

U.S. NUCLEAR REGULATORY COMMISSION  
OFFICE OF NUCLEAR REACTOR REGULATION, DIVISION OF LICENSE RENEWAL  
SEABROOK ASR-MONITORING PROGRAM AUDIT REPORT

Docket No: 50-443

License No: NPF-86

Licensee: NextEra Energy Seabrook, LLC

Facility: Seabrook Station, Unit 1

Location: P.O. Box 300, Lafayette Road  
Seabrook, NH 03874

Dates: October 27-29, 2015

Auditors: Angela Buford, Structural Engineer, Lead Auditor, NRR  
George Thomas, Senior Structural Engineer, Division of License Renewal, NRR  
Bryce Lehman, Structural Engineer, Division of Engineering, NRR  
Brian Wittick, Branch Chief, Division of License Renewal, NRR  
Fred Bower, Branch Chief, Division of Reactor Projects, Region I

Approved By:   /RA/    
Brian Wittick, Chief  
Aging Management of Structures, Electrical, and Systems Branch  
Division of License Renewal  
Office of Nuclear Reactor Regulation

Concurred By  
e-mail: Fred Bower, Chief R-I/DRP/PB3  
Timothy Lupold, Chief NRR/DE/EMCB

ENCLOSURE

## SEABROOK ASR-MONITORING PROGRAM AUDIT REPORT

### 1 INTRODUCTION AND BACKGROUND

#### 1.1 Introduction

The U.S. Nuclear Regulatory Commission (NRC) staff from the Office of Nuclear Reactor Regulation (NRR), Division of License Renewal and Division of Engineering and Region I Division of Reactor Projects performed an audit of the NextEra Energy Seabrook, LLC (NextEra, or the Applicant) Alkali-Silica Reaction (ASR) Monitoring Aging Management Program (AMP) October 27-29, 2015. The audit was performed in support of the NRC staff's ongoing review of the Seabrook license renewal application (LRA). The ASR Monitoring Program (ASRMP) is a plant-specific AMP proposed by the applicant to manage aging effects of ASR on affected concrete structures at Seabrook Station such that intended functions will be maintained during the period of extended operation. The audit was performed at the Ferguson Structural Engineering Laboratory (FSEL) 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 at FSEL and its use as a technical basis for developing elements of the plant-specific AMP, and to observe a sample of the large-scale testing, in order to identify the potential need for additional information in support of the staff's review of the adequacy of the AMP to manage the effects of aging for structures affected by ASR. An additional purpose of the audit was for the staff to establish an understanding of the technical bases of the testing and witness a sample of the testing to support a potential license amendment request review in accordance with 10 CFR 50.90.

The regulatory bases for the audit were the requirements of Title 10 of the Code of Federal Regulations, Part 54 (10 CFR Part 54), Requirements for Renewal of Operating Licenses for Nuclear Power Plants; the guidance provided in Revision 2 of NUREG-1800, Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants (SRP-LR); and the guidance provided in Revision 2 of NUREG-1801, Generic Aging Lessons Learned (GALL) Report. Additional basis for the audit was 10 CFR 50.90, Amendment of License or Construction Permit at Request of Holder, in anticipation of the licensee submitting a license amendment based on the large-scale testing program as a technical basis to address an ASR-related non-conforming condition with the current licensing basis (CLB).

During its three-day audit, the NRC staff reviewed the applicant's testing program and program bases information, interviewed various applicant representatives, toured the test facilities, and observed test setup and shear tests of a large-scale concrete beam specimen. The staff conducted a review of the technical merits of the testing program as necessary to support a licensing decision in accordance with 10 CFR Part 54; additional NRC staff technical review would be performed pursuant to requirements of 10 CFR 50.90 as necessary to support

resolution of the applicant's CLB under 10 CFR Part 50. This audit report documents the results of the staff's activities during the audit.

## 1.2 Background

By letter dated May 25, 2010, the applicant submitted its application for license renewal for Seabrook Station, Unit 1. In letter dated May 16, 2012 (ADAMS Accession No. ML12142A323), the applicant supplemented its application to include a plant-specific ASRMP to manage the effects of aging due to ASR. The NRC staff conducted an audit of the plant-specific ASRMP dated November 18-20, 2013 (ADAMS Accession No. ML13354B785). By letter dated June 30, 2015 (ADAMS Accession No. ML15183A023), NextEra supplemented the LRA to incorporate additional information. In this submittal, the applicant stated for the first time that aspects of the "parameters monitored", "monitoring and trending", and "acceptance criteria", program elements of its ASR Monitoring plant-specific AMP are correlated to structural test data obtained from a large-scale testing program at the University of Texas at Austin, Ferguson Structural Engineering Laboratory (FSEL). The applicant also stated that the large scale testing program validates the use of ASR expansion to monitor the level and rate of ASR progression. By letter dated October 2, 2015, (ADAMS Accession No. ML15251A333), the staff issued requests for additional information based on the applicant's June 30, 2015, submittal.

## 2 LRA AMP B.2.1.31A, PLANT-SPECIFIC ASR MONITORING PROGRAM AUDIT SCOPE

Summary of Information Provided by the Applicant. The applicant's June 30, 2015, letter describes the applicant's use of data obtained from the large-scale test program at the University of Texas at Austin, Ferguson Structural Engineering Laboratory (FSEL) to correlate results of large-scale beam and block tests to ASR impact on Seabrook structures. The applicant also asserts that the testing program validates the use of expansion to measure ASR severity and monitor ASR progression. The June 30, 2015, letter states that the applicant plans to monitor through-wall expansion at the site through the use of borehole extensometers installed in drilled core bore holes in various locations and will continue to monitor combined cracking index (CCI) to monitor expansion in the in-plane directions. The applicant committed to install the borehole extensometers in at least 34 representative in situ locations, and provides several tables categorizing the locations by "exposure," "level of ASR," "type of concrete element," "thickness of concrete element," and "design compressive strength of concrete."

Included in the applicant's June 30, 2015, letter as Enclosure 4 is the report MPR-4153, Revision 1, titled "Seabrook Station – Approach for Determining Through-Thickness Expansion from Alkali-Silica Reaction," (hereafter referred to as MPR-4153). In this report, the applicant describes the basis for the proposed methodology to quantitatively relate the extent of ASR in existing plant structures at Seabrook to the large-scale testing results. The approach includes correlating measured through-wall expansion in large-scale test specimens and a corresponding reduction in modulus of elasticity with comparable loss in modulus of elasticity of cores drilled

from Seabrook structures. The applicant stated that to obtain data or original elastic modulus of plant concrete it may either opt to (“Approach 1”) use original 28-day compressive strength records from construction, or (“Approach 2”) measure elastic modulus of “control locations where ASR has not affected the structure.” It also stated that “the 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.” In addition, MPR-4153 states that there is an uncertainty value related to the approach for determining original elastic modulus.

MPR-4153 describes the applicant’s approach to measuring the through-wall expansion of test specimens and describes how the methodology includes correcting for deep pin locations and the existence of a large center crack in the through-thickness direction. The expansion measurement correction equation (Reference 21 of MPR-4153) is based on average measured through-thickness expansions across the total width using 9 sets of measurements across the breadth.

The applicant’s June 30, 2015, submittal describes recently identified operating experience regarding global displacement of structures due to ASR. The applicant stated that the program will manage this phenomenon by monitoring “critical building geometry locations” with laser targets and gap measurements. The applicant also stated that the building deformations are not structural capacity concerns.

Audit Activities. During its audit, the staff conducted interviews and discussion with the applicant’s staff, consultants, and laboratory technical experts; and reviewed information generated by NextEra’s contractor that provided detailed insights about different aspects of the large-scale testing program and how the results of the testing will be applied to the AMP and to the CLB resolution efforts. In addition, the staff toured the FSEL facilities including the large-scale concrete testing laboratory and setup for application of loads and data acquisition, core and cylinder testing area, greenhouse for accelerating ASR in test specimens, and formwork for constructing the large-scale specimens. In addition, the staff observed two large-scale shear load tests to failure on test specimen with 1.3 percent through-thickness ASR expansion, and observed material property testing (e.g., elastic modulus, compressive strength) of concrete cores removed from test specimens prior to the load test. The staff was informed that these cores would be used to establish correlation between test results and Seabrook structures for this level of ASR expansion.

During its onsite audit, the staff noted that the applicant has engaged in four separate testing programs:

- Shear testing of large-scale beams
- Reinforcing bar (rebar) anchorage testing of large-scale beams
- Anchor bolt testing in concrete blocks
- Instrument evaluation study for choosing through-wall expansion instrumentation

The staff noted that the purpose of the shear, rebar anchorage, and anchor bolt programs is to determine the effect of ASR on structural performance of concrete structures with regard to shear, lap-splice capacity, and performance of anchor bolts at Seabrook for different levels of ASR severity. The intent of the testing is to establish a threshold for which there is an impact on the structure intended functions. The staff also noted that the testing is intended to be used as the technical bases to establish a methodology to resolve non-conformances with the current design and licensing bases, however, the staff did not evaluate the testing programs for their adequacy in that regard. The staff noted that the purpose of the instrumentation block program is to determine which extensometer would be used to measure through-wall ASR cracking in Seabrook structures. The staff also reviewed information regarding the results of the testing and noted that the applicant's testing results appear to show that for the ASR expansion levels tested, ASR did not have a detrimental effect on the specimens' load carrying capabilities for the shear, rebar anchorage, and anchor bolt tests.

During the audit, the staff reviewed aspects of the applicant's use of large-scale test program as a bases for developing applicable elements of the plant-specific program against criteria described in SRP-LR, Appendix A.1, which provides the staff's technical position and guidance for evaluating the demonstration of aging management through plant-specific programs.

Audit Results. Prior to the audit, by letter dated October 2, 2015 (Accession No. ML15251A333), the staff issued new and follow up RAIs to request information pertaining to concerns associated with the applicant's June 30, 2015, submittal. The staff's concerns documented in the RAIs included:

- Addressing recent operating experience concerning building deformation caused by global ASR expansion
- Representativeness between test specimens and methodology of measurement and correlation of testing program to Seabrook structures
- Uncertainties and variations associated with estimate of normalized modulus
- Representative sample for monitoring through-wall expansion
- Combined cracking index (CCI) as a surrogate for ASR expansion in the in-plane direction

During the audit, the staff reviewed relevant technical basis information and determined that although there appeared to be sufficient program technical bases beyond what was included in the June 30, 2015, RAI response letter, much of this additional information needed to be finalized and submitted to the NRC in order for the staff to complete its review. In its review of program elements one through ten against the corresponding guidance for each element described in SRP-LR, Appendix A.1, the staff determined that aspects of several AMP program elements appeared to be either different than as stated in the June 30, 2015, submittal, incomplete, or needed to be updated to include technical basis. The staff determined that the detailed description of the program elements had not been sufficiently addressed in the current

AMP submittal in the June 30, 2015, letter and additional information was required. During the audit the applicant stated that it would submit an updated AMP in its entirety, as part of the responses to the RAIs the staff issued in its October 2, 2015, letter.

Based on this audit, the staff found that additional information is needed before the staff can determine that the applicant's AMP is sufficient; however, the staff did not identify the need to issue additional RAIs beyond those issued in its October 2, 2015 letter. The staff's evaluation of the responses to the October 2, 2015, RAIs and the updated AMP will be documented in the safety evaluation report.

Exit Meeting. A final briefing was held with the applicant on October 29, 2015, to discuss the results of the ASR Monitoring Program audit.

### 3 AUDIT PARTICIPANTS

#### NRC

- Brian Wittick, Branch Chief, Division of License Renewal, NRR
- Angela Buford, Structural Engineer, Division of License Renewal, NRR
- George Thomas, Senior Structural Engineer, Division of License Renewal , NRR
- Bryce Lehman, Structural Engineer, Division of Engineering, NRR
- Fred Bower, Branch Chief, Division of Reactor Projects, Region I

#### NextEra and Contractors

- Michael Ossing, NextEra Energy Seabrook (NEE-SBK)
- Michael Collins, NEE-SBK
- Ken Browne, NEE-SBK
- Brian Brown, NEE-SBK
- Jaclyn Hulbert, NEE-SBK
- John W. Simons, MPR Associates (MPR)
- Jim Moroney, MPR
- Chris Bagley, MPR
- Ozzie Bayrak, Ferguson Structural Engineering Laboratory, University of Texas at Austin