager, at (603) 773-7003.

If you have any questions regarding this correspondence, please contact Mr. Michael O'Keefe, Licensing Manager, at (603) 773-7745.

Sincerely,
NextEra Energy Seabrook, LLC.

Kevin T. Walsh
Site Vice President

Enclosure 1- NextEra Response to NRC Requests for Additional Information-Set 19, dated September 14, 2012

Enclosure 2- Update to Information Provided on April 26, 2012 in Response to RAI B.2.1.11-2

cc:

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NEXTera™ ENERGY SEABROOK

I, Kevin Walsh, Site Vice President of NextEra Energy Seabrook, LLC hereby affirm that the information and statements contained within are based on facts and circumstances which are true and accurate to the best of my knowledge and belief.

Sworn and Subscribed

Before me this

2nd day of November, 2012

Kevin T. Walsh

Site Vice President

Notary Public

SHIRLEY SWEENEY
MY COMMISSION EXPIRES NOV. 18, 2014
NOTARY PUBLIC NEW HAMPSHIRE

Enclosure 1 to SBK-L-12217

NextEra Response to NRC Requests for Additional Information-Set 19,
Dated September 14, 2012

Request for Additional Information Follow-up (RAI) B.2.1.28-3

Background

In response to RAI B.2.1.28-3, dated March 30, 2012, the applicant stated:

> Additional inspections of the exterior face of the Containment Structure were performed in September 2011. The results show a maximum crack width of 8 mils, which is less than the 15 mil criteria for acceptance without further evaluation in the first-tier of the Structural Monitoring Program. Inspections revealed two isolated locations of the Containment Structure exterior surface that exhibit pattern cracking that may be indicative of [alkali-silica reaction] ASR. The width of the pattern cracking on the exterior surface of the Containment Structure is smaller than the cracking in the "B" Electrical Tunnel and is considered insignificant. Although the identified crack width does not meet the Structural Monitoring Program threshold for further evaluation, these two locations will be included in the second-tier evaluation criteria of the program due to the past groundwater in-leakage and follow-up inspections will be performed.

By letter dated May 16, 2012, the applicant submitted a plant-specific alkali-silica reaction (ASR) Monitoring Program. Element 1, "Scope of Program" states that the program scope includes concrete structures within the scope of the license renewal Structures Monitoring Program. However, the Containment Building (including equipment hatch missile shield), which is within the scope of the American Society of Mechanical Engineers (ASME) Section XI, Subsection IWL Program, is listed within the scope of the ASR Monitoring Program.

Issue

The applicant has indicated that the pattern cracking on containment may be indicative of ASR, however, by using the acceptance criteria for passive cracks defined in American Concrete Institute (ACI) 349.3R to justify that follow-up inspections will be performed, the applicant has concluded that further evaluation is not necessary. According to ACI 349.3R, concrete surfaces that have passive cracks less than 0.4 mm (15 mils) in maximum width are generally acceptable without further evaluation. Passive cracks are defined as those having an absence of recent growth and an absence of other degradation mechanisms at the crack. The cracks observed in the Containment Structure are indicative of ASR and considered active (not passive), meaning they grow over time, and can affect the structural integrity of the structure. According to ACI 349.3R, active cracking, settlements, or deflections that are observed in a structure are unacceptable, need further technical evaluation, and should be treated because cracking damage can continue or intensify.

The staff is concerned that the applicant has not demonstrated that the pattern cracking on containment, which may be indicative of ASR, will be adequately managed during the period of extended operation. In addition, the staff is not clear if the Containment Building is within the scope of the ASR Monitoring Program, or how the pattern cracking on containment will be

monitored and trended to demonstrate that the effects of aging will be adequately managed during the period of extended operation.

Request

a) Clarify whether or not the Containment Building is within the scope of the plant-specific ASR Monitoring Program.

b) If the Containment Building is within the scope of the plant-specific ASR Monitoring Program, clarify the following:

    i. Whether the cracking index and individual crack width of the pattern cracking on the Containment Building will be monitored at the six month interval described in the May 16, 2012, submittal during the period of extended operation.

    ii. If a structural evaluation will be performed in case the combined cracking index and or individual crack width exceeds the acceptance criteria of the ASR Monitoring Program.

NextEra Energy Response

a) The Containment Building, which is within the scope of the American Society of Mechanical Engineers (ASME) Section XI, Subsection IWL Program, is within the scope of the plant-specific ASR Monitoring Program. The equipment hatch missile shield, which is not in the scope of the American Society of Mechanical Engineers (ASME) Section XI, Subsection IWL Program, is also included in the ASR Monitoring Program.

b) Areas of the containment building exhibiting signs of pattern cracking are subject to monitoring in accordance with the Structural Monitoring Program. As described in Reference 3, the horizontal and vertical Cracking Indices are averaged to obtain a Combined Cracking Index (CCI). Tier 2 quantitative monitoring of CCI and individual crack width will be performed of the containment building locations exhibiting a CCI of .5 mm/m or greater or an individual crack width of .2 mm or greater on a 2 ½ year frequency. Additionally, any area found to meet the Tier 3 criteria (1.0 mm/m CCI or 1.0 mm individual crack width) are subject to structural evaluation and monitoring on a 6 month frequency.

Request for Additional Information Follow-up (RAI) B.2.1.31-1

Background

In response to RAI B.2.1.31-1, dated March 30, 2012, regarding the staffs concern on how the effects of future degradation will either be prevented or managed and how structural integrity will be maintained during the PEO, the applicant stated:

> The Structural Monitoring and Section XI IWL Programs will provide the programmatic requirements to manage and prevent future degradation during the period of extended operation.

- Aging management of ASR-related degradation will be integrated into the Structural Monitoring Program where concrete inspection, tracking and evaluation are performed in accordance with ACI 349 and the Maintenance Rule Program.

  NextEra has initiated actions to perform testing on full-scale replicas of station structural configurations. Through this testing, quantitative crack limits will be developed. The crack limits will be used in the Structural Monitoring Program to manage the effects of ASR-related degradation on concrete material properties of plant structures. These quantitative crack limits will be used to develop acceptance criteria such that corrective action can be implemented prior to loss of intended function.

- Aging management of ASR age related degradation will be integrated into the Section XI IWL Program where concrete inspection, tracking and evaluation are in accordance with ACI 349.

The applicant further stated that:

> NextEra has initiated actions to perform testing on full-scale replicas of station structural configurations that will provide the data necessary to establish the current and future implications of ASR deterioration on concrete material properties of plant structures. The use of representative scale and materials will ensure that data collected during each of the test programs will be directly applicable to the assessment and management of in-scope structures at Seabrook Station.
>
> The testing will be used to develop the following correlating data:
> - Concrete material properties in different stages of ASR
> - Crack mapping index (quantitative damage limits)

By letter dated May 16, 2012, the applicant submitted a plant-specific ASR Monitoring Program, B.2.1.31A to augment the existing Structures Monitoring Program, B.2.1.31.

Issue

The applicant did not clearly indicate whether the May 16, 2012, submittal was intended to replace in whole, replace in part, or supplement the March 30, 2012, response. The response to RAI B.2.1.31-1, provided on March 30, 2012, is not consistent with the plant-specific ASR Monitoring Program submitted on May 16, 2012. The March 30, 2012, response states that the applicant plans to perform testing on full-scale replicas of station structural configurations to develop quantitative crack limits. The crack limits will be incorporated into the Structural Monitoring Program to manage the effects of ASR on concrete walls. These quantitative crack limits will be used to develop acceptance criteria such that corrective action can be implemented prior to loss of intended function. However, the Element 6, "Acceptance Criteria" of the plant specific ASR Monitoring Program has combined crack mapping index and crack width limits for concrete that are not based on any tests on full-scale replicas of the Seabrook station structural configurations. The staff is concerned that the applicant has not demonstrated the aging effects of ASR (i.e., cracking, degradation of mechanical properties) will be adequately managed. In

addition, the staff is not clear as to what the acceptance criteria will be to demonstrate that the effects of aging will be adequately managed, or the basis for the acceptance criteria.

Request

a) Clarify which aging effects the proposed crack mapping index and crack width limits are intended to monitor and trend.

b) Clarify whether the acceptance criteria is the one stated in the ASR Monitoring Program, or the one described in the March 30, 2012, response which indicates that the acceptance criteria will correlate the degradation of mechanical properties to cracking, based on testing at the University of Texas.

c) Provide the technical basis for which the acceptance criteria were developed and/or will be developed.

NextEra Energy Response

a) The aging effect/mechanism addressed by the Alkali-Silica Reaction Monitoring Program is cracking due to expansion/reaction with aggregates. As described in the ASR Monitoring Program, Element 3, Parameters Monitored/Inspected (Reference 3), crack indexing and crack widths are used to monitor and trend the aging effects of concrete for ASR.

b) The CCI and individual crack limits stated in letter SBK-L-12101, (ML12142A323) dated May 16, 2012 are used in the ASR Monitoring Program. These action levels, incorporated in the program, were established based on review of industry data. Results from the full scale testing to be performed at the University of Texas will be used to facilitate future structural evaluations.

The following changes have been made to SBK-L-12061 dated March 30, 2012:

1. Delete the following statement in the third paragraph of "OVERVIEW", Enclosure 1, page 3 of 19:

~~Through this testing, quantitative crack limits will be developed. The crack limits will be incorporated into the Structural Monitoring Program to manage the effects of ASR on concrete walls. These quantitative crack limits will be used to develop acceptance criteria such that corrective action can be implemented prior to loss of intended function.~~

2. Response provided to RAI B.2.1.31-1, Request 4 *"Explain how future degradation will either be prevented, or managed during the period of extended operation,"* in Enclosure 1, page 9 of 19 is revised as follows:

~~NextEra has initiated actions to perform testing on full-scale replicas of station structural configurations. Through this testing, quantitative crack limits will be developed. The crack limits will be used in the Structural Monitoring Program to manage the effects of ASR-related degradation on concrete material properties of plant structures. These quantitative crack limits will be used to develop acceptance criteria such that corrective action can be implemented prior to loss of intended function.~~

To manage the aging effects of cracking due to expansion and reaction with aggregates in concrete structures, the existing Structures Monitoring Program, B.2.1.31, has been augmented by a plant specific Alkali-Silica Reaction (ASR) Monitoring Program, B.2.1.31A. The ASR Monitoring Program will be structured according to the guidelines in ACI 349.3R, "Structural Condition Assessment of Buildings."

There are no preventive actions specified in the Seabrook Station Structures Monitoring Program, which includes implementation of NUREG-1801 XI.S5, XI.S6, and XI.S7. These are monitoring programs only. Similarly, the ASR Monitoring Program does not rely on preventive actions.

c) The basis for the Seabrook ASR Monitoring Program acceptance criteria is provided in response to RAI B.2.1.31-6 contained in this letter.

Request for Additional Information (RAI) B.2.1.31-5

Background

The applicant in its letter dated May 16, 2012, submitted a plant specific ASR Monitoring Program, B.2.1.31A to augment the existing Structures Monitoring Program, B.2.1.31.

Element 4 Detection of Aging Effects of the ASR Monitoring Program states that ASR is detected by visual inspections performed by qualified individuals. These individuals must either be a licensed Professional Engineer experienced in this area, or work under the direction of a licensed Professional Engineer. The applicant also states that to identify and verify the presence of ASR, the maximum crack width, a cracking index, and a description of the cracking including any visible surface discoloration are documented.

Issue

The staff is concerned that ASR visual examination, along with measurement of crack width and cracking index, will be used to rule out the presence of ASR in a concrete structure. Visual inspections of concrete structures may indicate the presence of ASR; however, further investigation (i.e. petrographic examination) must be conducted to confirm the absence of ASR.

Request

a) Clarify whether the ASR visual inspections will be used to rule out the presence of ASR in a concrete structure.

b) If so, what criteria and/or testing will be used to confirm the absence of ASR in those structures.

NextEra Energy Response

a) Visual inspections will be used to monitor the progression of ASR. They will not be used to rule out the presence of ASR as all original plant structures are known to have utilized the same type of potentially reactive coarse aggregate that can result in ASR expansions given enough time and the right conditions.

Petrographic analysis performed on cores removed from the B electrical tunnel in 2010 and five additional extent of condition areas in 2011 confirmed the presence of ASR in several of the samples. Further evaluation has resulted in the conclusion that a portion of the rock used for the coarse aggregate throughout the plant contained sufficient reactive silica to produce ASR expansions (micro cracking) with the right environment. This has occurred despite the fact that the aggregates used met standards for non-reactivity at the time of construction. Testing done to current standards confirms that the aggregates would be considered reactive. Therefore, NextEra concludes that the potential for ASR expansion exists in all areas of the plant.

The potential structural impact of ASR comes from the expansions (micro cracking) due to the formation of the expansive gel. As gels form and expand, micro-cracks are produced in the aggregate extending into the cement paste. The rate of progression will vary greatly in different areas of the plant and within a given structure. The actual observed rate is influenced by several factors including: the actual concentration of reactive forms of silica (amorphous silica), alkalis present, temperature and humidity. While very reactive aggregates can cause rapid expansion rates that manifest in visible cracks and measurable expansion rates in a few years, ASTM testing for reactive aggregates and specification of low alkali cement has been somewhat effective in preventing rapidly-progressing ASR. On the other hand, slow reacting aggregates may not manifest for decades. The ASR expansions identified at Seabrook Station are the result of one of these slow reacting aggregates and, in all cases at Seabrook the ASR rates are very slow-progressing. This has been shown by monitoring of the highest impacted areas for the last year. This monitoring has shown no discernable changes, which is consistent with very slow-progressing ASR.

Confinement provided by reinforcing steel and other restraints is a key factor in evaluating the impact of ASR on reinforced concrete structures. Confinement limits ASR expansion of the in situ structure, which reduces the extent of deleterious cracking and the resulting reduction in concrete properties. When expansion reaches levels of about .05%, visible cracks begin to form on the exposed surfaces. These cracks are often in a characteristic map cracking pattern and may also have signs of ASR gel material.

The potential structural concern with ASR is not with the chemical reaction itself, but with this expansion and cracking in the material. The correct focus therefore is on the level of ASR expansion (cracking) that is occurring. The best monitoring method for this effect is to measure signs of ASR expansion in the unrestrained sections of the structure (i.e., the exposed surface) using crack mapping and indexing. If any significant ASR-induced expansion is present, it will be most evident on the exposed surface. The degree of expansion (observable as cracking) is most severe at the surface of a structure due to the confluence of several factors. First, the surface concrete is a 2 to 3 inch thick cover over the steel-reinforced material. Because this surface is not within the reinforced part of the wall, the material is free to expand as the ASR gel is formed. Second, the surface of the wall is subject to wetting and drying cycles, which can increase the flow of alkalis in this area. Therefore the potentially deleterious impact from ASR (expansion and cracking) is best monitored by trending expansion and crack development on the unreinforced surface. Core bores provide limited information because they only evaluate the specific localized condition bounded in the core sample. Because it is only focused on a single point (the bore diameter),

a core sample can easily miss signs of ASR that are evident when viewing the structure's surface as a whole.

To reiterate, because the potential for ASR expansion exists for all concrete structures at the plant, the ASR Monitoring Program makes no effort to rule out ASR in any areas. And because the aging effect of concern (cracking and expansion) associated with ASR is most readily seen on the unreinforced surface concrete, NextEra's ASR Monitoring Program focuses on those areas likely to give the earliest indication of that aging effect.

All in-scope structures listed in the ASR Monitoring Program are being monitored for ASR expansion as part of the revised structures monitoring program using a three tiered approach with action levels based on both maximum crack width and measured Combined Crack Index. Actions levels are based on crack width and combined crack index specific for the ASR mechanism. This is consistent with methodology from the Federal Highway Administration published reports on ASR. The structures monitoring program will continue to monitor the structures for signs of all distress mechanisms including ASR. If the visual indications of ASR, including pattern cracking, presence of ASR gels or staining etc, are identified during structures monitoring program inspections, then the identified area will be monitored specifically for progression of ASR.

b) There is no intent to try to rule out the possibility of ASR in any in scope plant structures in the plant. All areas have the potential to experience some level of ASR expansion and the monitoring programs will address any changes in structural condition that develop.

Request for Additional Information (RAI) B.2.1.31-6

Background

The applicant in its letter dated May 16, 2012, submitted a plant specific ASR Monitoring Program, B.2.1.31A to augment the existing Structures Monitoring Program, B.2.1.31.

Element 6 -Acceptance Criteria of the ASR Monitoring Program states:

> NextEra has performed a baseline inspection and ASR associated cracks have been evaluated and categorized. NextEra has assessed 131 accessible areas to date in this manner. The areas affected by ASR have been identified and assessed for apparent degradation from ASR, including estimation of in situ expansion. The results are presented in MPR-3727, Revision 0, *"Seabrook Station: Impact of Alkali-Silica Reaction on Concrete Structures and Attachments."* Based on site specific assessment and review of industry source documentation this report provides recommendations for screening thresholds used in the ASR Monitoring Program. Using these thresholds, ASR affected areas are screened and categorized for Qualitative or Quantitative Monitoring and Trending and Structural Evaluation.
>
> A Combined Cracking Index (CCI) of less than the 1.0 mm/m and Individual Crack Width of less than 1.0 mm can be deemed Acceptable with Deficiencies. Areas with deficiencies determined to be acceptable with further review are trended for evidence of further degradation.

Issue

The staff is concerned that the proposed CCI and Individual Crack Width criteria may not be adequate. The staff reviewed the following industry publications and found that detailed investigation and structural evaluation may be appropriate if the CCI is greater than 0.5 mm/m and/or an Individual Crack Width is greater than 0.20 mm for the nuclear power plant concrete structures that are important to safety and exposed to groundwater.

1. FHWA, "Report on the Diagnosis, Prognosis, and Mitigation of Alkali Silica Reaction (ASR) in Transportation Structures"
2. Institution of Structural Engineers, "Structural Effects of Alkali-Silica Reaction -Technical Guidance Appraisal of Existing Structures"
3. French National Rule for Inservice Inspection of Nuclear Power Plant Structures
4. Oak Ridge National Laboratory letter Report NRC/LTR-9514, "In-Service inspection Guidelines for Concrete Structures in Nuclear Power Plants"

Request

Provide the basis for using a CCI of 1.0 mm/m or less and Individual Crack Width 1.0 mm or less as Acceptable with Deficiencies without performing detailed investigation and structural evaluation.

NextEra Energy Response

Basis for Screening Thresholds in the AMP

Screening methods from several published studies were considered and combined to form the basis of the screening thresholds in the ASR AMP for the structures at Seabrook Station. These publications and their screening methods are discussed in the following sections.

Structural Effects of Alkali-Silica Reaction – ISE (U.K.) 1992

The Institution of Structural Engineers (U.K.) publication *Structural Effects of Alkali-Silica Reaction* (Sections 6.3.2 and 8.2) describes a screening method for ASR-affected concrete using five categories as outlined below:

- Category I: Expansions on the order of 0.4 mm/m are of no concern even if ASR has been identified petrographically as they occur in the normal service of concrete unaffected by ASR. Expansions up to 0.6 mm/m will only marginally impact strength.
- Category II: Expansions in the range of 0.6 to 1.0 mm/m have an impact on some concrete characteristics such as tensile strength, but will only have a marginal impact on highly reinforced structures.
- Category III: Expansions in the range of 1.0 to 1.5 mm/m should have a detailed appraisal with consideration to potential capacity reductions.
- Category IV: Expansions in the range of 1.5 to 2.5 mm/m require a detailed appraisal with consideration to potential capacity reductions.

- Category V: Expansions of 2.5 mm/m or greater should be subject to special study, testing and monitoring.

The ISE screening method requires structural evaluation when in-situ expansions have advanced to the range of 1.5 mm/m to 2.5 mm/m. The ISE publication only suggests structural evaluation for expansions in the range of 1.0 mm/m to 1.5 mm/m. Expansions in the range of 0.6 mm/m to 1.0 mm/m are noted in the ISE publication to only have a marginal impact on highly reinforced structures such as those in-service at Seabrook Station. NextEra selected the criterion of 1.0 mm/m or greater (ISE Category III or greater) as the Combined Cracking Index (CCI) screening threshold for the AMP category of "Unacceptable, requires further evaluation."

Report on the Diagnosis, Prognosis, and Mitigation of Alkali-Silica Reaction (ASR) in Transportation Structures – FHWA 2010

The U.S. Department of Transportation – Federal Highway Administration publication *Report on the Diagnosis, Prognosis, and Mitigation of Alkali-Silica Reaction (ASR) in Transportation Structures* (Section 4.2.4) identifies cracking criteria based on the 1992 ISE publication. More detailed investigations are justified if expansions of 0.5 mm/m or individual cracks 0.15 mm (width) or greater are identified.

The basis for these two criteria is a reference to Section 9 of the 1992 ISE publication discussed above, which focuses on serviceability, not strength. Serviceability criteria relate to non-strength design requirements such as durability and deflection. Section 9 of the ISE publication describes serviceability criteria for several different types of structures.

- The FHWA criterion of 0.5 mm/m for expansions is directed at maintaining compatibility between neighboring structural elements and associated clearances. The applicable expansion criterion for structural elements with significant flexural loads (such as beams, slabs and walls) is 1.0 mm/m.
- The FHWA criterion of 0.15 mm for individual cracks is based on guidance in the ISE publication regarding cracking and reinforcement corrosion in prestressed concrete. The 0.15 mm criterion is aimed at protecting the integrity of the tendons which have a significantly smaller diameter, do not have surface deformations, carry much higher stresses and are more susceptible to corrosion. The applicable serviceability criterion from the ISE publication regarding cracking and corrosion in reinforced concrete is 0.3 mm.

It is important to note that the above criteria are based on serviceability requirements. However, the issue of primary interest for assessing the structural adequacy of the structures at Seabrook Station is structural strength, not serviceability. Strength-based criteria are discussed in Section 8 of the ISE publication, and were previously discussed in the preceding section on the ISE publication. Concerns for serviceability are sufficiently covered by qualitative monitoring and trending, thus structural evaluation is not deemed necessary.

NextEra selected the criterion of 0.5 mm/m as the CCI screening threshold for the AMP category of "Acceptable with Deficiencies, Quantitative Monitoring and Trending." NextEra considers that enhanced monitoring is consistent with a "more detailed

investigation," particularly in light of the fact that the criteria in the FHWA report focus on serviceability, not strength. The criterion of 0.3 mm or greater is applicable to the AMP category of "Acceptable with Deficiencies, Quantitative Monitoring and Trending," but the criterion from the ORNL publication is more conservative for this AMP category.

In-Service Inspection Guidelines for Concrete Structures in Nuclear Power Plants – ORNL 1995

Oak Ridge National Laboratory publication *In-Service Inspection Guidelines for Concrete Structures in Nuclear Power Plants* (Section 5.4.6) identifies cracking criteria for ASR-affected concrete using four categories based on a study of lightly reinforced concrete beams with undeformed reinforcement. Deformed reinforcing bars are used in modern reinforced structures such as Seabrook Station. The intentional deformations (i.e. ribs) on the reinforcement create additional surfaces for the concrete to mechanically adhere to the bar. Previously, reinforced concrete construction used smooth reinforcing bars (i.e. undeformed) which relied on friction and chemical bond to adhere to the concrete. Deformed rebar provides a higher strength connection with the surrounding concrete than undeformed bars. The four categories are explained below:

- Category 1: Crack widths up to 0.2 mm.
- Category 2: Crack widths in the range of 0.2 to 1.0 mm.
- Category 3: Crack widths in the range of 1.0 to 2.0 mm.
- Category 4: Crack widths greater than 2.0 mm[1].

Based on the ORNL screening method, structural evaluation is not required until crack widths are 1.0 mm or greater, meeting the criteria of Categories 3 or 4. Concrete with cracks with widths up to 1.0 mm has not likely been significantly damaged and will likely only have a marginal impact on highly reinforced structures such as those in-service at Seabrook Station, as discussed in the ORNL report.

Note that the discussion in the ORNL references a study from the Denmark Ministry of Transport, *Load Carrying Capacity of Structural Members Subjected to Alkali-Silica Reactions*, October 1990. The Danish study evaluated shear, punching shear and reinforcement anchorage in beam and slab specimens in which ASR degradation was grown. The damage categories described above and the conclusion that a structural evaluation is not required until Categories 3 or 4 are based on the Danish study.

The screening thresholds for crack width are based on the recommendations from the ORNL publication. NextEra selected the criterion of 1.0 mm as the individual crack width screening threshold for the AMP category of "Unacceptable, requires further evaluation." NextEra also selected the criterion of 0.2 mm as the individual crack width screening threshold for the AMP category of "Acceptable with Deficiencies, Quantitative Monitoring and Trending."

[1] Due to a typographic error in the ORNL publication, this value was reported as 0.2 mm.

Screening Thresholds in the AMP

The ASR AMP screening thresholds shown below in Table 1 utilize a combination of all three of the publications discussed in the previous sections, in the absence of studies more relevant to the reinforced concrete design and detailing used at Seabrook Station.

Table 1. Screening Thresholds for ASR-Affected Areas

Structural Monitoring Program Categories	**Recommendation for Individual Concrete Components**	**Combined Cracking Index (CCI)**	**Individual Crack Width**
Tier 3:Unacceptable (requires further evaluation)	Structural Evaluation	1.0 mm/m or greater	1.0 mm or greater
Tier 2:Acceptable with Deficiencies	Quantitative Monitoring and Trending	0.5 mm/m or greater	0.2 mm or greater
	Qualitative Monitoring	Any area with indications of pattern cracking or water ingress	
Tier 1:Acceptable	Routine inspection as prescribed by Structures Monitoring Program	Area has no indications of pattern cracking or water ingress – No visual presence of ASR	

Note: The criteria related to expansion due to ASR are expressed in terms of CCI to be consistent with the field walkdown results.

The recommendations in all three publications for when a detailed structural evaluation is necessary are based on published studies on the effects of ASR on concrete structures. In many cases, the studies cited in the respective documents used unreinforced concrete. Application of recommendations derived from unreinforced concrete specimens to reinforced concrete structures is conservative due to the beneficial effects of confinement provided by the reinforcement.

The screening threshold for "Acceptable with Deficiencies, Qualitative Monitoring" is based on general guidance common across the three publications. All areas with indications of pattern cracking or water ingress noted during general plant walkdowns are identified and monitored.

Summary

The basis for the screening thresholds for concrete expansion due to ASR is a combination of screening methods from three published studies written by the Institution of Structural Engineers, Federal Highway Administration and Oak Ridge National Laboratory. The screening thresholds in the ASR AMP represent a conservative compilation of the recommendations provided in these three publications.

Request for Additional Information (RAI) B.2.1.31-7

Background

The applicant in its letter dated May 16, 2012, submitted a plant specific ASR Monitoring Program, B.2.1.31A to augment the existing Structures Monitoring Program, B.2.1.31.

Element 5 -Monitoring and Trending of the ASR Monitoring Program states:

> NextEra has performed a baseline inspection and ASR associated cracks have been evaluated and categorized. NextEra has assessed 131 accessible areas to date in this manner. The areas affected by ASR have been identified and assessed for apparent degradation from ASR, including estimation of in situ expansion. Monitoring of CI and Individual Crack Width of at least 20 areas identified in the baseline inspection as having the CCI will be performed at six month intervals. Measurement of Cracking Index and Individual Crack Width will be performed in the same areas as the baseline. Trend data from these follow-up inspections will be used in determining the progression of expansion and a basis for any change to the frequency of the inspection.

Issue

It is not clear to the staff why only 20 areas out of the 131 areas with ASR cracks have been selected for baseline inspection. The ASR affected areas are in different structures and ASR degradation may progress at different rates and at different times. It is not clear to the staff how the aging of the structures due to ASR, in the remaining 111 areas, will be managed without any inspection and trending data. There is a potential that some of the remaining 111 areas may degrade at a faster rate than the 20 areas that are selected for baseline inspection. The crack index (CI) and Individual Crack Width need to be monitored in all ASR affected areas to establish a trend over time. In addition, it is not clear how the progression rate will be related to a change in frequency of inspection.

Request

a) Explain why only 20 areas out of 131 areas associated with ASR cracks have been identified for baseline inspection.

b) Provide clarification as to how the aging of the structures due to ASR in the remaining 111 areas will be managed without any inspection.

c) Clarify whether the trend data will be used to decrease the inspection frequency and if so, describe the basis for any change in inspection frequency.

d) When the total number of affected areas increases, describe if the number of areas being monitored will change and provide the technical justification for this approach.

NextEra Energy Response

a) Baseline inspection has been performed on all of the 131 locations that have cracks associated with ASR. Results of this inspection will be integrated into the Structural Monitoring Program and dispositioned as "Acceptable with Deficiencies" (Tier 2) or "Unacceptable-requires further evaluation" (Tier 3). Of the 131 locations, at least 20 areas that have the largest CCI will be quantitatively monitored at six month intervals to establish a rate of progression. These areas are those that currently meet the Tier 3 criteria. All other locations exhibiting the presence of ASR will be qualitatively or quantitatively monitored according to Tier 2 criteria on a 2 ½ year frequency.

b) The remaining areas will not be managed without inspection. The remaining areas where ASR has been identified currently meet the Tier 2 criteria. Inspections will be performed at these locations on a 2 ½ year frequency.

c) Trend data may be used in the future to adjust inspection frequency. The ASR Monitoring Program will be revised in the future, as appropriate, if either industry or plant specific operating experience show that program changes will enhance program effectiveness.

d) The areas affected by ASR are monitored. If new areas are identified, they will be placed in either a Tier 2 or Tier 3 action category. Based on CCI and Individual Crack Width, qualitative or quantitative monitoring is performed of all Tier 2 category conditions. Any new areas affected by ASR meeting the Tier 3 criteria, will be quantitatively monitored.

Request for Additional Information (RAI) B.2.1.31-8

Background

In response to follow-up RAI B.2.1.31-1, dated March 30, 2012, with regard to the staff's concern about the extent of degradation/corrosion of rebar and possible reduction of load carrying capacity in steel embedments and anchors in ASR affected areas, the applicant stated the following:

> NextEra conducted an operating experience review utilizing a key word search of corrective action documents from August 1998 through May 2010. In addition, during the removal of the "B" Electrical Tunnel core bores, a section of the concrete cover was removed to expose the rebar in the ASR affected area. No instances of rebar corrosion or degradation were identified in either of these reviews. Seabrook will continue to monitor for rebar corrosion through the Structural Monitoring Program."

The applicant also stated that "anchor bolt pull-out testing is being performed at the University of Texas. The results of this testing will provide the basis to manage the effects of aging on anchors and ensure that anchors continue to support the intended functions."

Issue

The applicant in its letter dated May 16, 2012, submitted a plant specific ASR Monitoring Program, B.2.1.31A to augment the existing Structures Monitoring Program, B.2.1.31. However, the plant specific ASR Monitoring Program does not address the inspection and monitoring of rebar that are embedded in the concrete, embeds, or anchors. Considering current degraded condition of the concrete and the continued infiltration of ground water through cracks generated by ASR, there is a higher potential for degradation of the rebar. Lack of corrosion in one rebar that was inspected in 2010 does not guarantee that other rebar will not be corroded in the future due to the continuous ingress of ground water through ASR affected cracks during the period of extended operation that ends in 2050. It is not clear to the staff how the applicant plans to inspect and monitor the rebar, embeds, and anchors for the ASR affected areas.

Request

a) Discuss any plans to expose additional areas of ASR affected concrete, and describe how these areas will be inspected and monitored for corrosion and loss of bond during the period of extended operation.

b) Describe how the embeds and anchors in the ASR affected structures will be inspected and monitored during the period of extended operation.

NextEra Energy Response

a) There are no plans to expose additional areas for rebar inspection. However, the Structural Monitoring Program does inspect for corrosion staining of undefined source on concrete surfaces as well as other degradation such as cracking, scaling, spalling and popouts. These attributes are indicative of subsurface corrosion of reinforcing steel.

Alkalinity of the concrete, in conjunction with the silica in the aggregate, can result in ASR. ASR processes produce a gel that absorbs water, expands, and causes the concrete to crack. ASR does not directly cause the reinforcement to corrode (i.e., steel to oxidize). The concern is that at relatively high levels of ASR expansion/macro cracking the cover concrete of the reinforcement could allow oxygen and water to begin corrosion. In practice, the alkaline environment that fosters the ASR process also protects the reinforcement steel by causing a film to form around the rebar, sealing the steel off from the effects of the environment. The alkalinity protects the steel by a process called "passivation." The alkaline levels that result in passivation of steel are significantly less than those that would cause ASR in concrete. Therefore the expectation is that the steel reinforcement associated with ASR expansions would remain passivated and not be subject to corrosion.

Although the alkalinity and PH levels associated with ASR would be expected to preclude corrosion, the structures monitoring program provides ongoing monitoring specifically for any indication of reinforcing steel corrosion. This includes looking for indications of rust staining, as well as other degradation such as cracking, scaling, spalling and popouts.

Additionally, several recent physical investigations have confirmed that the reinforcing steel at Seabrook is not experiencing any corrosion as a result of ASR. Reinforcing steel was contacted during removal of four cores from the Containment Enclosure Building. Review of photographs of these core removals shows that there is no indication of corrosion of the exposed bars. In addition, NextEra also removed a section of cover concrete in an area affected by ASR in order to validate the condition of the reinforcing steel. The uncovered steel showed no indication of corrosion. Also, ultrasonic testing of the concrete liner in the vicinity of the identified ASR locations demonstrates no impact to the liner.

b) The Structural Monitoring Program inspects areas around embedments and anchors in concrete for corrosion of the exposed embedded metal surfaces and corrosion stains around the embedded metal, detached embedments, or loose bolting material. The ASR-affected areas are within the scope of the Structures Monitoring Program.

Request for Additional Information (RAI) B.2.1.31-9

Background

The applicant in its letter dated May 16, 2012, submitted a plant specific ASR Monitoring Program to augment the existing Structures Monitoring Program, B.2.1.31. GALL Report AMP XI.S6, "Structures Monitoring Program," recommends detection of aging affects for inaccessible, below-grade concrete structural elements when conditions exist in accessible areas that could indicate the presence of degradation.

Issue

The staff reviewed Element 3, "parameters monitored," and Element 4, "detection of aging effects," of the plant specific ASR Monitoring Program and did not find any discussion on how the effects of the ASR will be detected and monitored in the inaccessible structures such as base slabs of buildings, water intake and discharge structures, service water pump house, and below grade walls of the spent fuel pool covered with the liner plate on inside surface.

Request

Describe how inaccessible concrete elements of structures that are affected by ASR will be monitored and inspected during the period of extended operation.

NextEra Energy Response

Most structures have accessible surfaces which can be monitored. Since these surfaces have the least confinement, the expansion will be most pronounced on the exposed surfaces. Examination of inaccessible areas, such as buried concrete foundations, will be completed during inspections of opportunity or during focused inspections. An opportunistic or focused inspection for buried concrete will be performed under the Maintenance Rule Program every 5 years (if no opportunistic inspection was performed during a 5-year period, a focused 5 year inspection is required) to ensure that the condition of buried concrete foundations on site is characterized sufficiently to provide reasonable assurance that the foundations on site will perform their intended function through the period of extended operation. Additional inspections may be performed in the event that an opportunistic or focused inspection or visible portions of the concrete foundation reveal degradation and will be entered into the Corrective Action Program. In addition, in its LRA (Ref. 1), NextEra committed to enhance the ("Dig Safe") procedure to include an inspection of opportunity when planning excavation work that would expose inaccessible concrete (Commitment #33).

Request for Additional Information (RAI) B.2.1.31-10

Background

In response to Follow-up RAI B.2.1.31-1, dated March 30, 2012, the applicant stated that it will develop a long range plan to implement mitigation measures to arrest degradation attributed to ASR. Utilizing the rate of progression of ASR concrete degradation, the applicant will prioritize areas to be remediated. The applicant will develop mitigation techniques to divert groundwater from the below grade structures utilizing industry input on waterproofing technology and insights gained from the new groundwater fate and transport study (the study of groundwater distribution and movement) completed for the Seabrook site. Implementation of the action plan is scheduled to be completed in December 2013.

Issue

The staff reviewed Element 2, "preventive actions" of the plant specific ASR Monitoring Program and noted that the program does not rely on preventive actions. It is not clear to the staff if the applicant is still planning to develop and implement mitigation measures to arrest degradation attributed to ASR as stated in the letter dated March 30, 2012.

Request

Clarify whether or not mitigation measures will be taken to arrest degradation attributed to ASR, and indicate if those mitigation measures will be relied upon to demonstrate that the effects of ASR will be adequately managed, during the period of extended operation.

NextEra Energy Response

Mitigation measures, such as the installation of several dewatering stations, have been taken and will continue to be pursued in attempt to slow the effects of aging. The ASR Monitoring Program is a condition monitoring program that inspects for the presence and extent of aging effects. As such, mitigation measures are not relied upon to manage the aging effects during the period of extended operation.

Request for Additional Information (RAI) B.2.1.31-11

Background

By letter dated May 16, 2012, the applicant submitted a plant-specific ASR Monitoring Program. Element 1, "Scope of Program" states the program scope includes concrete structures within the scope of the license renewal Structures Monitoring Program.

Issue

The staff noted that the Containment Enclosure Building (CEB) was not included within the scope of the ASR Monitoring Program. Considering that the CEB has already been confirmed to be affected by ASR through petrographic examination, the staff needs clarification on whether the CEB is considered within the scope of the plant-specific ASR Monitoring Program and whether the scope of the ASR Monitoring Program is limited to those structures within the scope of the Structures Monitoring Program.

Request

a) Clarify whether the CEB and any building that may become or is susceptible to ASR will be included within the scope of the plant-specific ASR Monitoring Program.

b) Clarify whether there are structures outside the scope of the Structures Monitoring Program that are within the scope of the plant-specific ASR Monitoring Program.

c) If structures outside the scope of the Structures Monitoring Program are included in the ASR Monitoring Program, describe how and when newly discovered areas exhibiting visual signs of ASR will be identified.

NextEra Energy Response

a) Structures identified in Table 2.2-1 of the License Renewal Application were determined to be within the scope license renewal. The CEB (Containment Enclosure Building) is included. The Structures Monitoring Program provides for the aging management of in-scope structures and structural components. Scope of the ASR Monitoring Program includes all concrete structures within the scope of the License Renewal Structural Monitoring Program.

   To clarify that the Containment Enclosure Building is in-scope of the ASR Monitoring Program the following change has been made to SBK-L-12101, Enclosure 2, page 9 of 18:

ELEMENT 1 - SCOPE OF PROGRAM

The Seabrook Station Alkali-Silica Reaction (ASR) Monitoring Program provides for management of aging effects due to the presence of ASR. Program scope includes concrete structures within the scope of the License Renewal Structures Monitoring Program. License Renewal structures within the scope of this program include:

- Containment Building (including equipment hatch missile shield)
- ***Containment Enclosure Building***
- Containment Enclosure Ventilation Area

b) There are no structures outside the scope of the Structures Monitoring Program that are within the scope of the plant-specific ASR Monitoring Program. All concrete structures within the scope of the Structures Monitoring Program are also included in the scope of the plant specific ASR Monitoring Program. Structures identified in Table 2.2-1 of the License Renewal Application were determined to be within the scope license renewal and are age managed by the Structures Monitoring Program.

c) As noted in response to Item "b", above, there are no structures outside the scope of the Structures Monitoring Program included in the ASR Monitoring Program.

Enclosure 2 to SBK-L-12217

Update to Information Provided on April 26, 2012 in Response to RAI B.2.1.11-2
(Reference SBK-L-12084 dated April 26, 2012, Enclosure 1)

In response to the NRC Staff Request for Additional Information (RAI) B.2.1.11-2 (Reference 5, Enclosure 1), NextEra provided the following information:

> *"To resolve the issues in the DGHX Plastisol PVC lined piping, actions have been assigned to support replacement of the Plastisol PVC lined pipe in the subsequent refueling outage (currently scheduled for fall of 2012)"* and that *"Replacement of both Trains of Plastisol PVC lined Service Water piping is currently scheduled for the upcoming refueling outage in fall of 2012"* (Page 5 of 8), and *"Replacing the Plastisol PVC lined piping (currently planned for Refueling Outage 15 in October 2012) prior to entering the Period of Extended Operation ensures that failure of this lining material does not become a viable aging mechanism requiring management."* (Page 6 of 8).

Reference to the planned replacement schedule is also made on page 3-62 of the "Safety Evaluation Report with Open Items Related to the License Renewal of Seabrook Station" (ML12053A192).

Plastisol PVC lined piping in the "A" train of the Diesel Generator Heat Exchanger (DGHX) piping was replaced with AL6XN material in Refueling Outage 15 (Fall of 2012).

Replacement of the Plastisol PVC lined piping in the "B" train is scheduled for Refueling Outage 16 (Spring of 2014) when the "B" train will be taken out of service for other outage activities. A full inspection of the Plastisol PVC lined piping in the "B" train of the DGHX piping was performed during Refueling Outage 15. Based on this inspection, two pipe spools were replaced with AL6XN piping material. All of the remaining pipe spools in the "B" train DGHX piping were either repaired or found to be satisfactory for continued operation.

Existing Commitment #69 made in Reference 5 remains unaffected by this schedule change. Commitment #69 is to "Replace the Diesel Generator Heat Exchanger Plastisol PVC lined Service Water piping with piping fabricated from AL6XN material." prior to entering the Period of Extended Operation.