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

October 2, 2015

Mr. Dean Curtland
Site Vice President
Seabrook Station NextEra Energy
626 Lafayette Road
Seabrook, NH 03874

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION RELATED TO THE REVIEW OF THE SEABROOK STATION LICENSE RENEWAL APPLICATION – SET 25 (TAC NO. ME4028)

Dear Mr. Curtland:

By letter dated May 25, 2010, NextEra Energy Seabrook, LLC submitted an application pursuant to Title 10 of the *Code of Federal Regulations* Part 54, to renew the Operating License NPF-86 for Seabrook Station, Unit 1, respectively. The staff of the U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing the information contained in the license renewal application and has identified, in the enclosure, areas where additional information is needed to complete the review.

The request for additional information was discussed with Mr. Edward Carley, and a mutually agreeable date for the response is November 30, 2015. If you have any questions, please contact me at 301-415-1427 or by e-mail at Richard.Plasse@nrc.gov.

Sincerely,

/RA/

Richard Plasse, Project Manager
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-443

Enclosure:
Requests for Additional Information

cc: Listserv

October 2, 2015

Mr. Dean Curtland
Site Vice President
Seabrook Station NextEra Energy
626 Lafayette Road
Seabrook, NH 03874

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION RELATED TO THE REVIEW OF THE SEABROOK STATION LICENSE RENEWAL APPLICATION – SET 25 (TAC NO. ME4028)

Dear Mr. Curtland:

By letter dated May 25, 2010, NextEra Energy Seabrook, LLC submitted an application pursuant to Title 10 of the *Code of Federal Regulations* Part 54, to renew the Operating License NPF-86 for Seabrook Station, Unit 1, respectively. The staff of the U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing the information contained in the license renewal application and has identified, in the enclosure, areas where additional information is needed to complete the review.

The request for additional information was discussed with Mr. Edward Carley, and a mutually agreeable date for the response is November 30, 2015. If you have any questions, please contact me at 301-415-1427 or by e-mail at Richard.Plasse@nrc.gov.

Sincerely,

/RA/

Richard Plasse, Project Manager
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-443

Enclosure:
Requests for Additional Information

cc: Listserv

DISTRIBUTION:
See next page

ADAMS Accession No.:ML15251A333 ***Concurred via e-mail**

OFFICE	LA:RPB1:DLR*	PM: RPB1:DLR	BC:RPB1:DLR	PM: RPB1:DLR
NAME	YEdmonds	RPlasse	YDiaz-Sanabria	RPlasse
DATE	9/ 21 /15	10/ 01 /15	10/ 2 /15	10/ 2 /15

OFFICIAL RECORD COPY

SEABROOK STATION, UNIT 1
LICENSE RENEWAL APPLICATION
REQUEST FOR ADDITIONAL INFORMATION SET 25

B.2.1.31A-8: ***Addressing Recent Operating Experience***

Background:

The regulation in 10 CFR 54.21(a)(3) requires applicants to demonstrate that the effects of aging will be adequately managed so that intended functions will be maintained consistent with the current licensing basis during the period of extended operation.

LR-ISG-2011-05 "Ongoing Review of Operating Experience" recommends that Aging Management Programs (AMPs) be informed and enhanced when necessary through the systematic and ongoing review of both plant-specific and industry operating experience (OE), as discussed therein. The mark-up in LR-ISG-2011-05 for Section A.1.2.3.10 "Operating Experience" of SRP-LR Appendix A.1 "Aging Management Review – Generic (Branch Technical Position RLSB-1)" states, in part:

> Consideration of future plant-specific and industry operating experience relating to AMPS should be discussed. The ongoing review of operating experience may identify areas where AMPs should be enhanced or new AMPs developed. As such, an applicant should ensure that it has adequate processes to monitor and evaluate plant-specific and industry operating experience related to aging management to ensure that the AMPs are effective in managing aging effects for which they are credited. The AMPs are informed by this review of operating experience on an ongoing basis, regardless of the AMP's implementation schedule. The ongoing review of operating experience information should provide objective evidence to support the conclusion that the effects of aging are managed adequately so that the structure- and component-intended function(s) will be maintained during the period of extended operation.

LR-ISG-2011-05 also states that "Currently available operating experience applicable to new programs should also be discussed. … Thus, when developing the elements for new programs, an applicant should consider the impact of relevant operating experience from implementation of its existing AMPs and from generic industry operating experience."

As documented in Seabrook Station, Unit No. 1 – Integrated Inspection Report 05000443/2015002 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15217A256), Seabrook Station has recently discovered operating experience in structures affected by alkali-silica reaction (ASR), as described below, that may be potentially attributable to aging effects causing global bulk expansion of concrete. The report indicates that the applicant's evaluation of the degraded conditions confirmed that the identified deformation is due to bulk expansion from long-term cumulative effects of ASR and strain associated with creep.

ENCLOSURE

During walkdown of plant structures, and from NRC Inspection Reports 05000443/2015002, 05000443/2014005 (ADAMS Accession No. ML15037A172), 05000443/2014003 (ADAMS Accession No. ML14212A458), and 05000443/2014009 (ADAMS Accession No. ML14349A751), the NRC staff noted the following:

- Relative deformation (differential movement) of the Containment Enclosure Building (CEB) indicated by changes in the 3-inch seismic gaps or annulus gap between adjacent structures, damaged fire seals, misalignment of conduits/piping at penetrations or between adjacent structures, deformed flexible conduit couplings, bent small pipes/conduits and supports, etc.

- Discrete wide horizontal cracking, spalling, doorway misalignments etc., in the Residual Heat Removal (RHR) and Containment Spray (CS) Vault.

- Cracking, displacements or other indications of structural conditions adverse to quality associated with the Fuel Storage Building (FSB).

The applicant's response to RAI B.2.1.31A-5(a), by letter dated June 30, 2015, includes changes to the "parameters monitored or inspected," "monitoring and trending," and "acceptance criteria" program elements of the ASR Monitoring Program in License Renewal Application (LRA) Section B.2.1.31A, with qualitative descriptions for "monitoring building deformation" and a related new Commitment No. 91 which states: "In building geometry locations where the potential for deformation is likely, enhance the program to monitor for building displacement using laser targets and by taking gap measurements." The implementation schedule for Commitment No. 91 is described as "within 10 years prior to the period of extended operation."

<u>Issue</u>:

Regarding aging management of structure and component as they relate to the ASR Monitoring Program or the Structure Monitoring Program or both, the wording in the applicant's response to RAI B.2.1.31A-5(a) appear to be unclear, relative to (a) monitoring building deformation, (b) the corresponding Commitment No. 91, and (c) implementation schedule (the descriptions in the response and new Commitment No. 91 appear to address the recently discovered operating experience related to the CEB). The staff identified the following concerns:

- The applicant's response does not include an update to the "Operating Experience" program element of the ASR Monitoring Program describing the review and evaluation of the cause and impact of any of the relevant recent operating experience, described in the "Background" section and other operating experience (if any), to determine how the AMP will be affected or new AMPs developed to ensure adequate aging management. The "Operating Experience" program element of the revised AMP appears to be incomplete in addressing the recent potentially ASR-related operating experience.

- The AMP does not appear to provide information that "commits" ongoing and future review of all relevant plant-specific and industry operating experience related to ASR as is recommended in LR-ISG-2011-05 for Section A.1.2.3.10 "Operating Experience" of SRP-LR Appendix A.1 "Aging Management Review – Generic (Branch Technical Position RLSB-1).

- It is not clear whether global aging effects of ASR such as potentially irreversible deformation, relative movement, displacements, or wide discrete cracking that manifests in the global direction of least restraint at the structural system level (as opposed to the structural component level) are addressed in the large-scale testing program that is being used to form the basis for structural functionality through the period of extended operation. It is also not clear if the applicant plans to address the global behavior of the structure by nonlinear analyses that simulate the kinetics of ASR.

- Though the applicant stated that it will monitor building deformation aging effect by monitoring critical building geometry locations "for displacement via laser targets and gap measurements," it is not clear (i) whether the observed indications are irreversible deformations (ii) what acceptance criteria the applicant has determined to be appropriate in terms of gap measurements to detect damage prior to a loss of intended function, (iii) how a structural evaluation would be performed, and (iv) how the results of the evaluation will affect the program.

- It is not clear that the applicant has fully characterized the phenomena observed in the recent operating experience and its implications to the current design basis in terms of impact to original calculations, etc. Although the applicant performed a temporary "prompt operability determination" (POD) that structures have been determined operable under the current operating license, the staff has not received any information to support a basis for long term functionality of affected structures and structural systems. Information is needed with regard to the current and long-term effects of this recent OE, for the staff's review.

- The revised program appears only to address differential lateral movement between structures observed in areas such as the containment enclosure ventilation area slab-to-wall interface. It does not appear to address other recently identified operating experience of large horizontal cracks in the RHR vault and indications in the FSB. It is not clear whether these issues have been evaluated to be related, if there has been an evaluation to determine the mechanism and structural implications of large macro cracking in these areas, as well as any impact on aging management of those structures. It is also not clear whether there has been an evaluation to determine if rebar has yielded in these areas, how during or prior to the period of extended operation rebar yielding would be considered and/or evaluated, and the implications for service through the period of extended operation.

- It is not clear if all potential aging effects of the ASR mechanism have been identified for monitoring in the AMP, including, but not limited to, those that involve irreversible deformation, relative movement, displacement, and discrete cracking.

- The applicant's response to RAI B.2.1.31A-5(a) asserts that the observed building deformation is not a structural capacity concern but does not provide any supporting basis. Commitment No. 91 does not appear to consider the basis for service through the period of extended operation for the CEB structures, and does not provide information for staff to evaluate the adequacy of this statement. Further, the intent of the wording of the implementation schedule for the commitment is unclear and, as written, conveys that it will be implemented during the 10-year period prior to the period of extended operation. It is not clear how the timeliness of this commitment would ensure adequate management of aging effects of ASR at the global structure (structural system) level for the period of extended operation.

The staff does not have sufficient information to determine whether aging effects of ASR from the recent operating experience have been adequately evaluated and incorporated into the AMP to provide adequate aging management during the period of extended operation.

<u>Request</u>:

The staff requests information for resolution of the issues in the issue section.

1) Describe, including technical basis, how the appropriate program elements of the ASR Monitoring Program, the Structures Monitoring Program, or other applicable AMP will adequately account for all relevant recent plant-specific operating experience described in the "Background" section, to address the concerns described in the "Issues" section. The information should provide objective evidence to support the conclusion that the aging effects of ASR will be managed adequately such that structure- and component-intended functions will be maintained during the period of extended operation. The information should also include an update to the "operating experience" program element to describe the recent operating experience in sufficient technical detail.

2) If the applicant determines that no modifications or enhancements to the ASR Monitoring Program, the Structures Monitoring Program, or other applicable AMP are necessary based on the operating experience described as Issue items 1 and 2, explain, with sufficient technical detail, the basis for that determination.

3) Update the LRA program elements and Updated Final Safety Analysis Report (UFSAR) supplement, as applicable, based on the response. To facilitate efficient staff review, provide the updated ASR Monitoring Program and associated UFSAR supplement, in its entirety.

B.2.1.31A-5(a1): ***Justify Representativeness of Large-scale Test Data to Actual Structure***

Background:

SRP-LR, Section A.1.2.3.3, states that the “parameters monitored or inspected” program element should provide a link between the parameters that will be monitored and how monitoring these parameters will ensure adequate aging management.

In its response to RAI B.2.1.31A-5(a), dated June 30, 2015, the applicant included as Enclosure 4 the report MPR-4153, Revision 1, “Seabrook Station – Approach for Determining Through-Thickness Expansion from Alkali-Silica Reaction (Proprietary)” as the technical basis for the proposed methodology to quantitatively relate the observed ASR effects in existing plant structures at Seabrook Station to the results of the large-scale test program at the Ferguson Structural Engineering Laboratory (FSEL). Chapter 2 of this document discusses expansion behavior in the test specimens, including formation of a large discrete crack on each specimen face between the reinforcement mats. The propagation of this crack dominates the through-thickness expansion measurements on the surface, whether measured between the deep pins or across the width, and causes bending of the deep pins. Section 2.2.1 of the report states that “Once the large crack forms, expansion measured using the embedded rods is governed by the increase in crack width. Expansion in the regions outside the embedded rods remains relatively unchanged. Therefore, expansion must be calculated based on the total width of the beam, rather than the distance between the rods, to appropriately characterize the expansion.” Section 5.2 of calculation 0326-0062-CLC-03 appended to the report includes an expansion measurement correction equation (from Reference 21 of the report). This equation is based on average measured through-thickness expansions across the total width using 9 sets of measurements across the breadth, intended to correct and appropriately characterize the expansion measured between the pins.

With regard to correlation between strain measurements in large-scale test beams versus Seabrook structures, the boundary conditions of the large scale test beams are such that they are free to expand at the top, bottom and all edges, causing a large crack to form in the center of the beam thickness around the perimeter. Currently it appears that the applicant is using deep pin measurements taken at the free edge of the concrete (with a correction) to determine total expansion (and using this total expansion as a surrogate for strain).

The applicant indicated in its revised ASR Monitoring Program “Monitoring and Trending” program element that ASR expansion-to-date on Seabrook structures will be determined by directly comparing the reduction in elastic modulus (normalized modulus) on the structure to a correlating relationship between through-thickness expansion and reduction in elastic modulus and through-thickness expansion developed based on measured data on the large-scale specimens.

Issue:

It is not clear if the expansion measured on the test specimens is representative of ASR expansion and its potential effects on Seabrook structures to which the test results will be applied for reasons below:

1) *Expansion measured on test beams may be overestimated:* ASR expansion at Seabrook is occurring in walls that are restrained at the four boundary edges, whereas the large-scale specimens with free edges have large cracking at the top and bottom that do not extend through the depth of the concrete. As indicated in Reference 21 to MPR-4153, this large cracking along the middle of the width is an edge effect unique to the design of the test specimen that may not be representative of Z-direction expansion of the entire specimen, and this effect is not likely to occur in actual structures with different restraints at the boundary. Even though the applicant stated that there is correction accounting for the crack by normalizing the expansion along the entire thickness of the beam as opposed to just between the deep pins, it appears that the measured top and bottom "expansions" across the width are predominantly a measure of the surface deformation from propagation of the wide discrete surface crack developed in the top and bottom faces of the test specimen, and the measurements at these two surfaces are possibly outliers, and thus not representative of ASR expansion on the specimen. It appears that this methodology would likely result in significantly larger measurements in the top and bottom (which the applicant has indicated are the areas currently being measured) that could cause the expansion to be inflated versus the true through-thickness measurements. Therefore, it is not clear that the through-wall expansion measured from the freely expanding deep pins in the large-scale specimens is a true representation of expansion in the through-wall direction for these specimens. The expansion measurements used for correlation and comparison to Seabrook appear not to have an appropriate correction for this phenomenon, nor is there information to indicate that measurements are being taken at the center of the specimen. Thus, it is not clear whether the ASR strain measurements in the large-scale specimens are accurate for direct comparison.

   Further, it appears that cores taken from the test specimens for measurement of elastic modulus at the time of expansion measurement do not traverse the large surface crack; therefore, its effect is not captured in the measured elastic modulus used for developing the correlation with measured expansion. Therefore, it is not clear whether outlier "expansion" measurements (i.e., on the surface with pins) in the large scale specimens can be directly associated with elastic modulus reduction of cores taken from the center where the large crack and free expansion is not occurring.

   The methodology proposed by the applicant is such that this measured expansion value is applied directly to elastic modulus reduction factors (i.e., normalized modulus) which will be direct surrogates for expansion to-date in Seabrook structures; it is not clear whether this method of measuring expansion will accurately represent Seabrook expansion to date. The through-thickness expansions measured on the width of test specimen (even with the correction) appears to potentially overestimate the ASR expansion. This measured expansion on the specimen may not be conservative in developing the relationship between expansion and normalized modulus used to correlate the large scale test data to the actual structure and may need to be further corrected.

2) *Boundary conditions of Seabrook structures and components:* For the large-scale beam test specimens, there is no external restraint and the progression of ASR is likely to be relatively more uniform in the specimen because of the significantly aggressive reactive material in the concrete mix uniformly distributed through the volume to facilitate accelerated expansion. The boundary conditions (constraints at the boundary edges) of the test specimens are generally free on all the edges. The test specimens do not appear to represent the boundary conditions of the structural components (e.g., walls) and other external restraints on Seabrook structures. In addition to internal confinement provided by the reinforcement, the boundary conditions of the monolithically constructed structural system and components and other external features, such as concrete structural fill in below-grade areas, may also provide significant external restraint that influences the overall expansion and distribution of aging effects (e.g., cracking) from ASR in the Seabrook structures. Further, in the actual structures, ASR results in differential volumetric expansion that is initiated and propagated randomly in a non-uniform manner. As a result of these boundary conditions, the volumetric expansion (i.e., swelling of the gel) will re-orient in the direction(s) of least restraint, which at the component level may be the out-of-plane direction, but likely more focused in the more unrestrained surface layers near the reinforcement mat; or at the structural system level in the global direction of least restraint (e.g., could be vertical or some other dimension). It is not clear whether through-wall measurements are fully representative of volumetric expansion. Since the boundary conditions are different between the large-scale specimens and the Seabrook walls, resulting in potentially different through-wall expansion behavior, the staff needs additional information to determine whether through wall measurements as the single monitoring parameter are sufficient and a basis for direct comparison of large-scale test specimens to Seabrook structures and structural components that are also subject to external restraint.

3) The descriptions in LRA Sections A.2.1.31A and B.2.1.31A, as revised by applicant's response to RAI B.2.1.31A-5(a), do not appear to include reference to the technical basis document(s) (e.g., Report MPR-4153) used by the revised AMP to correlate the large-scale test program results to Seabrook structures.

Request:

1) Considering the issues above, provide information, with supporting objective evidence, to demonstrate that ASR expansions observed and measured (even after proposed correction) on the large-scale test specimens at FSEL are representative of ASR effects on actual Seabrook structures, and appropriate for correlation of results between test specimens and actual Seabrook structures.

2) Since ASR results in volumetric expansion that can reorient in direction(s) of least restraint, explain why out-of-plane expansion (and not volumetric strain) is considered the appropriate parameter to correlate test results to Seabrook structures.

3) Update the ASR Monitoring Program elements and UFSAR supplement, as applicable, based on the response, and also to incorporate by reference the document(s) (e.g., Report MPR-4153) used as the technical basis for methodologies used by the AMP to correlate the large-scale test program results to Seabrook structures.

B.2.1.31A-5(a2): ***Uncertainties and Variations Associated with Estimate of Normalized Modulus***

Background:

In its response to RAI B.2.1.31A-5(a), dated June 30, 2015, the applicant included as Enclosure 4 the report MPR-4153, Revision 1, "Seabrook Station – Approach for Determining Through-Thickness Expansion from Alkali-Silica Reaction (Proprietary)" as the technical basis for the proposed methodology to quantitatively relate the extent alkali-silica reaction (ASR) in existing plant structures at Seabrook Station to the results of the large-scale test program at the FSEL. Figure 3-3 and Equation 1 of the report show the development of the correlation between normalized concrete modulus and expansion data from the test specimens. Based on Sections 3.1.1 and 3.2.1 of report MPR-4153, the normalized modulus value used in Figure 3-3 and Equation 1 of the report for developing the relationship between normalized modulus and through-thickness expansion, is the ratio (E_t/ E_0) of the elastic modulus by testing cores extracted from the specimen at the time of expansion measurement (E_t) to the 28-day elastic modulus (E_0) obtained by testing cylinders (8 inches in height and 4 inches in diameter), that were molded at the time of specimen fabrication, at age 28 days.

Section 3.3 of report MPR-4153 describes two approaches for obtaining elastic modulus at 28 days in Seabrook structures for the purpose of normalization and determining the expansion to date. "Approach 1" uses 28-day elastic modulus calculated using the American Concrete Institute (ACI) 318 equation based on original concrete cylinder strength (f'_c) measured at 28 days. For "Approach 2," MPR-4153 states that it plans to test the elastic modulus of the cores obtained during installation of extensometers at "control locations where ASR has not affected the structure." MPR-4153 states that the applicant "should evaluate selection of a representative reference core on a case-by-case basis.

In both approaches, there are variations introduced in the estimate 28-day elastic modulus from the use of the ACI 318 equation based on 28-day cylinder strength (“Approach 1”) or measured elastic modulus from cores because of change (i.e., increase) in concrete strength with age (“Approach 2”). In both cases, the normalized modulus at the time of installation of extensometers is determined as the ratio of the measured modulus on cores extracted at the installation location to the 28-day modulus estimate from Approach 1, or Approach 2, or both.

Section 3.3.1 of MPR-4153, states:

> NextEra has retrieved records for concrete fabrication from original construction for selected buildings…For structural assessment of particular concrete members; application of values from [MPR Calculation 0326-0062-CLC-02] will need to be evaluated on a case-by-case basis to determine whether the available data are sufficiently representative of the concrete being evaluated. NextEra may need to retrieve additional original construction records to implement this approach.

Section 4.2 of MPR-4153 discusses an uncertainty value related to the approach for determining original elastic modulus but does not give any information regarding the methodology for determining this uncertainty value.

Issue:

- Report MPR-4153 does not provide the size, orientation, and locations of cores extracted from test specimens to be used in conducting tests for concrete material properties at the time of expansion measurement and load test.

- It is not clear if using the concrete material properties (i.e., modulus); from cylinder test, data at 28-days and core test data from the large scale beam specimens at the time of expansion measurement is appropriate for normalization of elastic modulus to determine ASR degradation. It is not clear whether the error associated with variations such as type of specimen (cylinder vs core) and size (diameter, d; height, h; and h/d ratio) of test specimens used may influence the values obtained for the normalized modulus were considered in the calculation of uncertainty or in the development of the correlating factors between expansion and normalized modulus.

- It is not clear what value of f'_c (mean, median, or probability of exceedance consistent with the statistical basis in the ACI 318 code) will be used in the ACI 318 equation for arriving at the 28-day elastic modulus based on 28-day test data of cylinder strength.

- With regard to the statement from Section 3.3.1 of MPR-4153 referenced in the “Background” section above, it is not clear how the applicant will assess the data and the criteria to be used to determine whether the available data are “sufficiently representative.” It is not clear whether original data is available and if not, how the inputs to the modulus calculation will be determined.

- Uncertainties and variations associated with the recommended correlating approach based on estimate of normalized elastic modulus on the test specimens and on Seabrook structures are not addressed and it is not clear whether they need to be addressed statistically in a bounding manner.

Request:

The staff requests information for resolution of the issues in the issue section.

1) Provide additional information regarding the methodology used to determine the uncertainty value associated with developing the empirical relationship between concrete material property and measured expansion. Include the basis for determination of the uncertainty value used for the normalized correlation between expansion and reduction in elastic modulus.

2) Discuss whether and how the methodology considered factors such as size variation, orientation and locations of cores from the test specimens used in measuring concrete material properties, including elastic modulus. In addition, discuss whether and how the methodology considered uncertainty or errors associated with comparison between concrete cylinders 28-day test data and extracted cores. If these factors were not considered, provide technical justification that such consideration is not needed.

3) Clarify, with the basis, what value of f'_c (mean, median, or probability of exceedance consistent with the statistical basis in the ACI 318 code) will be used in the ACI 318 equation in “Approach 1” for arriving at the 28-day elastic modulus based on 28-day test data of cylinder strength of Seabrook structures.

4) With regard to the statement from Section 3.3.1 of report MPR-4153 referenced in the “Background” section above, clarify how the applicant will assess the data and the criteria to be used to determine whether the available data are “sufficiently representative.” Also clarify whether “original data” referenced in that statement are available and if not, how the inputs to the modulus calculation will be determined.

B.2.1.31A-5(a3): ***Representative Sample for Monitoring Through-wall Expansion***

Background:

The applicant’s response to RAI B.2.1.31A-5(a), dated June 30, 2015, states that the ASR Monitoring Program will be enhanced (revised Commitment No. 83) to install borehole extensometers in at least 34 representative locations that the applicant has stated are representative of the ASR on site such that the program will monitor, trend, and assess ASR expansion in the out-of-plane (through-wall) direction.

Section A.1.2.3.4 “Detection of Aging Effects” of Appendix A.1 “Aging Management Review – Generic (Branch Technical Position RLSB-1) of SRP-LR states, in part:

> For a condition monitoring program, when sampling is used to represent a larger population of SCs, applicants should provide the basis for the inspection population and sample size. The inspection population should be based on such aspects of the SCs as a similarity of materials of construction, fabrication, procurement, design, installation, operating environment, or aging effects. The sample size should be based on such aspects of the SCs as the specific aging effect, location, existing technical information, system and structure design, materials of construction, service environment, or previous failure history. The samples should be biased toward locations most susceptible to the specific aging effect of concern in the period of extended operation. Provisions on expanding the sample size when degradation is detected in the initial sample should also be included.

Section A.1.2.3.4 “Detection of Aging Effects” of the SRP-LR also states that this program element describes “when,” “where,” and “how” program data are collected (i.e., all aspects of activities to collect data as part of the program), including how frequently evaluated. The section further states that the discussion should provide information that links the parameters to be monitored or inspected to the aging effects being detected and managed prior to loss of function.

Issue:

1) The response to RAI B.2.1.31A-5(a), dated June 30, 2015, does not include an update to the “detection of aging effects” program element of the ASR Monitoring Program with the information recommended in Section A.1.2.3.4 of SRP-LR (as described in the Background section) with regard to the representative sample of locations and aspects of activities to collect and evaluate data in the program enhancement to monitor out-of-plane ASR expansion.

2) In the breakdown of number of instruments to be installed provided in the applicant’s response to RAI B.2.1.31A-5(a), Issue No. 3, almost 50 percent of the extensometers are to be installed in “Tier 1” ASR locations and over 50 percent will be installed in “Ambient Weather Conditions.” The staff needs additional information to determine whether the chosen locations and sample will be sufficient to manage through-wall cracking.

3) ASR damage is likely to progress more quickly in areas of high humidity and temperature. It is not clear, from the tables given in the RAI response, whether the most severe areas are well-represented. It is also not clear whether the areas that exhibit the highest combined crack index (CCI) are the most severely affected areas, and the criteria that will be used to determine if an increase in sample size is required.

4) The response to RAI B.2.1.31A-5(a) does not appear to address the durability and long-term reliability of the borehole extensometer proposed to be used to monitor out-of-plane expansion, and how the measurements would continue if an extensometer became non-functional in service. The response also does not discuss the data acquisition system that will be used to gather and process data from the proposed extensometers to ensure adequate aging management.

Request:

The staff requests information for resolution of the issues in the Issue section with regard to the representative sample for monitoring through-wall expansion. Also, the staff requests the applicant to update the "detection of aging effects" program element to the ASR Monitoring Program and UFSAR supplement, as applicable and appropriate (based on the response).

1) Provide an update to the "detection of aging effects" program element of the ASR Monitoring Program with information recommended in Section A.1.2.3.4 of SRP-LR (as stated in the background section) to describe the basis for (a) the inspection population and sample size and (b) all aspects of activities to collect data, including how frequently the data are sampled and evaluated, regarding representative sample of locations in the program enhancement to monitor out-of-plane ASR expansion.

2) Provide additional information to demonstrate the adequacy of sampling locations for through-wall cracking management (i.e., determination of whether the chosen locations and sample will be sufficient to manage through-wall cracking).

3) Provide additional information to demonstrate the bounding conditions of the aging management measures relative to (a) sampling most severe locations (correlation with CCI) and (b) triggering point for increasing sample size.

4) Provide additional information to demonstrate the reliability of the aging management measures relative to durability of supporting instrumentation (e.g., borehole extensometer and data acquisition system).

RAI B.2.1.31A-5(a4): ***CCI as a surrogate for ASR expansion in the in-plane direction***

Background:

The applicant's response to RAI B.2.1.31A-5(a), dated June 30, 2015, for Issue 1 states that "CCI [Combined Crack Index] is used as a surrogate for accumulated strain from ASR expansion in the in-plane directions."

In the changes to LRA Section B.2.1.31A by letter dated September 13, 2013, under "Program Description," the applicant provided the basis for use of the crack index methodology on page 8 of 18 of Enclosure 1. The applicant states "The total strain in the concrete can be approximated as the sum of the strain at crack initiation plus the crack index ($\varepsilon = \varepsilon_{cr}$ + CI)…" The applicant provided an illustration in Figure A-1 of the expansion in ASR-affected concrete and goes on to conclude that "the Cracking Index (CI) provides a reasonable approximation of the total strain applied to the concrete after crack initiation." SRP-LR, Section A.1.2.3.3, states that the "parameters monitored or inspected" program element should provide a link between the parameters that will be monitored and how monitoring these parameters will ensure adequate aging management.

<u>Issue</u>:

While continued surface crack indexing may be a necessary component for a complete measure of ASR expansion, which is volumetric in nature, there is a lack of clarity in the ASR Monitoring Program with regard to the following.

- It is not clear whether the applicant's statement referenced in the "Background" section is indicating that the large-scale test program directly measures rebar strain and correlates to CCI. For its review, the staff needs additional information in support of the statement that CCI is a "surrogate for accumulated strain."

- In order to maintain strain compatibility between concrete and rebar in ASR-affected concrete, the strain in the rebar will be equal to the strain applied to the concrete. Therefore, a CCI of 1 mm/m (which is the acceptance criteria used in the program to distinguish between Tier 2 and Tier 3 criteria for initiation of a structural evaluation corresponds to 1 millistrain of expansion resulting in rebar stress of 29 ksi. The staff is concerned that this may represent a significant magnitude of rebar stress due to ASR expansion that has not been or will not be accounted for during the period of extended operation. The program does not address rebar strain limits as compared to ASR progression through the period of extended operation to ensure the concrete maintains its design functionality.

- The current AMP uses the Tier 1-2-3 approach to determine monitoring frequency and it relies upon CCI in two directions. It is not clear if and how CCI will be used to characterize ASR progression during the period of extended operation. Also, there is lack of clarity with regard to the correlation of CCI with anchor bolt capacity.

- It is not clear whether in-plane cracking measurements will be used, qualitatively or quantitatively, in conjunction with through-wall expansion measurement data, to characterize ASR severity or progression.

Request:

The staff requests information for resolution of the issues in the Issue section.

1) Clarify the physical significance of CCI as a surrogate for strain in rebar due to ASR as explained in the applicant's revision to LRA Section B.2.1.31A by letter dated September 13, 2013, and whether and how the corresponding rebar stress is accounted for.

2) Clarify whether the large-scale test program directly measures rebar strain and correlates to CCI. Provide the technical basis as to how CCI correlates to stress in the rebar and how rebar stress is quantified.

3) Describe the role of CCI in the large scale test program with regard to correlating the test results to Seabrook structures and components, including evaluating impact on anchor capacity.

4) Clarify, with supporting basis, if and how the program will account for information gained from the elastic modulus testing in terms of comparison of ASR severity for monitoring purposes.

5) Clarify whether in-plane cracking measurements will be used, qualitatively or quantitatively, in conjunction with through-wall expansion measurement data, to characterize ASR severity or progression.

6) Update program elements and UFSAR supplement, as applicable, based on the responses.

Letter to D. Curtland from R. Plasse dated October 2, 2015

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION RELATED TO THE REVIEW OF THE SEABROOK STATION LICENSE RENEWAL APPLICATION – SET 25 (TAC NO. ME4028)

DISTRIBUTION:

HARD COPY:
DLR RF

E-MAIL:
PUBLIC
RidsNrrDlr Resource
RidsNrrDlrRpb1 Resource
RidsNrrDlrRpb2 Resource
RidsNrrDlrRarb Resource
RidsNrrDlrRasb Resource
RidsNrrDlrRerb Resource
Listserv

Richard.Plasse@nrc.gov
Lois.James@nrc.gov
Tam.Tran@nrc.gov
James.Danna@nrc.gov
Brian.Wittick@nrc.gov
Dennis.Morey@nrc.gov
John.Lamb@nrc.gov
David.McIntyre@nrc.gov
Eugene.Dacus@nrc.gov
Brian.Harris@nrc.gov
Glenn.Dentel@nrc.gov
Paul.Cataldo@nrc.gov
Christopher.Newport@nrc.gov
Nancy.McNamara@nrc.gov
Doug.Tifft@nrc.gov
Neil.Sheehan@nrc.gov
Diane.Screnci@nrc.go