



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION**  
REGION I  
2100 RENAISSANCE BOULEVARD, SUITE 100  
KING OF PRUSSIA, PA 19406-2713

August 10, 2018

Mr. Mano Nazar  
President and Chief Nuclear Officer  
Nuclear Division  
NextEra Energy Seabrook, LLC  
Mail Stop: EX/JB  
700 Universe Blvd.  
Juno Beach, FL 33408

**SUBJECT: SEABROOK STATION, UNIT NO. 1 – FOLLOW-UP OF ALKALI SILICA  
REACTION OPEN ITEM LICENSE RENEWAL INSPECTION REPORT  
05000443/2018011**

Dear Mr. Nazar:

On May 3, 2018, the U.S. Nuclear Regulatory Commission (NRC) completed an on-site team inspection at Seabrook Station, Unit No. 1 as part of the license renewal review process. The scope of this inspection was to examine plant activities and documents that support the application for a renewed license at Seabrook Station as they relate to managing the effects of aging due to alkali silica reaction (ASR) in concrete structures. The NRC inspectors discussed the results of this inspection with Mr. Christopher Domingos, Site Director, and other members of your staff via a teleconference exit on June 27, 2018. The results of this inspection are documented in the enclosed report.

The presence of ASR in Seabrook Station concrete structures was identified in 2010. The NRC completed a license renewal team inspection in 2011, which determined that except for the ASR issue, the inspection results supported a conclusion of reasonable assurance with respect to managing the effects of aging in systems, structures and components identified in NextEra's license renewal application for the Seabrook Station. The team noted, at that time, NextEra was developing programs to manage the effects of ASR on Seabrook Station concrete structures and that additional NRC inspection was warranted once these programs were finalized. The NRC subsequently completed two team inspections on this technical issue, and since 2013, conducted inspections approximately every six months to evaluate NextEra's activities to develop and implement your structural aging management programs. This inspection follows-up on the 2011 license renewal inspection.

The inspectors reviewed procedures and records related to your monitoring of the effects of ASR in Seabrook concrete structures, observed activities, interviewed personnel, and conducted plant walk downs of several areas to independently assess structural condition. No findings or violations of NRC requirements were identified during this inspection.

The inspection team concluded that for the ASR issue, your staff adequately performed scoping and screening of structures, systems, and components as required in 10 CFR 54.4(a) and 54.21, respectively, and established aging management programs as described in the license renewal application. The inspection further concluded the documentation supporting the application was in an auditable and retrievable form. The inspection results support the conclusion that there is reasonable assurance that the effects of aging due to ASR in the Seabrook systems, structures, and components will be managed through implementation of

these programs as described in the application for a renewed license currently under review by the NRC Office of Nuclear Reactor Regulation.

This letter, its enclosure, and your response (if any) will be made available for public inspection and copying at <http://www.nrc.gov/reading-rm/adams.html> and at the NRC Public Document Room in accordance with 10 CFR 2.390, "Public Inspections, Exemptions, Requests for Withholding."

Sincerely,

***/RA/***

Mel Gray, Chief  
Engineering Branch 1  
Division of Reactor Safety

Docket No. 50-443  
License No. NPF-86

Enclosure:  
Inspection Report 05000443/2018011

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SUBJECT: SEABROOK STATION, UNIT NO. 1 – FOLLOW-UP OF ALKALI SILICA REACTION OPEN ITEM LICENSE RENEWAL INSPECTION REPORT 05000443/2018011 DATED AUGUST 10, 2018

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 ADAMS Accession No. ML18222A292

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**U.S. NUCLEAR REGULATORY COMMISSION  
Inspection Report**

Docket Number: 50-443

License Number: NPF-86

Report Number: 05000443/2018011

Enterprise Identifier: I-2018-011-0039

Licensee: NextEra Energy Seabrook, LLC (NextEra)

Facility: Seabrook Station, Unit No. 1 (Seabrook)

Location: Seabrook, NH

Inspection Dates: 04/30/2018 – 05/03/2018 (on-site)  
05/23/2018 – 06/27/2018 (in-office)

Team Lead: Niklas Floyd, Senior Reactor Inspector, Region I, DRS

Inspector: Angela Buford, Structural Engineer, NRR, DE

Approved By: Mel Gray, Chief  
Engineering Branch 1  
Division of Reactor Safety

## SUMMARY

The U.S. Nuclear Regulatory Commission (NRC) conducted a license renewal follow-up inspection at the Seabrook Station in accordance with the Reactor Oversight Process. The Reactor Oversight Process is the NRC's program for overseeing the safe operation of commercial nuclear power reactors. Refer to <https://www.nrc.gov/reactors/operating/oversight.html> for more information.

NRC inspectors from Region I and the Office of Nuclear Reactor Regulation performed on-site inspections of the applicant's license renewal activities, specifically those related to alkali-silica reaction (ASR). The team performed the evaluations in accordance with Manual Chapter 2516, "Policy and Guidance for the License Renewal Inspection Programs," and Inspection Procedure 71002, "License Renewal Inspection." With regards to ASR, the team concluded the applicant adequately performed scoping and screening of structures, systems, and components as required in 10 CFR 54.4(a) and 54.21, respectively, and established aging management programs as described in the license renewal application. The team concluded that the applicant provided documentation that supported the application and inspection process in an auditable and retrievable form. The inspection results support the conclusion that there is reasonable assurance that the effects of aging due to ASR in the Seabrook systems, structures, and components will be managed through implementation of these programs as described in the application for a renewed license currently under review by the NRC Office of Nuclear Reactor Regulation.

No findings or more-than-minor violations were identified.

## **INSPECTION SCOPE**

This inspection was conducted using the appropriate portions of the applicable inspection procedures (IPs) in effect at the beginning of the inspection unless otherwise noted. Currently approved IPs with their attached revision histories are located on the public website at <http://www.nrc.gov/reading-rm/doc-collections/insp-manual/inspection-procedure/index.html>. The inspectors reviewed selected procedures and records, observed activities, and interviewed personnel to assess NextEra's performance and compliance with Commission rules and regulations, license conditions, site procedures, and standards.

## **OTHER ACTIVITIES – TEMPORARY INSTRUCTIONS, INFREQUENT, AND ABNORMAL**

### 71002 – License Renewal

#### Scope of Review

The NRC performed an inspection of NextEra's license renewal and aging management activities to address concrete degradation due to the effects of ASR. The purpose of this inspection was to determine whether the actions taken by NextEra since the previous IP 71002 inspection in 2011 were adequate to manage the effects of aging in concrete structures due to ASR at the Seabrook Station by meeting the following three objectives:

- To verify the applicant's license renewal program, including supporting activities, are planned or implemented in accordance with the requirements of 10 CFR 54 and the applicant's license renewal application.
- To verify the applicant has adequate programs planned or in place to implement aging management for the structures, systems, and components that require an aging management review.
- To verify the information and documentation required are retrievable, auditable and consistent with the license renewal application and approved programs and procedures.

#### Background

On May 25, 2010, NextEra submitted to the NRC its application for renewal of its operating license for Seabrook Station, Unit No. 1 (ADAMS Accession Number ML101590099). NextEra requested renewal of the operating license for an additional 20 years beyond the current 40-year license, which expires on March 15, 2030. During preparations for license renewal in the 2009 to 2010 timeframe, NextEra identified that the intrusion of moisture into sections of walls in certain below-grade structures at the Seabrook Station could cause potential degradation of some of the concrete as evidenced by pattern cracking. The petrographic examination of concrete core samples subsequently confirmed that the pattern cracking occurring in Seabrook Station structures was due to ASR. The reaction forms a gel that can expand and cause micro-cracks in the concrete. The Seabrook Station was the first nuclear power plant in the United States to identify the presence of the ASR in its concrete structures.

On April 8, 2011, the NRC completed a license renewal inspection (ML111360432) utilizing NRC IP 71002 as part of the review process for the license renewal application. The inspection was conducted by a team of NRC regional experts with materials and license renewal backgrounds. The inspection team concluded scoping and screening of non-safety related systems, structures, and components were implemented as required in 10 CFR 54.4(a)(2), and the aging management portions of the license renewal activities were planned or implemented as described in the license renewal application. The team further concluded that except for the ASR issue, the inspection results supported a conclusion of reasonable assurance with respect to managing the effects of aging in the systems, structures, and components identified in the application. The inspection team noted that NextEra staff were developing an initial response to the aging effects of ASR and that investigation and testing were ongoing. As a result, the inspection team was unable to arrive at a conclusion about the adequacy of the aging management review for the ASR issue.

Consistent with this conclusion, the NRC staff reviewing the license application designated as Open Item, OI 3.0.3.2.18-1, in the Seabrook Station license renewal draft Safety Evaluation Report (ML12160A374), NRC staff concerns that NextEra had not adequately enhanced the Structures Monitoring Program to manage the effects of ASR. NextEra communicated plans to submit additional information to the NRC to provide for an acceptable program to manage the effects of ASR.

At an April 23, 2012, public meeting with NextEra, NRC staff discussed their focus on the long-term operability of the affected structures. Subsequently, by letters dated May 3 and May 10, 2012 (ML12125A022 and ML12131A479), NextEra described the actions it would take to address the degraded conditions as well as to ensure that Seabrook Station continued to meet its current licensing basis as a result of the ASR issue. The NRC issued a Confirmatory Action Letter (CAL) to confirm the actions committed to by NextEra (ML12125A172). The NRC conducted two team inspections that comprehensively reviewed selected procedures and records, observed activities, and interviewed station personnel regarding the adequacy of NextEra's actions to address the impact of ASR on reinforced concrete structures, which was documented in inspection reports dated December 3, 2012 and August 9, 2013 (ML12338A283 and ML13221A172). Based on the reviews of NextEra's actions to complete these commitments, the NRC issued a CAL closure letter on October 9, 2013 (ML13274A670). Further significant corrective actions were in progress at the time of the closure letter, including a planned test program of ASR-affected large scale concrete specimens at the University of Texas, Ferguson Structural Engineering Laboratory.

On September 3, 2013, the NRC documented in a mid-cycle performance review letter to NextEra (ML13246A107) NRC plans to continue to provide focused oversight of the testing being conducted at the Ferguson Structural Engineering Laboratory and the continual assessment of ASR progression in the on-site Seabrook Station concrete structures. The NRC inspection activities were conducted using focused Problem Identification and Resolution samples in accordance with NRC IP 71152 on a semi-annual frequency. The following table provides a list of these inspections completed to date:

<b>Date</b>	<b>Inspection Report Number</b>	<b>ADAMS Accession Number</b>
01/30/2014	05000443/2013005	ML14030A509
05/06/2014	05000443/2014002	ML14127A376
02/06/2015	05000443/2014005	ML15037A172
08/05/2015	05000443/2015002	ML15217A256
02/12/2016	05000443/2015004	ML16043A391
05/06/2016	05000443/2016008	ML16127A155
02/08/2017	05000443/2016004	ML17040A220
08/14/2017	05000443/2017002	ML17227A018
02/12/2018	05000443/2017004	ML18043A821
05/14/2018	05000443/2018001	ML18134A222

During a plant tour on May 23, 2014, NRC inspectors identified several instances of large, discrete cracks in the residual heat removal equipment vaults. The NRC issued a finding of very low safety significance in an inspection report dated August 5, 2014 (ML14212A458) because NextEra did not perform an adequate technical evaluation when it was determined the crack sizes exceeded the quantitative limits specified in NextEra procedures. Later in 2015, NRC inspectors observed degraded seismic and fire seals that appeared to have been caused by differential movement between adjoining concrete buildings. NextEra staff initiated a root cause that confirmed some of the structures affected by ASR had evidence of bulk expansion (macro-cracking and some reinforced concrete wall displacements) due to the aggregate effect of induced micro-cracking. The bulk expansion due to ASR resulted in building deformation and impacted some structures, systems, and components attached to the adjoining structures as evident by deformed flexible conduit couplings and reduced seismic isolation gaps. The building deformation (observed in structures such as the residual heat removal equipment vaults and the containment enclosure building) and its impact to equipment were considered a new phenomenon related to the effects of ASR, and NextEra subsequently developed an additional plant-specific aging management program to manage this effect.

In a report dated December 17, 2015 (ML15337A047), NRC staff from the Office of Nuclear Reactor Regulation, Division of License Renewal, documented the results of an audit performed at the Ferguson Structural Engineering Laboratory at the University of Texas at Austin. The purpose of the audit was for staff to establish a clear understanding of NextEra's large-scale test program and its use as a technical basis for developing elements of the plant-specific aging management program. Prior to the audit, the NRC staff issued requests for additional information pertaining to various staff concerns with the current aging management program. One of those concerns included addressing recent operating experience concerning building deformation caused by bulk ASR expansion. Based on this audit, the NRC staff found that additional information was still needed in order for the NRC staff to complete its review of the aging management programs as part of the license renewal application.

In February 2016, NextEra completed its testing of large-scale ASR-affected test specimens at the Ferguson Structural Engineering Laboratory, and based on results from the testing program, NextEra enhanced its Structures Monitoring Aging Management Program for both the Alkali-Silica Reaction Monitoring and the Building Deformation Monitoring programs. On August 9, 2016, the NRC received NextEra's updated license renewal application submittal



which included these updates to the aging management programs (ML16224B079). The NRC sent several requests for additional information to which NextEra subsequently responded. Further NRR audits were conducted as documented in reports dated December 21, 2016 (ML16333A247), and July 26, 2017 (ML17199T383). The NRC completed an audit of the license renewal application in March 2018 and documented the results in a site audit report (ML18135A046).

The inspectors recognized the significant passage of time between the previous license renewal inspection and this current inspection with regard to issues outside of ASR. Therefore, the inspectors coordinated with NRC staff in the Division of Materials and License Renewal to review the license renewal application supplements and the annual update letters submitted since the 2011 inspection to identify any significant changes that would warrant re-inspection and inclusion in the scope of this IP 71002 inspection. No issues requiring re-inspection were identified; therefore, the scope of this inspection was focused on the review of the open item from the license renewal inspection conducted in 2011 related to managing the aging effects of ASR at the Seabrook Station.

## INSPECTION RESULTS

Observation	71002 License Renewal
<p>NextEra staff completed activities as part of a long-term corrective action plan to address the aging effects of ASR to include identification, evaluation, structural monitoring and corrective actions including modifications. A significant part of NextEra's activities included completion of a large-scale testing program to better understand the impact of ASR on structural performance and enhancements to the on-site monitoring programs through the use of various tools such as crack gauges and through-wall expansion measurements. The NRC conducted previous inspections of NextEra's testing program and periodic on-site visits to review the ongoing structures monitoring program implementation and results, which were documented in publicly-available NRC inspection reports. These inspections also provided insights into staff review of Seabrook Station's License Amendment Request 16-03, "Revise Current Licensing Basis to Adopt a Methodology for the Analysis of Seismic Category I Structures with Concrete Affected by Alkali-Silica Reaction," that NextEra submitted on August 1, 2016. The NRC verified during those previous inspections that operating experience from testing and on-site observations at the Seabrook Station were appropriately considered for input into applicable aging management programs.</p> <p>During this license renewal inspection, the inspectors reviewed the following Seabrook Station aging management programs: Structures Monitoring, Alkali-Silica Reaction, and Building Deformation. The inspectors noted the programs were organized such that the Alkali-Silica Reaction and Building Deformation Aging Management Programs were both implemented under the Structures Monitoring Program. The Structures Monitoring Aging Management Program is the parent program to monitor the condition of structures and structural components within the scope of the Maintenance Rule and license renewal, such that there is not a loss of intended safety function. The Alkali-Silica Reaction Aging Management Program monitors cracking due to expansion and reaction with aggregates in concrete structures to evaluate the impact of ASR on the structural strength and anchorage capacity. The Building Deformation Aging Management Program monitors location-specific criteria, based on initial crack measurements and a building-specific structural evaluation, to evaluate the impact of deformation on the structural function. This program also monitors and</p>	

evaluates the impact to functionality of systems and components that are connected and/or adjoining to the affected structures.

The inspectors reviewed Seabrook Station's procedures for monitoring and evaluating reinforced concrete structures susceptible to ASR degradation to verify that parameters to be monitored and monitoring frequencies specified were being implemented in accordance with the license renewal application. For the ASR program, the inspectors reviewed a sample of results from in-plane expansion measurements, which were trended using combined crack indexing and embedded pins. The frequency was verified for Tier II locations (cracking > 0.5 mm/m) to be every 30 months and for Tier III locations (cracking > 1.0mm/m) to be every 6 months. The inspectors further verified that all Tier III locations were being monitored for through-thickness expansion, measured via borehole extensometers. The inspectors also verified the in-plane and through-thickness expansion for all structures remained below the established limits described in the procedure and based on the results from NextEra's large-scale testing program.

For the Building Deformation program, the inspectors reviewed a sample of location-specific monitoring criteria (e.g., in-plane strain rate, crack widths/lengths, structural dimensions, equipment offsets) at the frequency established from the individual structural evaluations. The inspectors noted that all ASR-affected structures were to receive a structural evaluation and that several evaluations were in progress with an estimated completion date of September 2018. Once a structural evaluation was performed for building deformation, the monitoring frequency was established based on the limiting criteria from the ASR and Building Deformation programs. For components impacted by structural deformation, the inspectors reviewed a sample of results from walk downs conducted at a minimum frequency of every 2 years focused on features including, but not limited to, distorted flexible couplings, non-parallel HVAC joints, distortions or tears in seals, crimped tubing, offset hanger rods, and misaligned pipe flanges.

The inspectors performed detailed walk downs of portions of the following structures:

- A and B Residual Heat Removal Equipment Vaults;
- Fuel Storage Building;
- Containment Enclosure Ventilation Area.

The inspectors reviewed criteria from the applicable structures monitoring procedures as described above to independently assess whether structural conditions and deficiencies such as discrete cracks, pattern cracking, concrete pop-outs, scaling, spalling, water ingress, coating separation or misalignment observed in these areas were previously identified by NextEra staff and appropriately evaluated against the applicable acceptance criteria. The inspectors accomplished this by comparing the results of their plant walk downs to the records in the Seabrook Station structures monitoring program database for these particular areas. The inspectors observed the database records included both quantitative measurements and qualitative descriptions accompanied by dated photographic documentation of the conditions by area. The inspectors independent walk downs and review of the database records did not identify any deficiencies that were not previously identified and evaluated by NextEra staff.

The inspectors further reviewed the condition of these areas as documented of the Seabrook Station structures monitoring program database to verify the results of previous examinations,

including identified deficiencies, photographic records and corrective actions, were documented, retrievable, and provided an auditable record of the conditions, trends and action taken. Based on these reviews, the inspectors concluded that NextEra staff were implementing their established processes in accordance with the plant procedures and structural deficiencies were being appropriately tracked, trended, and dispositioned.

The inspectors identified the following observations that were discussed with NextEra staff:

1. The inspectors identified several instances where the aging management programs docketed to the NRC as part of the license renewal application were not consistent with Seabrook Station's on-site processes and procedures. For example, the docketed Building Deformation Program in the license renewal application described the consideration of moment redistribution and the 100-40-40 percent rule for a detailed structural evaluation, however these methods were appropriately not utilized at Seabrook Station or included in their implementing procedures. These differences between the docketed aging management programs in the license renewal application and implementing procedures reflected changes made to their procedures by NextEra staff as a result of responses to NRC requests for information. These inconsistencies were also identified during the NRC audit in March 2018, and required an update to the license renewal application. The inspectors discussed the license renewal application documents in question with NextEra staff and determined that NextEra staff was in the process of making appropriate changes. Subsequent to the on-site inspection dates, NextEra submitted the revised aging management programs for ASR and Building Deformation to the NRC on May 18, 2018 (ML18141A785). The inspectors completed an in-office inspection of the submittal and found the docketed and updated Structures Monitoring Aging Management Programs to be consistent with the implemented processes and procedures reviewed during the on-site inspection between April 30 and May 3, 2018.
2. The inspectors identified that raw data for the Invar rods located in the Residual Heat Removal Vaults was being collected, but the data was not translated into units useful for monitoring and trending (i.e., inches displacement). The rods were installed to aid in measuring the vertical displacement of the vaults over a span of multiple building elevations. The inspectors noted that vertical displacement of the vaults was a parameter identified in Appendix C of the Structures Monitoring Program Manual with a threshold limit requiring periodic monitoring. Based on discussions with NextEra staff, the inspectors understood that there was an action being tracked (AR 02148021, Assignment No. 22) to develop a procedure to correlate the recorded electronic data to unit length and that the precision of the measurement technique would then be assessed against the standard specified by the vendor. The inspectors concluded that the monitoring and trending of the Invar data was not critical to detect degradation because a review of the other monitored parameters for the residual heat removal vault would adequately detect degradation in a timely manner.

Based on the previous NRC inspections of ASR-related issues completed to date and the results of this follow-up license renewal inspection, the NRC concluded that for the ASR issue, NextEra staff adequately performed scoping and screening of structures, systems, and components as required in 10 CFR 54.4(a) and 54.21, respectively, and established aging management programs as described in the license renewal application. The inspection further concluded the documentation supporting the application was in an auditable and retrievable form. The inspection results support the conclusion that there is reasonable assurance that the effects of aging due to ASR in the Seabrook systems, structures, and

components will be managed through implementation of these programs as described in the application for a renewed license currently under review by the NRC Office of Nuclear Reactor Regulation.

#### **EXIT MEETINGS AND DEBRIEFS**

The inspectors verified no proprietary information was retained or documented in this report.

- On May 3, 2018, the inspectors debriefed the preliminary license renewal inspection results to Mr. Eric McCartney, Regional Vice President, and other others of NextEra Staff.
- On June 27, 2018, the inspectors telephonically conducted an exit meeting of the license renewal inspection results with Mr. Christopher Domingos, Site Director, and other members of NextEra staff.

**DOCUMENTS REVIEWED**Procedures

ES1807.031, Inservice Inspection Procedure Primary Containment Section XI IWL Program, Revision 04

PI-AA-102-1001, Operating Experience, Revision 19

PI-AA-104-1000, Condition Reporting, Revision 17

SMP2.1, Structures Monitoring Inspections, Data Collection, and Evaluation, Revision 04

SMP3.1, ASR Monitoring Walkdowns, Data Collection, and Evaluation, Revision 02

SMP4.1, Building Deformation Monitoring Walkdowns, Data Collection, and Evaluation, Revision 05

SMP5.1, Equipment Impacted by Structural Deformation Monitoring Walkdowns, Data Collection, and Evaluation, Revision 03

SMPM, Structures Monitoring Program Manual, Revision 05 and 06

Condition Reports

00207755

00392697

02014325

02261159

02262440\*

\*initiated in response to inspection

Work Orders

40509687

40515022

40537747

40546928

Miscellaneous

2016 ASME IWL Examination Results, dated December 8, 2016

2016 IWL Containment Concrete Examination Plan, dated September 22, 2016

Extensometer Data of Through Thickness Expansions, dated May 2, 2018

FP 101154, March 2017 - Joint Width Measurements at Twenty-Five Seismic Isolation Joint Locations, Revision 0

FP101203, 2017 Tier 2 Inspections – ASR Inspections and Cracking Index Measurements on Concrete Structures, Revision 0

FP101204, 2017 Tier 2 Inspections – Measurements for ASR Expansion on Concrete Structures, Revision 0

FP101229, December 2017 Tier 3 Inspections – ASR Inspections and Cracking Index Measurements on Concrete Structures, Revision 0

FP101230, December 2017 Tier 3 Inspections – Measurements for ASR Expansion on Concrete Structures, Revision 0

LRAP-ASR, Aging Management Program Basis Document for Alkali-Silica Reaction (ASR) Monitoring Program, Revision 4

LRAP-BD, Aging Management Program Basis Document for Building Deformation Monitoring Program, Revision 1

LRAP-S002, Aging Management Program Basis Document for ASME Section XI, Subsection IWL, Revision 2

LRAP-S006, Aging Management Program Basis Document for Structures Monitoring Program, Revision 1

SBK-L-17180, Supplement 58 - Revised Alkali-Silica Reactor Aging Management Program, dated November 3, 2017

SBK-L-18028, Supplement 60 - Response to Final Requests for Additional Information for the Safety Review of the Seabrook Station License Renewal Application - ASME Section XI, Subsection IWL Program, dated February 28, 2018

SMP Program Health Reports from 1QTR 2013 to 2QTR 2018

Status of Building Deformation Structural Evaluations, dated 5-23-2018

Structures Monitoring Program Inspection Reports for A/B RHR Equipment Vaults, dated April 30, 2018