June 10, 2019

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of NextEra Energy Seabrook, LLC (Seabrook Station, Unit 1)	)))))	Docket No. 50-443

C-10 RESEARCH AND EDUCATION FOUNDATION, INC.
INTIAL STATEMENT OF POSITION ON C-10'S CONTENTIONS REGARDING NEXTERA'S PROGRAM FOR MANAGING ASR AT SEABROOK STATION NUCLEAR POWER PLANT

I. INTRODUCTION

Pursuant to 10 C.F.R § 2.1207(a)(1) and the Atomic Safety and Licensing Board's ("ASLB's") February 15, 2018 Revised Scheduling Order, C-10 Research and Education Foundation, Inc. ("C-10") hereby submits its Initial Statement of Position on C-10's admitted contentions A, B, C, D, and H. These contentions challenge the adequacy of a license amendment request ("LAR") by NextEra Energy Seabrook L.L.C. ("NextEra") to address the pernicious effects of Alkali Silica Reaction ("ASR") on Seismic Category I reinforced concrete safety structures, including the containment.

As demonstrated below and in the attached testimony of Dr. Victor E. Saouma, a highly qualified ASR expert (Testimony of Victor E. Saouma, Ph.D Regarding Scientific Evaluation of NextEra's Aging Management Program for Alkali-Silica Reaction at the Seabrook Nuclear Power Plant at 7 (June 10, 2019) ("Saouma Testimony") (**Exh. INT001**), NextEra has failed to meet its burden of proving that its program for monitoring the progress of ASR at Seabrook is based on an adequate understanding of the condition of the Seabrook concrete or that it contains effective monitoring measures. Both the testing and analytical methods that underlie the

monitoring program "are substandard and inadequate to support any conclusion that the ability of the Seabrook containment to withstand a design basis earthquake has not been unduly compromised by the presence of ASR," and thus the monitoring program is substandard. Saouma Testimony at 8.

As discussed below in Section III, the NRC Staff has already approved NextEra's LAR, and it has also approved NextEra's application for a twenty-year renewal of its operating license in partial reliance on the LAR. Accordingly, C-10 requests the ASLB to order the reversal of the LAR and to refer to the Commission the question of whether the license renewal decision should also be reversed for its dependence on the seriously deficient LAR.

II. LEGAL FRAMEWORK

A. NRC Safety Requirements

As the ASLB noted in admitting C-10's contentions, NextEra's LAR applies to concrete in Seismic Category I structures, "which include those Seabrook structures necessary to control the release of radioactive material or otherwise mitigate the consequences of an accident." *NextEra Energy Seabrook, L.L.C.* (Seabrook Station, Unit 1), LBP-17-7, 86 N.R.C. 59, 78 (2017), *aff'd,* CLI-18-4, 87 N.R.C. 59 (2018) ("LBP-17-7) (citing Reg. Guide 1.29, Rev. 5 at 5 (July 2016)). At Seabrook, as many as twenty-six Seismic Category I structures are affected by ASR or could be affected by ASR. *Id.* These structures include the containment, whose purpose "is to confine radiation and fission products that might otherwise be released to the atmosphere in the event of an accident." *Id.*

As a Seismic Category I structure, the Seabrook containment must "be able to withstand an earthquake and other natural disasters, within the design basis of the plant." *Id.*, 86 N.R.C. at 79 (citing General Design Criterion ("GDC") 2, "Design Bases for Protection Against Natural

Phenomena"). GDC 2 requires, *inter alia,* that: "Structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions." Other regulatory requirements for containment integrity are set forth in GDC 1, 4, 16, and 50; and Appendix B to 10 C.F.R. Part 50. Safety Evaluation Related to Amendment No. 159 to Facility Operating License No. NPF-86 at 2 (March 11, 2019) ("NRC Safety Evaluation") (publicly available version at ML18204A291) (**EXH. INT024).**

The phenomenon of ASR has been studied extensively by the NRC and other U.S. and international government agencies and research institutions. Saouma Testimony at 6 **(Exh. INT001)**. And while Seabrook was the first U.S. nuclear reactor identified to have ASR in its concrete, its presence has been known for ten years. LBP-17-07, 86 N.R.C. at 69. Yet, the NRC has established no regulations or regulatory guides to specifically address ASR or its implications on serviceability and strength. Saouma Testimony **(Exh. INT001)** at 6-7. Moreover, applicable codes for the design of reactor containments do not contain "methods to address the effects of ASR on the structural properties used in the design of concrete structures, and publicly available test data related to ASR effects on structures focus primarily on the science of ASR rather than the structural implications." LBP-17-07, 86 N.R.C. at 70 (footnote omitted).

B. Burden of Proof

As provided by 10 C.F.R. § 2.325, "unless the presiding officer otherwise orders, the applicant or the proponent of an order has the burden of proof."). *See also La. Energy Servs., L.P.* (Claiborne Enrichment Center), (Claiborne Enrichment Center), CLI-98-3, 47 N.R.C. 77, 89 (1998).

III. C-10'S EXPERT WITNESS

C-10's expert witness, Dr. Victor E. Saouma, is one of the world's foremost experts on ASR. He has conducted research on ASR for a wide array of academic institutions and international government agencies, including the NRC. And the topics of his research have covered a great breadth and depth, including theoretical, numerical (deterministic/probabilistic, static/dynamic), and experimental (material and structural). Dr. Saouma has developed what is probably the most widely referenced and copied model for ASR, the "Saouma Model." He is providing testimony for C-10 *pro bono,* because he is very concerned, both as a scientist and a citizen, about the inadequacy of the work that has been done on ASR at Seabrook. Sauoma Testimony at 1-2, 3, **Exh. INT001.**[1]

IV. FACTUAL AND PROCEDURAL BACKGROUND

A. Alkali Silica Reaction

Alkali Silica Reaction is a chemical reaction in concrete caused by a Ph imbalance. Saouma Testimony **(Exh. INT001)**. Under conditions of high relative humidity, ASR results in the formation of a viscous gel that first fills up voids, and then causes the concrete to expand. The ultimate effects of ASR include both expansion and degradation of the concrete's mechanical properties. This combination of expansion and degradation affects tensile and shear strengths along with elastic modulus. Tensile strength will control the formation of (undesirable) cracking, and the elastic modulus degradation will result in larger deformation and potential

[1] **Exh. INT001** is a complete version of Dr. Saouma's testimony, and includes some proprietary information. C-10 plans to file **Exh. INT002**, a redacted and publicly available version of Dr. Saouma's testimony, as soon as possible. Appendix A to this Statement of Position lists the documents reviewed and relied on by Dr. Saouma for his testimony, **Exhibits INT001** through **INT026.**

cracking. The decrease in shear strength can compromise the integrity of a containment during an earthquake. *Id.* at 6.

B. NextEra's License Renewal Application

On May 25, 2010, a year after discovering ASR at Seabrook in 2009, NextEra applied for renewal of its operating license, from 2030 to 2050. Letter from Paul O. Freeman, NextEra to U.S. NRC re: Seabrook Station Application for Renewed Operating License (ML101590099). While ASR was not addressed in the original license renewal application, subsequent amendments to the application clarified that the license renewal application would address the management of ASR. *See, e.g.,* Letter from Eric McCartney, NextEra to U.S. NRC, re: Seabrook Station, License Renewal Application Relating to the Alkali-Silica Reaction CASR) Monitoring Program (Aug. 9, 2016) (ML16224B079).

C. Investigations of ASR by NextEra and the NRC

1. NextEra

In 2012, three years after discovering ASR at Seabrook, NextEra conducted an interim assessment of ASR at Seabrook which "determined that the structures at Seabrook remain suitable for service for an interim period, given the extent and rate of ASR identified." Safety Evaluation at 5 (**EXH. INT024).** But the assessment also found that "additional work needed to be done to verify that the structures satisfy the ACI 318-71 (Seabrook's design code) requirements." *Id.*

In the absence of governing ASR standards or applicable ASR guidance, NextEra therefore "devised its own methodology" for assessing and monitoring ASR. LBP-17-07, 86 N.R.C. at 70. NextEra retained a consultant, MPR Associates, to conduct "large-scale test programs" at the Ferguson Structural Engineering Laboratory (FSEL) of the University of Texas

at Austin. *Id.* The testing was completed in 2016. NRC Safety Evaluation at 6. Subsequently, "using the results from the test program and literature, NextEra developed a method for evaluating and monitoring ASR-affected concrete structures." *Id. See also* LPB-17-7, 86 N.R.C. at 69.

1. NRC Staff

The NRC Staff also took steps to study the phenomenon of ASR. NextEra's commitment to undertake the testing and analysis was confirmed by the Staff in Confirmatory Action Letter No. 1-2012-002, Confirmatory Action Letter, Seabrook Station, Unit 1 – Information Related to Concrete Degradation Issues (May 16, 2012) (ML12125A172). In the summer of 2012, the NRC Staff also chartered a "Seabrook ASR Issue Technical Team" that was "envisioned to shape the long-term resolution and corrective actions of this issue at [Seabrook]." Charter at 1, attached to Memorandum from Eric J. Leeds, Office of Nuclear Reactor Regulation, to Those on Attached List, re: Seabrook Alkali-Silica Reaction Issue Technical Team Charter (July 9, 2012) (ML12270A060).

And in the fall of 2012, the Regional Administrator of Region 1 requested approval by the NRC's Executive Director of Operations to "conduct additional inspections and assessments associated with the degradation of concrete due to [ASR] in safety-related structures at Seabrook." Memorandum from William M. Dean to R.W. Borchardt, re: Request for Deviation from the Reactor Oversight Process Action Matrix to Provide Increased Oversight of the Alkali-Silica Reaction Issue at Seabrook (Sept. 5, 2012) (ML12242A370).

Finally, in 2014, the NRC contracted for independent research on ASR, including a grant to Dr. Saouma for "Experimental and Numerical Investigations of Alkali Silica Reaction at Nuclear Reactors." Letter from Erika Eam to Dr. Victor Saouma, Ph.D, re: Grant No. NRC-HQ-

60-14-G-0010. Saouma Testimony at 2 **(Exh. INT004)**. Dr. Saouma conducted a three-year investigation and produced a four-volume report. *Id.* at 2. Dr. Saouma's Final Summary Report to the NRC is attached as **Exh. INT005.**

C. NextEra's License Amendment Request and C-10's Hearing Request

In 2016, NextEra applied for the license amendment that is the subject of this hearing. Letter from Ralph A. Dodds to U.S. Nuclear Regulatory Commission re: Seabrook, License Amendment Request 16-03 - Revise Current Licensing Basis to Adopt a Methodology for the Analysis of Seismic Category I Structures with Concrete Affected by Alkali- Silica Reaction (August 1, 2016) (ML16216A240) **(Exh. INT010)**. NextEra proposed to "revise the Seabrook Station Updated Final Safety Analysis Report to include methods for analyzing seismic Category I structures with concrete affected by an alkali-silica reaction." A hearing notice was published in the Federal Register at 82 Fed. Reg. 9,604 (Feb. 7, 2017). The hearing notice included a "No Significant Hazards" determination that the license amendment could be issued *prior* to the hearing without jeopardizing public health and safety.[2]

C-10 submitted a hearing request *pro se.* C-10 Research and Education Foundation Inc. Petition for Leave to Intervene) (Apr. 10, 2017). In LBP-17-07, the ASLB granted C-10's hearing request, finding that C-10 had standing and had submitted five admissible contentions. The five contentions generally asserted that the large-scale test program undertaken for NextEra at FSEL had yielded data that are not representative of the progression of ASR at Seabrook; and that as a result, the proposed monitoring, acceptance criteria, and inspection intervals are not adequate to satisfy NRC safety regulations. The admitted contentions also raised concerns

[2] The LAR and key supplements and consultant reports are listed in Appendix A and attached as **Exhibits INT010** through **INT023.**

regarding the insufficiency of crack width indexing and extensometer deployment for determining the presence of ASR, NextEra's misconception of the effects of ASR within a reinforced concrete structure, the need for continuous petrographic sampling and analysis, the lack of representativeness to Seabrook Station, and the unacceptability of the proposed length of intervals between inspections.

D. C-10's Emergency Petition to NRC Commissioners

In the fall of 2018, C-10 retained Dr. Saouma to assist it with preparation of its evidentiary case on its admitted contentions. Early in 2019, Dr. Saouma informed C-10 that his review of the LAR and NextEra's consultant reports raised grave concerns that the quality of the investigation into ASR at Seabrook and the resultant safety assessment and monitoring program were inadequate to demonstrate compliance with NRC safety regulations. In January 2019, C-10 also retained undersigned counsel to assist its previously entirely *pro bono* team with the preparation of its case.

In a January 10, 2019 memorandum, the NRC Staff notified the Commissioners that:

1) the NRC Staff had made a No Significant Hazards determination that the LAR could be issued before completion of the hearing,

2) issuance of the LAR was imminent, and

3) the NRC Staff was about to approve NextEra's license renewal application, before the hearing on C-10's admitted contentions had even begun.

Memorandum from Ho K. Nieh, Director, Office of Nuclear Reactor Regulation, to NRC Commissioners, re: Renewal of Full-Power Operating License for Seabrook Station, Unit 1, attached to letter from Jeremy Wachutka to ASLB re: In the Matter of NextEra Energy Seabrook, LLC (Seabrook Station, Unit 1), Docket No. 50-443-LA-2, ASLBP No. 17-953-LA-BD01 (Jan.

11, 2019) ("Nieh Memorandum"). The Nieh Memorandum also noted the dependence of the license renewal decision on the LAR:

> Four of the Seabrook license renewal aging management programs (i.e., the plant-specific Alkali-Silica Reaction (ASR) Monitoring Program, the plant-specific Building Deformation Monitoring Program, the Structures Monitoring Program, and the ASME Section XI, Subsection IWL aging management program) are based, in whole or in part, on the methodology submitted in the license amendment request.

Id. at 2.

Concerned that the NRC was about to take two major licensing actions based on faulty safety analyses and without first holding a hearing regarding the problems that had been raised in C-10's contentions, C-10 submitted an Emergency Petition to the Commissioners on February 12, 2019. Emergency Petition by C-10 Research and Education Foundation for Exercise of Commission's Supervisory Authority to Reverse No Significant Hazards Determination and Immediately Suspend License Amendment and License Renewal Decisions (Feb. 13, 2019). The Petition asked the Commissioners to take the following immediate actions:

- reverse the No Significant Hazards Determination, order the suspension of both the Staff's LAR decision and its LRA decision,
- open an in-depth inquiry into best practices for assessing ASR, and
- provide guidance and instruction to the Staff for establishment of significantly more rigorous and sophisticated state-of-the-art methods and criteria for evaluating safety risks posed by ASR at Seabrook and other reactors.

Id. at 3-4, 16. C-10 supported its Emergency Petition with a declaration and detailed expert report by Dr. Saouma, *Review of Selected Documents Regarding the Structural Evaluation of Seabrook Nuclear Power Plant* (Feb. 12, 2019) ("Expert Report") (**Exh. INT007 (Proprietary).**

C-10's Emergency Petition remains pending before the Commissioners.

E. Issuance of License Amendment

On March 11, 2019, the NRC Staff gave formal approval to NextEra's LAR and issued the license amendment. Letter from Justin C. Poole, NRC, to Mano Nazar, NextEra, re: Seabrook Station, Unit No. 1 – Issuance of Amendment No. 159 re: Methodology for Analysis of Seismic Category I Structures with Concrete Affected by Alkali-Silica Reaction (CAC No. MF8260; EPID L-2016-LLA-0007) (ML18204A291). As stated in the NRC Staff's Notification to the NRC Commissioners, the NRC Staff also made a No Significant Hazards determination, thereby permitting itself to issue the license amendment before the hearing.

F. Renewal of NextEra's Operating License

On March 12, 2019, the NRC Staff renewed the Seabrook operating license for an additional twenty years, from 2030 to 2050. Letter from William F. Burton, NRC to Mano Nazar, NextEra (ML18345A121). As stated in the Nieh Memo, four of the renewed license's aging management programs were "based, in whole or in part, on the methodology submitted in the license amendment request."

V. SUMMARY OF KEY POINTS TO BE MADE IN THE TESTIMONY

The key points of Dr. Saouma's testimony are summarized in his response to Question C.1. *See* **Exh. INT001.** And they are also reflected in his Expert Report, (**Exh. INT007).** As discussed in Dr. Saouma's expert report, the manner in which NextEra's consultants have analyzed the impact of ASR on Seabrook is seriously deficient in five major respects:

- First, the concrete used in the FSEL testing program was not representative of the concrete at Seabrook.
- Second, the specimen (scaled) dimensions, loads and boundary conditions are not representative of Seabrook.
- Third, NextEra failed to explain the impact of the large horizontal crack that occurred before the shear test on results or to make a convincing argument that indeed shear cracks were induced by the test.

- Fourth, NextEra relies on fundamentally incorrect assumptions about ASR. For instance, it confuses material strength with structural strength and assumes that adding a "design basis load" to the Seabrook safety analysis can account for ASR.

By themselves, these errors, which were incorporated into NextEra's finite element analysis, had the effect of rendering that analysis completely unreliable to support any conclusions about the safety of the Seabrook plant under earthquake conditions.

Furthermore, these errors adversely affected the adequacy of parameters used in NextEra's monitoring program (the reliance on CCI in particular). Both the monitoring program for ASR progression and the monitoring program for structural deformation depend on FSEL test results. And both programs are seriously deficient because of that dependence.

In addition, as testified by Dr. Saouma, the problems with NextEra's safety assessment and monitoring programs were compounded by the fact that NextEra and its consultants applied an analytical method to the FSEL data that was extremely simplistic and contains numerous significant flaws (ASR modeling and seismic analysis, among others.) By feeding erroneous and unreliable data into an analytical model that was already inadequate to address the complexity of ASR at Seabrook, NextEra compounded the problem and made it even worse.

In considering this issue, it is important to recognize that testing and analysis (any analysis) is a very tightly coupled process where the latter depends greatly on the reliability of the former. Hence, the results of any finite element analysis whose cracking/failure/safety criteria depend on erroneous experimental data will consequentially be flawed. Here, NextEra first relied on test results to conclude that Seabrook is currently safe to operate. Then NextEra gauged the nature and degree of monitoring required based on the level of safety assurance it had obtained from the results of the flawed testing and analysis of the data. Finally, NextEra based its acceptance criteria for determining the safety of Seabrook's operation and its parameters for monitoring ASR on the FSEL test results and SGH analysis. These criteria were approved by the

NRC Staff. Ultimately, the entire program for safety assessment and monitoring depended on and was fatally undermined by the faulty FSEL tests.

Dr. Saouma also expresses his overarching concern about the absence of any credible peer review of NextEra's work. NextEra relied on consultants with standard engineering experience, and did not seek review by independent ASR experts. The NRC Staff ultimately accepted scientifically unproven assertions. Given that this is the very first occurrence of ASR in a nuclear containment vessel, that the NRC has funded at least two major projects on ASR, both NextEra and the NRC Staff should have ensured that their work would receive independent review by qualified experts in the field and that they would uphold the highest scientific and safety standards possible.

Dr. Saouma concludes that NextEra has given insufficient attention to the complexities of ASR and has made significant errors in the tests relied on for its safety analysis. Therefore, based on his expertise, the published state of the art of ASR, and basic principles of structural engineering, he concludes that the testing program and subsequent safety assessment and monitoring program are not sufficiently reliable to support their stated purpose of confirming regulatory compliance for the next thirty years.

I. STATEMENT OF C-10'S POSITION ON APPLICATION OF THE LAW TO THE EVIDENCE

As discussed above, Dr. Saouma has concluded that NextEra's LAR, including the FSEL testing program, the safety assessment to which the results of the testing program were applied, and the monitoring program that depends on the test results and the safety assessment, are inadequate to support continued regulatory compliance at Seabrook. NextEra's regulatory analysis was also inadequate to address the difference between designing a new reactor for

regulatory compliance and assessing the ability of an already-operating reactor to comply with safety regulations despite deteriorating conditions.

Finally, neither NextEra nor the NRC Staff obtained a peer review of their analyses of the ASR issue at Seabrook. Given the complexity of ASR, given the fact that the NRC has yet to develop regulatory standards or guidance for ASR, and given the depth and breadth of NextEra's misapprehension of the phenomenon of ASR and appropriate methods to investigate it, NextEra's failure to consult independent experts is also fatal to the credibility of its application.

In light of these serious deficiencies in NextEra's measures for addressing ASR at Seabrook, the ASLB should conclude that NextEra has not met its burden of proving that its LAR will ensure compliance with applicable NRC design requirements for Category I structures. Accordingly, the ASLB should reverse the NRC Staff's approval of the LAR.

The ASLB should also take judicial notice that the NRC's recent decision to renew the Seabrook operating license from 2030 until 2050 lacks a lawful predicate because it is based in part on (a) the LAR's unjustified findings of safe operation and (b) a monitoring plan whose parameters were devised to confirm those faulty findings and thus are inadequate to assess the true extent and progression of ASR at Seabrook.

II. REQUEST FOR RELIEF, INCLUDING REFERRAL TO THE COMMISSION OF WHETHER LICENSE RENEWAL DECISION SHOULD BE REVERSED.

Because the defective license amendment is now part of NextEra's aging management plan for the license renewal term, any decision by the ASLB to invalidate the issuance of the license amendment should have the effect of nullifying the license renewal decision that depends on it. While reversing the license renewal decision is beyond the scope of the ASLB's jurisdiction, it is within the ASLB's authority to notify the Commissioners of the legal ramifications of its decisions. Accordingly, C-10 requests the ASLB to:

a) reverse the NRC Staff's decision issuing a license amendment to NextEra; and

b) notify the Commission that the reversal of the LAR should have the effect of nullifying the license renewal decision.

Respectfully submitted,

___/signed electronically by/__
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