UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	Docket No. 50-443-LA-2
NEXTERA ENERGY SEABROOK, LLC	ASLBP No. 17-953-02-LA-BD01
(Seabrook Station, Unit 1)	

Hearing Exhibit

Exhibit Number: NRC091

Exhibit Title: Staff Testimony in Response to Exhibit INT051-R

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NRC STAFF TESTIMONY OF ANGELA BUFORD,
BRYCE LEHMAN, AND GEORGE THOMAS IN RESPONSE TO EXHIBIT INT051-R

Q.1. Please state your name, occupation, and by whom you are employed.

A.1. This information is provided in A.1a–A.1c of Exhibit NRC001-R-00-BD01.

Q.2. Please describe the nature of your responsibilities on behalf of the U.S. Nuclear Regulatory Commission.

A.2. This information is provided in A.2a–A.2c of Exhibit NRC001-R-00-BD01.

Q.3. Please explain what your duties have been in connection with the NRC Staff review of the NextEra Energy Seabrook, LLC license amendment request (LAR) to revise the Seabrook Station, Unit No. 1 Updated Final Safety Analysis Report (UFSAR) (NRC007-00-BD01) to include an ASR expansion monitoring program, based, in part, on a large-scale test program (LSTP) at the Ferguson Structural Engineering Laboratory (FSEL), to demonstrate that Seabrook structures with alkali-silica reaction (ASR) continue to meet the design codes for original construction (INT010-00-BD01 (nonproprietary); NRC089-00-BD01[1] (proprietary)).[2]

[1] The NRC Staff does not cite Exhibit INT011-00-BD01 because it includes highlighting that is not a part of the original document.

[2] NextEra supplemented the LAR on September 30, 2016 (NRC010-00-BD01), October 3, 2017 (NRC013-00-BD01), December 11, 2017 (NRC014-00-BD01), and June 7, 2018 (NRC015-00-BD01). Separately, on May 18, 2018, in updating its license renewal application for Seabrook, NextEra provided

A.3. This information is provided in A.3a–A.3c of Exhibit NRC001-R-00-BD01.

Q.4. What is the purpose of this testimony?

A.4. On November 25, 2019, the Board ordered NextEra to deliver to the C-10 Research and Education Foundation (C-10) all documents within its possession, custody, or control not previously produced containing data regarding the tested mineralogical components of aggregate in Seabrook concrete.[3] In response, NextEra produced one document[4] that it referred to as the Santa Ana Aggregates Document.[5] This document includes an examination of aggregate samples from a New Mexico quarry, along with a comparison of that aggregate to Seabrook's aggregate. The Board also ordered C-10 to file written testimony from its expert witness, Dr. Victor Saouma, "explaining how the newly produced data affects his evaluation of the comparability of the Seabrook aggregate and the LSTP test specimen aggregate."[6] In response, C-10 filed Exhibit INT051-R. Finally, the Board stated that NextEra and the NRC Staff "may file written rebuttal testimony in response to Dr. Saouma's new written testimony."[7] The purpose of this pleading is to provide the NRC Staff's rebuttal testimony in response to Exhibit INT051-R.

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revised versions of MPR Associates (MPR) reports previously submitted as LAR supplements (NRC016-00-BD01).

[3] Order (Granting C-10's Motion to Compel Mineralogical Data and Request to Submit Supplemental Written Testimony concerning the data; Denying C-10's Motion to Submit Additional Exhibits), at 17 (Nov. 25, 2019) (unpublished) (ML19329D913) (Nov. 25, 2019 Order).

[4] SGH Project No. 120766, Examination of Aggregate Samples from New Mexico by the University of Texas, in Support of the On-Going Evaluation [of] the Impact of ASR, Seabrook Nuclear (Sept. 17, 2012) (ML19339H136) (Santa Ana Aggregates Document).

[5] *See* Letter from Paul M. Bessette, Counsel for NextEra, to Diane Curran, Counsel for C-10, Mineralogical Data (Dec. 5, 2019) (ML19339H135).

[6] Nov. 25, 2019 Order at 17.

[7] *Id*.

Q.5. In Exhibit INT051-R, Dr. Saouma posits that the LSTP test specimens might not be representative of Seabrook concrete structures because of the characteristics of their ASR gel as compared to the ASR gel at Seabrook. Specifically, Dr. Saouma states that, because the reactivity of the aggregate has a significant effect on the characteristics of the gel, NextEra must provide a table with side-by-side columns that compare each of the specific mineralogical characteristics of the LSTP test specimens with Seabrook core samples (INT051-R at 1–2). What is the NRC Staff's response to this argument?

A.5. ASR is a chemical reaction in concrete that produces a gel that can absorb water and expand. The expansion of the gel is resisted by internal restraints within the concrete (influenced by reinforcement configuration, voids, etc.). This interaction between internal restraints and ASR gel expansion results in preferentially oriented microcracking in directions of least restraint and, ultimately, volumetric expansion of the affected concrete component.

The safety of ASR-affected concrete structures is based on the effect of the expansion caused by the ASR gel on the structures' structural capacity. NextEra contracted with the FSEL to conduct the LSTP to determine the effect of varying levels of ASR-induced expansion on the structural capacity of Seabrook concrete structural components. In order to do this, the FSEL developed test specimens that were representative of Seabrook concrete structural components with respect to the aspects of concrete structural components that may affect the impact of ASR on structural capacity. Specifically, the FSEL ensured that the characteristics of the test specimens' concrete mix design (e.g., aggregate size and gradation and proportions, cement type, water-to-cement ratio, strength characteristics at 28 days, etc.) and reinforcement configuration matched the concrete structures at Seabrook as closely as reasonably achievable. Other aspects of concrete structural components, however, do not significantly affect the impact of ASR on structural capacity and, therefore, the FSEL did not have to match those aspects between the test specimens and Seabrook concrete structural components in order for the test

specimens to be representative of Seabrook. For instance, the FSEL used aggregates in the LSTP concrete mix with higher reactivity than the slow-reacting aggregate in the Seabrook concrete. The FSEL needed to do this in order to (1) achieve and assess the structural impact of higher levels of ASR expansion than currently exist in Seabrook's structures and (2) ensure that the ASR expansion developed in less time than the decades it took to develop in the concrete at Seabrook. This difference did not adversely affect representativeness because the LSTP load tests determined ASR impact on structural capacity for given levels of ASR expansion, and the structural impact on a concrete structural component from a given level of ASR expansion is independent of the time in which the level of expansion was reached. Ultimately, the FSEL determined that, at the levels of ASR expansion tested, the test specimens demonstrated no loss of structural capacity. Therefore, the NRC Staff found it acceptable for NextEra to establish ASR expansion limits at these levels at Seabrook. Within these limits, NextEra can still conservatively estimate the structural capacity of Seabrook concrete structures using their design basis codes regardless of any reductions in the material properties of their concrete due to ASR.

Dr. Saouma's argument in Exhibit INT051-R is essentially that the exact characteristics of ASR gel can affect structural capacity and that, therefore, NextEra must demonstrate that the gel (amount and constituency) in the LSTP test specimens is representative of the gel in Seabrook concrete structures. The NRC Staff does not agree that this is necessary and to the NRC Staff's knowledge, nothing in the literature supports Dr. Saouma's argument. Industry guidelines and published research on the structural impacts of ASR do not differentiate based on the characteristics of the gel giving rise to the ASR expansion (see, e.g., NER012-00-BD01, The Institution of Structural Engineers, "Structural Effects of Alkali-Silica Reaction"; NER013-00-BD01, U.S. Department of Transportation, Federal Highway Administration, "Report on the Diagnosis, Prognosis, and Mitigation of Alkali-Silica Reaction (ASR) in Transportation

Structures"). Moreover, at least one industry guideline explicitly states that the amount of gel in a concrete specimen is not necessarily representative of the amount of ASR expansion.[8] In addition, Dr. Saouma does not provide any support for his argument. Therefore, the NRC Staff concludes that there is no reason to believe that the exact characteristics of the gel could affect structural capacity and, in turn, impact the ASR expansion limits derived from the LSTP.

The exact characteristics of the ASR gel, though, could affect the rate of expansion due to the gel and, thus, the rate at which the ASR expansion limits could be reached. However, this possibility does not affect the NRC Staff's determination that the Seabrook ASR expansion monitoring program's 6-month inspection interval is adequate. The current rate of expansion at Seabrook, as determined from in-situ monitoring measurements, could increase 1,000 percent in six months in the location with the highest through-thickness expansion and still be well below the expansion limits.[9] Additionally, the NRC Staff hasn't seen any evidence in the literature of ASR progressing more quickly than on a time period of years, except in experiments where ASR is purposefully accelerated.[10] Even in the LSTP where all the factors were manipulated to accelerate expansion, it still took on average over a year to reach the expansion limits.[11] Moreover, industry guidelines generally recommend that measurements be taken every six months for the first 3 to 5 years and then every five years if the evolution of the damage is slow

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[8] NRC076-00-BD01, Canadian Standards Association, "Guide to the Evaluation and Management of Concrete Structures Affected by Alkali-Aggregate Reaction," at 29 ("The alkali-silica gel … is a characteristic feature of ASR. The presence of large amounts of gel in a concrete specimen does not necessarily indicate that large expansion or extensive cracking has occurred in the structure. On the other hand, cracking due to ASR has been observed in many concrete structures in which very little gel was found.").

[9] Memorandum (Distributing Redacted Transcript) at 685–86, 695–96, 1135–36, 1194, 1202 (Sept. 24–27, 2019) (ML19312B609) (Tr.).

[10] *Id*. at 1126–27.

[11] *Id*. at 397.

or nil (NER013-00-BD01 at 79–80). Therefore, the NRC Staff concludes that the exact characteristics of the ASR gel at Seabrook did not need to be replicated in the LSTP test specimens in order to find that the inspection intervals were conservative.

Q.6. After reviewing all of the information available since the issuance of the safety evaluation for the LAR (INT024-00-BD01 (nonproprietary); INT025-00-BD01 (proprietary)), including the Santa Ana Aggregates Document and Exhibit INT051-R, is it still the NRC Staff's expert opinion that the Seabrook ASR expansion monitoring program is acceptable and provides reasonable assurance that Seabrook structures will continue to meet the NRC's requirements?

A.6. Yes.

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AFFIDAVIT OF ANGELA BUFORD

I, Angela Buford, do hereby declare under penalty of perjury that my statements in the foregoing testimony are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR 2.304(d)

Angela Buford
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Execute in Rockville, Maryland
this 10th day of January 2020

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AFFIDAVIT OF BRYCE LEHMAN

I, Bryce Lehman, do hereby declare under penalty of perjury that my statements in the foregoing testimony are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR 2.304(d)

Bryce Lehman
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Execute in Rockville, Maryland
this 10th day of January 2020

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AFFIDAVIT OF GEORGE THOMAS

I, George Thomas, do hereby declare under penalty of perjury that my statements in the foregoing testimony are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR 2.304(d)

George Thomas
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Washington, DC 20555
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Execute in Rockville, Maryland
this 10th day of January 2020