UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

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

Hearing Exhibit

Exhibit Number: NER077

Exhibit Title: Testimony of NextEra Witnesses John Simons, Christopher Bagley, Oguzhan Bayrak, Matthew Sherman, and Edward Carley in Response to Exhibit INT051-R

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In the Matter of:	Docket No. 50-443-LA-2
NEXTERA ENERGY SEABROOK, LLC	January 10, 2020
(Seabrook Station Unit 1)	

TESTIMONY OF NEXTERA WITNESSES JOHN SIMONS, CHRISTOPHER BAGLEY, OGUZHAN BAYRAK, MATTHEW SHERMAN, AND EDWARD CARLEY IN RESPONSE TO EXHIBIT INT051-R

Q1. Please state your names for the record.

A1. (JS, CB, OB, MS, EC) John Simons ("JS"). Christopher Bagley ("CB"). Dr. Oguzhan Bayrak ("OB"). Matthew Sherman ("MS"). Edward Carley ("EC").

Q2. Have you previously provided testimony in this proceeding?

A2. (JS, CB, OB, EC) Yes, we previously provided testimony in the Testimony of NextEra Witnesses Michael Collins, John Simons, Christopher Bagley, Oguzhan Bayrak, and Edward Carley ("MPR Testimony") (NER001), and the Testimony of NextEra Witnesses John Simons, Christopher Bagley, Oguzhan Bayrak, and Edward Carley in Response to Exhibit INT030 (NER076).

(MS) Yes, I previously provided testimony in the Testimony of NextEra Witnesses Said Bolourchi, Glenn Bell, and Matthew Sherman ("SGH Testimony") (NER004).

(JS, CB, OB, MS, EC) Additionally, we provided testimony at the Atomic Safety Licensing Board hearing that occurred from September 24-27, 2019, in Newburyport, Massachusetts. Our professional qualifications, scope of involvement in this proceeding, and other relevant background are provided in the MPR Testimony and SGH Testimony.

Q3. What is the purpose of this supplemental testimony?

A3. (JS, CB, OB, MS, EC) Pursuant to the Board's order of November 25, 2019,[1] the purpose of this testimony is to respond to the Supplemental Testimony of Victor E. Saouma, Ph.D. Regarding Adequacy of Petrographic Documents to Support Mineralogical Comparison Between Seabrook Concrete and LSTP Test Specimens (INT051-R) ("Saouma Mineralogy Testimony").

In accordance with the Board's order, our testimony focuses on a portion of the coarse aggregate (i.e., gravel) used in the concrete mixture design for the Large Scale Test Program ("LSTP") described in a petrography report ("Santa Ana Aggregates Report") recently provided to C-10.[2] Discussions on other aspects of representativeness of the LSTP compared to Seabrook (i.e., large scale specimens, experimental design, reinforcement, ASR levels, other constituents of the concrete mixture design) are already part of the record of this proceeding and are not repeated herein.[3]

Q4. Have you reviewed the Saouma Mineralogy Testimony (INT051-R)?

A4. (JS, CB, OB, MS, EC) Yes.

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1 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) (Nov. 25, 2019) (unpublished).

2 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) (FP100750, Rev. 1). This document was produced to C-10 on Dec. 5, 2019. *See* Letter from P. Bessette to D. Curran, "Mineralogical Data," Attach. (Dec. 5, 2019).

3 *See, e.g.*, MPR Testimony A101 through A157 (NER001); MPR-4273, Rev. 1, Seabrook Station - Implications of Large-Scale Test Program Results on Reinforced Concrete Affected by ASR (March 2018) § 2.4.2 (INT021 (P), INT019 (NP)); MPR-3757, Rev. 4, "Shear and Reinforcement Anchorage Test Specimen Technical Evaluation" (FP100760) § 3 (May 2014) (NER026).

Q5. Please summarize Dr. Saouma's testimony in INT051-R.

A5. (JS, CB, OB, MS, EC) As described in Paragraph 1 of INT051-R, the purpose of Dr. Saouma's testimony is to explain how the Santa Ana Aggregates Report affects his evaluation of the representativeness of the coarse aggregates used in the LSTP as compared to the aggregates used at Seabrook. As we understand it, Dr. Saouma advances two arguments. First, Dr. Saouma argues that both physical and chemical characteristics of the minerals[4] that comprise the coarse aggregate are important for the purpose of analyzing representativeness between the concretes at Seabrook versus that in the LSTP test specimens. Second, he argues that NextEra has not provided enough information to allow for such a comparison.

Q6. Do you agree with Dr. Saouma that <u>physical</u> characteristics of the aggregates used in Seabrook and LSTP concretes are important to analyzing representativeness?

A6. (JS, CB, OB, MS, EC) Yes. As part of the original development of the LSTP, we identified all critical characteristics necessary to meet the objective of the testing program (i.e., to investigate the *structural* capacity of ASR-affected reinforced concrete in particular limit states). With respect to the characteristics of the coarse aggregate, which is the subject of the Santa Ana Aggregates Report, the two critical characteristics we identified were size and surface roughness.[5] The size of aggregate and the surface roughness (i.e., angular surfaces from crushing the rocks rather than smooth surfaces) can both affect the aggregate interlock mechanism for developing shear strength (i.e., capacity).[6]

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4 Note that minerals are solid chemical compounds characterized by both their chemical composition and the specific arrangement of their crystalline structure. For convenience, both of these attributes are combined into the term "chemical characteristics of the minerals" herein.

5 MPR Testimony at A116 (NER001).

6 MPR-3757 at 3-8, 3-9 (NER026).

Q7. Do you agree with Dr. Saouma that chemical characteristics of minerals of the aggregates used in the Seabrook and LSTP concretes are important to analyzing representativeness?

A7. (JS, CB, OB, EC) No. The LSTP did not include any critical characteristics that pertain to the chemical characteristics of the minerals in the aggregate.[7] This deliberate decision was supported by available industry guidance and academic literature, which do not differentiate structural effects of ASR (e.g., capacity reduction) on the basis of the *chemistry* of any resulting ASR gel. Instead, the literature differentiates structural effects of ASR based on observed *expansion* levels.[8]

The rate of ASR formation is, however, affected by the chemical characteristics of the minerals and was a necessary and practical consideration for the LSTP. Trial batching of various concrete mixture designs during LSTP planning demonstrated that aggregate with more reactivity than is present in the Seabrook concrete was needed to achieve bounding levels of ASR expansion in a useful timeframe.[9] Thus, the LSTP necessarily used a faster-reacting aggregate with similar physical characteristics (i.e., size and surface roughness),[10] but with different chemical characteristics (composition, crystalline structure). Importantly, at the evidentiary hearing, Dr. Saouma testified that it is valid to "ignore" chemical attributes of the ASR gel in testing programs for the purpose of accelerating expansion.[11]

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7 *See also* MPR Testimony at A118, 120 (NER001).

8 *See, e.g.*, U.S. Dep't of Transportation, Federal Highway Administration, "Report on the Diagnosis, Prognosis, and Mitigation of Alkali-Silica Reaction (ASR) in Transportation Structures" (FHWA-HIF-09-004) at 37, tbl.9 (Jan. 2010) (NER013) ("FHWA Guideline"; The Institution of Structural Engineers, "Structural Effects of Alkali-Silica Reaction" §§ 6.3.2, 8.2 (July 1992) (NER012) ("ISE Guideline").

9 MPR Testimony at A115, A116, A198 (NER001); Tr. at 643-644.

10 Tr. at 643-644.

11 Tr. at 1008. Indeed, Dr. Saouma has done so in his own research. Saouma, V. "Experimental and Numerical Investigation of Alkali Silica Reaction in Nuclear Reactors" at 6 (Dec. 2017) (INT005) ("…to enhance the

Q8. In Paragraph 2 of INT051-R, Dr. Saouma testifies that "reactivity of the aggregate has a significant effect on the characteristics of the gel and microcracking." How do you respond?

A8. (JS, CB, OB, MS) We agree with Dr. Saouma on several key facts. Our prefiled testimony provides an overview of ASR development including the importance of the crystalline structure of the silica within the aggregate on reactivity,[12] the importance of aggregate chemical characteristics on reaction rate,[13] and the fact that expansion of gel causes cracking.[14] Our prefiled testimony also acknowledges that differences in concrete mixture design may result in ASR gel with different chemical and physical attributes.[15] We also state that differences in concrete mixture design may affect the typical crack pattern.[16] These various discussions are consistent with Dr. Saouma's claims.

However, we disagree with Dr. Saouma's assertion that these differences affect the representativeness of the LSTP, as designed and implemented for Seabrook. NextEra's approach is focused on the *structural* implications of ASR across a wide range of expansion levels in order to implement an effective aging management program on a plant-wide basis. These *structural* implications are not significantly affected by the rate of reaction, characteristics of the gel, or the specific pattern of microcracks comprising a given expansion level. This position is supported by literature,[17] and is consistent with the ASR test programs at Oak Ridge National Laboratory

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reaction, cement with a high natural alkalinity was selected and then the alkalinity was further raised by adding sodium hydroxide").

12 MPR Testimony at A65 (NER001).

13 MPR Testimony at A73 (NER001).

14 MPR Testimony at A65 and A73 (NER001).

15 MPR Testimony at A117 (NER001).

16 Tr. at 603.

17 *See infra* A7. *See also* Tr. at 995.

and the National Institute of Standards and Technology, which are not intended to be applicable only to a specific type of ASR gel.[18]

With regard to the ASR gel, as discussed in our prefiled testimony,[19] it "is only relevant because it can cause expansion and cracking, but it is the cracking that may ultimately produce structural consequences." The gel itself does not have any contribution to the structural capacity of the member, so its specific chemical characteristics are not important for a structural evaluation.

With regard to the cracking pattern, industry guidelines for addressing ASR focus on the level of expansion, but do not differentiate structural consequences based on specific crack pattern characteristics.[20] Recommended actions are based on measured total expansion, and do not include any conditional provisions if the given expansion is comprised of many tiny microcracks or a lesser number of wider cracks. Thus, there is no technical basis for establishing critical characteristics related to specific arrangements of microcracks in the test specimens. And Dr. Saouma has cited no such technical basis.

Q9. Does Dr. Saouma cite any technical basis, independent research, or published literature to support a claim that chemical characteristics of the minerals in the aggregate have *structural* implications or is relevant to NextEra's *aging management* approach to ASR?

A9. (JS, CB, OB, MS) No. Chemical characteristics of the minerals in the aggregate may be a relevant input to the type of predictive chemo-mechanical modeling approach advocated by Dr. Saouma.[21] However, Dr. Saouma cites no support for a claim that these

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18 Tr. at 996 (Buford).

19 MPR Testimony at A118 (NER001).

20 *See, e.g.*, FHWA Guideline at 37, tbl. 9 (NER013); ISE Guideline §§ 6.3.2, 8.2 (NER012).

21 *See* MPR Testimony at A198 (NER001).

chemical characteristics are a relevant consideration (much less a critical characteristic) for NextEra's approach to ASR monitoring.

Q10. As to Dr. Saouma's claim that NextEra has not provided enough information to allow for a mineralogical comparison of the Seabrook and LSTP concretes (and their constituents), how do you respond?

A10. (JS, CB, OB, MS, EC) We disagree with this assertion. For each critical characteristic (including those related to physical characteristics of the aggregate), we performed a technical evaluation that explicitly compared the LSTP specimen design with the Seabrook concrete to establish appropriate acceptance criteria.[22] These efforts are documented in MPR-3757 (NER026), MPR-4262 (NER022-R), and MPR-3722 (NER023),[23] which were available to C-10 as early as 2018.[24] The characteristics of each LSTP test specimen were assessed to ensure conformance to the defined acceptance criteria. This approach of validating that each LSTP test specimen adhered to pre-defined criteria was documented in the various commercial grade dedication ("CGD") reports for the LSTP.[25]

Furthermore, although not a critical characteristic, the aggregates used at Seabrook and the LSTP are well-described in the petrographic reports, each of which provide a list of specific minerals present. At the evidentiary hearing, Dr. Saouma stated that he "did not find [] a traditional classical petrographic report that petrographers do, indicating what kind of aggregate,

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22 MPR Testimony at A114 (NER001).

23 Notably, Dr. Saouma acknowledged at the evidentiary hearing that he was able to compare information in MPR-3757 regarding physical characteristics of the coarse aggregate in the LSTP and Seabrook concretes as to gradation (i.e., size) and concluded that "[t]here is a very strong similarity in the gradation between the two." Tr. at 1074.

24 *See* Letter from P. Bessette to N. Hildt-Treat, "Initial Disclosures Pursuant to 10 C.F.R. § 2.336; NextEra Energy Seabrook, LLC (Seabrook Station Unit 1), Docket No. 50-443-LA-2," Encl. 3 (item nos. 27, 46, 65) (Jan. 4, 2018) ("Initial Disclosures"); Letter from P. Bessette to N. Hildt-Treat, "NextEra Energy Seabrook, LLC (Seabrook Station Unit 1), Docket No. 50-443-LA-2" (Mar. 20, 2018) ("Initial Production").

25 MPR Testimony at A99 & tbl.1 (NER001) (listing the various CGD reports); *see also id*. at A100 (describing the CGD process); Tr. at 992.

the mineralogic origin, quartzite, dolomite, all these fancy names that petrographers give to different aggregates."[26] But such petrographic reports were disclosed to C-10 throughout the course of this proceeding. For example, a listing of specific minerals present in the coarse aggregate used in the LSTP test specimens is available in MPR-4262 (NER022-R), which states that "[t]he coarse aggregate consisted of limestone, including cherty limestone, quartzite, gneiss, chert, basalt, andesite, and sandstone."[27] The recently-provided Santa Ana Aggregates Report provides similar information in various tables.[28] And a list of specific minerals present in Seabrook's coarse aggregate is available in multiple petrography reports.[29]

Q11. In Paragraph 3 of INT051-R, Dr. Saouma says that "it is not clear from the document [the Santa Ana Aggregates Report] whether the Santa Ana aggregate was used in the LSTP, or whether it was merely sampled." Was the Santa Ana aggregate used in the LSTP?

A11. (JS, CB) Yes. Usage of the Santa Ana aggregate material in each LSTP specimen was clearly documented in various MPR reports and verified as part of the commercial grade dedication process.[30] Dr. Saouma is correct that the Santa Ana Aggregates Report, itself, does not assert that the subject aggregate was used in the LSTP. But that is because the Santa Ana Aggregates Report was prepared in September 2012—before NextEra had selected a specific concrete mixture design for the LSTP specimens.

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26 Tr. at 1074.

27 MPR-4262 at K-6 (NER022-R) (discussing one LSTP test specimen). This is typical of the other specimens.

28 Santa Ana Aggregates Report at 3, tbls. 2 & 3.

29 *See, e.g.*, Simpson Gumpertz & Heger Inc., Document No. RPT-100502-1 at 2-3 (Aug. 2010). *See also, e.g.*, Simpson Gumpertz & Heger Inc., Document No. RPT-100502-2 through -4 (providing similar information. These documents were disclosed and produced to C-10 in 2018. *See* Initial Disclosures, Encl. 2 at 3 (item no. 24) (Jan. 4, 2018); Initial Production.

30 *See, e.g.*, MPR-4262, "Shear and Reinforcement Anchorage Testing of Concrete Affected by Alkali-Silica Reaction," Vol. I, Rev. 1 (July 2016) & Vol. II, Rev. 0 (FP100994) at 4-9, 4-10 (Jan. 2016) (NER022-R) (identifying the Santa Ana aggregates as being used in the LSTP's shear and reinforcement anchorage test programs).

Q12. In Paragraph 3 of INT051-R, Dr. Saouma states that the Santa Ana Aggregates Report lacks mineralogical information regarding the "sand" (i.e., fine aggregate) used in the LSTP and Seabrook structures. How do you respond?

A12. (JS, CB, OB) The Santa Ana Aggregates Report provides information on the characteristics of the LSTP's *coarse* aggregate obtained from Lafarge Aggregates in Bernalillo, NM. It does not provide (or purport to provide) information on the characteristics of the *fine* aggregate (i.e., sand), which was obtained from a separate source. Information on the chemical constituents of the minerals in the fine aggregate are contained in separate petrography reports for the LSTP specimens,[31] and Seabrook's concrete.[32]

Q13. In Paragraph 3 of INT051-R, Dr. Saouma states that "a reasonable mineralogical comparison would include a table with side-by-side columns." How do you respond?

A13. (JS, CB) Table 3-1 of MPR-3757 provides a side-by-side table comparing the LSTP design requirements against the Seabrook concrete for all characteristics determined to be critical for purposes of the LSTP (which includes physical characteristics of the coarse aggregate). The CGD process (discussed above in A10) validated that the aggregate material used in each specimen satisfied these criteria. For chemical characteristics of the minerals in the aggregates, no such tables are provided because there are no critical characteristics for the LSTP pertaining to chemical characteristics of the minerals (as discussed above in A7 and A8).

Q14. Does this conclude your testimony?

A14. (JS, CB, OB, MS, EC) Yes.

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[31] *See, e.g.*, *id*. at K-6 (providing a listing of minerals in the fine aggregate).

[32] *See, e.g.*, Simpson Gumpertz & Heger Inc., Document No. RPT-100502-1 at 3 (Aug. 2010) ("The fine aggregate is primarily made up of quartz with lesser amounts of feldspar, micaceous minerals, chert, granite, and sand-sized particles of the coarse aggregate").

Q15. In accordance with 28 U.S.C. § 1746, do you state under penalty of perjury that the foregoing testimony is true and correct?

A15. (JS, CB, OB, MS, EC) Yes.

Respectfully Submitted,

Executed in accord with 10 C.F.R. § 2.304(d)
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