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

Revised Hearing Exhibit

Revised Exhibit Number: INT-049-R

Exhibit Revision Date: 2019.10.31

Revised Exhibit Title: SUPPLEMENTAL TESTIMONY OF VICTOR E. SAOUMA, PH.D REGARDING PETROGRAPHIC DOCUMENTS

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SUPPLEMENTAL TESTIMONY OF VICTOR E. SAOUMA, PH.D
REGARDING PETROGRAPHIC DOCUMENTS

1. The purpose of this supplemental testimony is two-fold. First, I will respond to questions raised by the Atomic Safety and Licensing Board ("ASLB") in its October 16, 2019 Memorandum (Request for Clarification) ("Memorandum"). Second, I will explain the significance to this proceeding of proposed Exhibit INT050, WJE Report No. 2014-3453.2 (May 26, 2016).

2. The ASLB's questions relate to whether C-10 received, during the document disclosure process, six documents identified by NextEra Energy Seabrook, LLC ("NextEra") as containing data regarding the mineralogical characteristics of Seabrook aggregate and the aggregate used by NextEra in the Large Scale Testing Program ("LSTP") at Ferguson Engineering Laboratories ("FSEL"). *See* Memorandum at 2. Those documents are:

- Simpson Gumpertz & Heger Inc., Document No. 120109-RPT-01 (Apr. 2012);
- Simpson Gumpertz & Heger Inc., Document No. RPT-100502.02-7 (July 2011);
- Simpson Gumpertz & Heger Inc., Document No. 110594-RPT-02 (Jan. 2012);
- Simpson Gumpertz & Heger Inc., Document No. RPT-100502-2 (Aug. 2010);
- Simpson Gumpertz & Heger Inc., Document No. RPT-100502-4 (Aug. 2010); and
- Simpson Gumpertz & Heger Inc., Project No. 130064 (Mar. 2013).

3. I am aware that C-10 previously had received six documents identified above, during the document disclosure process. However, I did not have a sufficient opportunity to review the documents until recently. I did not come into this case until late 2018, when I was retained by C-10 as a *pro bono* expert witness. During my document review and preparation of my testimony, I was also teaching and conducting research full-time at the University of Colorado. Presented with a very large number of discovery documents (approximately 350), I focused my review, for purposes of preparing my testimony, on the key consultant reports prepared by MPR and SGH. In the last week, following completion of transcript corrections (a process which took over a week), I have reviewed the documents identified in the Memorandum as well as several other petrographic documents provided by NextEra to C-1 in the disclosure process.

4. The ASLB also asked whether the six documents, in addition to Appendix K to Exhibit NER022-R (MPR-4262, "Shear and Reinforcement Anchorage Testing of Concrete Affected by Alkali Silica Reaction," Vol. I, Rev. 1 (July 2016) & Vol. II, Rev. 0 (Jan. 2016)) are sufficient to allow a mineralogical comparison between Seabrook concrete and the concrete used in the LSTP. In my expert opinion, the data provided in NextEra's reports are sufficient to support a comparison of the *physical* characteristics of the aggregates in the Seabrook concrete and the LSTP specimens, *i.e.,* shape, hardness, strength, and size distribution of aggregate components. However, they are not adequate to support a *mineralogical,* because they lack information about the gel type that will be produced, and consequentially the crack widths and patterns, that are needed to ensure adequate alkali silica reaction (ASR) representativeness. I discussed this topic in my prefiled direct testimony (Exhibit INT001-R) at 10-11 and in my oral testimony at tr. 981-82 and 984-985.

5. In the course of reviewing petrographic analyses conducted by NextEra's consultants between 2010 and 2016, I identified an additional consultant's report which has very high significance for this proceeding: WJE Report No. 2014-3453.2 (proposed Exhibit INT050). In this report, WJE reports that microcracking was found in petrographic examinations of eight concrete cores taken from the residual heat removal ("RHR") and containment spray ("CS") equipment vault. *Id.* at 13. WJE found that out of the eight cores taken, only one had the most severe ASR at the surface. *Id.* All of the rest of the cores showed ASR that was the same throughout, or "significantly less" at the surface than at deeper portions:

> All eight cores with ASR were drilled from the exterior walls of the Equipment Vault. While some voids in these cores were coated or filled with alkali-silica gel, due to ASR, the majority of the air voids in these cores were coated with secondary ettringite deposits, suggesting that the concrete bad been exposed to internal moisture movement.
>
> Within each core, tile extent of ASR was also different depending on the locations of the cores. Of the eight cores with ASR, Core 2 was the only one that exhibited the most severe ASR in the top portion of the core. *All other cores either exhibited significantly less ASR in the top portions than the deeper portions or a similar extent of ASR between the top portions and deeper portions. This observation suggests that ASR in the concrete was likely initiated and controlled by a factor from deep inside the concrete, rather than from the top surface of the concrete.* The development of ASR was controlled by availability of moisture coming from the exterior end of the walls.

Id. (emphasis added).

6. WJE's observation of ASR that was more severe in the interior of core samples contradicts NextEra's testimony that ASR at the surface of Seabrook core samples has

been uniformly found to be more severe than at a depth within the cores. *See, e.g.,* tr. 397 (Sherman); tr. 456 (Sherman); tr. 532 (Carley); and tr. 705 (Bayrak).

7. Equally important, the WJE Report undermines the NRC Staff's safety analysis for NextEra's ASR monitoring and assessment program for ASR, because the Staff based its safety finding in part on the assumption that cracks inside the concrete would not be worse than cracks found at the surface. Tr. 693 (Buford).

8. Throughout this proceeding, I have raised the concern that NextEra's program for monitoring and assessing ASR Seabrook is fundamentally defective because it relies on surface observations of cracking as the sole means of determining whether additional monitoring or investigation of ASR is required. As I have stated, NextEra relies for this approach on the erroneous assumption that ASR is always more severe at the surface of a concrete structure than in the interior. Surface conditions are very different than interior conditions, partly because the surface is drier. This is explained in my prefiled opening testimony (Exhibit INT001-R at page 26, Figure 13), in my prefiled rebuttal testimony (Exhibit INT028) at page 26, and in my oral testimony during the September 24-27 hearings at pages 449, 451, 452, and 488.

9. Judge Trikouros asked me to provide documentation of my expert opinion on this subject, and I responded by identifying the following report: Stark, D., & De Puy, G. W. (1987). Alkali-silica reaction in five dams in southwestern United States. ACI Special Publication, 100, 1759-1786 ("Stark and DuPuy") (Exhibit INT037). *See* tr. 489 (citing page 1770). Stark and DuPuy provides significant observations of the phenomenon whereby ASR is more severe inside concrete structures than at the surface, and an explanation of the relationship of this phenomenon to the disparity between low surface humidity and high internal humidity. Nonetheless, of course, Stark and DuPuy does not relate to the Seabrook plant itself. Therefore, WJE's observations confirming the same phenomenon in Seabrook core samples is extremely important.

10. I also agree with WJE's diagnosis that the greater degree of ASR in the interior part of core samples indicates that ASR is initiated by forces within the concrete rather than the surface. This is a key reason why surface cracking is not a reliable indicator of the extent or severity of ASR within the concrete.

I declare that the foregoing testimony is true and correct to the best of my knowledge, and the opinions expressed herein are based on my best professional judgment.

Executed in accord with 10 C.F.R. § 2.304(d) by
Victor E. Saouma, Ph.D

October 28, 2019