

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE COMMISSION

In the Matter of NextEra Energy Seabrook, LLC (Seabrook Station, Unit 1)))))))	Docket No. 50-443
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DECLARATION OF VICTOR E. SAOUMA, Ph.D

Under penalty of perjury, Victor E. Saouma declares as follows:

My name is Victor E. Saouma. I am Professor of Civil Engineering at the University of Colorado in Boulder. I am also the Managing Partner of [X-Elastica](#). A copy of my Curriculum Vitae is attached to my declaration as **Exhibit 1**.

1. I am Professeur des Universités in France, and have been a visiting Professor at the Swiss Federal Institute of Technology (Lausanne), January-June 1990; 1997-1998, and Sept. Dec. 2011. I was also a visiting Professor, (typically 1 summer month): at the Universite de Toulouse (2009), Politecnico de Catalunya, (2007, 2010); Ecole Normale supérieure de Cachan, (1992, 1994, 2007)' I was an invited Professor for two years (2003-2004) at the Politecnico di Milano (CY: 2003-2004).
2. I am qualified by training and experience in the fields of Alkali Silica Reaction, Fracture Mechanics, nonlinear finite element analysis, probabilistic based safety assessment, seismic analysis, chloride diffusion experimental mechanics and structural testing.
3. I have received three graduate degrees in Civil Engineering: a Ph.D. from Cornell University in 1980, an M.E. from Cornell University in 1977, and a B.E. from the American University of Beirut in 1977.
4. I am a leading international expert in the field of Alkali-Aggregate Reaction (AAR). I have developed what is probably the most widely referenced and copied model for AAR (in Abaqus, Vector3, Grizzly/Moose at the Idaho National Laboratory) as well as in China, Switzerland, and Canada. My research has encompassed material and structural testing, theoretical and computational models, numerical simulations of dams, and nuclear reactors. I published a [book](#) on Numerical Modeling of AAR; and I have published over 30 papers on [AAR](#), chloride diffusion, Seismic Analysis and Stochastic Analyses. I have also published a total of about 100 articles on AAR in peer-reviewed journals.
5. In addition, I have published on the related subjects of fracture mechanics, risk based assessment of bridges and dams, chloride diffusion, fracture mechanics, experimental dynamics (including editing a [book](#) on the subject). Recently, I greatly contributed to the redaction of an EPRI report on the numerical modeling of NCVS.

6. My experimental work includes large scale testing of concrete for fracture properties (for EPRI), dynamic centrifuge testing of dam models (in Japan), real time hybrid simulation (a complex form for dynamic structural testing), ASR expansion, and the impact of ASR on shear strength, and ASR expansion under varying conditions (for the U.S. Nuclear Regulatory Commission (NRC)).
7. I am the Former Director and Principal Investigator of the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES), NSF Center on Fast Hybrid Test at the University of Colorado, Boulder; 2006-2009.
8. I have served as President of [FraMCoS](#) (Fracture Mechanics of Concrete) a scientific organization focusing on the fracture and cracking of concrete.
9. I am currently the Chair of RILEM's [RILEM TC 259-ISR](#) Prognosis of deterioration and loss of serviceability in structures affected by alkali-silica reactions. This committee seeks to expand our knowledge in the prognosis of structures affected by ASR, and to develop benchmark problem to validate numerical codes that assess ASR.
10. I have also served as a member of the Materials Aging and Degradation (MAaD) External Review Committee (ORNL, Light Water Reactor Sustainability R&D Program); a member of the Expanded Proactive Materials Degradation Analysis Expert Panel (PMDA) for concrete in nuclear reactors; and Reviewer of the French research program MACENA (associated with VeRCoRs).
11. I have conducted research on ASR for: the Swiss Dam Safety office, the Tokyo Electric Power Service Company, Oak Ridge National Laboratory, the NRC, and presently (2018-2021) for the Bureau of Reclamation.
12. I also spent four years conducting research for the Electric Power Research Institute on the applicability of fracture mechanics to concrete dams; and nine years conducting research for the Tokyo Electric Power Service Company on the seismic response of dams (numerical and experimental).
13. In 2014 and 2017, the NRC awarded me a \$703,000 contract to provide support for "Experimental and Numerical Investigation of Alkali Silica Reaction in Nuclear Reactors." The initial grant award is attached to my declaration as **Exhibit 2**. As stated at page 4 of the grant award, the impetus for my proposed research stemmed from "the apparent challenge confronting the NRC in assessing safety issues pertaining to the Seabrook nuclear power plant which suffers from Alkali Silica Reaction (ASR), and in particular NRC request that the licensee determines the long term safety of the plant within the framework of ML121250588 (2012)." In December 2017, I submitted a four-volume report on my research:
 - a. Vol. 1-A: Design of an AAR Prone Concrete Mix for Large Scale Testing (93 pages)
 - b. Vol. 1-B: AAR Expansion; Effect of Reinforcement, Specimen Type, and Temperature (123 pages)

- c. Vol. 1-C: Effect of AAR on Shear Strength of Panels (90 pages)
- d. Vol. 2: Diagnosis & Prognosis of AAR in Existing Structures (210 pages)¹
- e. Vol. 3-a: Risk Based Assessment of the Effect of AAR on Shear Walls Strength (25 pages)
- f. Vol. 3-b: Probabilistic Based Nonlinear Seismic Analysis of Nuclear Containment Vessel Structures with AAR (216 pages)
- g. Final Summary Report (23 pages)

I also made a presentation to the NRC near completion of my project.

- 14. The Final Summary Report is attached to my declaration as **Exhibit 3**. For the record, I have not received a response to my report from the NRC.
- 15. I have been retained by the C-10 Research and Education Foundation (C-10) to evaluate work done by NextEra, NextEra's consultants, and the NRC technical staff regarding the presence of ASR in concrete at the Seabrook nuclear power plant; and the effect of ASR on the integrity of the concrete, including the containment. In the course of my review, I evaluated both public and proprietary documents regarding NextEra's investigations. I also applied the insights of my work under the NRC contract described above in par. 13.
- 16. My report, entitled Concerns Regarding the Structural Evaluation of Seabrook Nuclear Power Plant (Feb. 12, 2009), reflects my professional opinion of NextEra's work. To summarize, in my expert opinion, the manner in which NextEra's consultants have analyzed the impact of ASR on Seabrook is seriously deficient. The experimental program relates poorly to the subsequent analysis, and sufficient attention has not been given to the unique and complex nature of ASR in terms of the concrete mix. The subsequent methodology for the *Analysis of Seismic Category I Structures with Concrete Affected by Alkali-Silica Reaction* is very simplistic and contains numerous significant omissions (ASR modeling and seismic analysis among others). Therefore, based on my expertise and the published state of the art of ASR and safety assessment, I conclude that the quality of the presented results is not sufficiently reliable to support their stated purpose of confirming regulatory compliance.
- 17. I am designating my report as **Exhibit 4** to my declaration. However, because my report contains unredacted proprietary information, it is not a public document. Therefore, I have attached, as **Exhibit 4a** to this public declaration, the Introduction and Executive Summary. I plan to prepare and publicly submit a redacted version of my report in the near future.

¹ Preparation of Vol. 2, Diagnosis & Prognosis of AAR in Existing Structures, is still in progress. Pending completion, its content is confidential.

18. I have authorized C-10 to present my declaration and report to the NRC Commissioners in support of a petition that requests appropriate remedial action regarding the question of whether the presence of ASR in the Seabrook containment and other components has resulted in noncompliance by NextEra with NRC safety regulations and the Atomic Energy Act.

The statements of fact in this declaration and in my report are true and correct to the best of my knowledge, and the opinions stated therein are based on my best professional judgment.

Executed in Accord with 10 CFR 2.304(d) by:

A handwritten signature in blue ink, appearing to read 'Saouma', with a horizontal line extending from the end of the signature.

Dated: February 12, 2019

Victor E. Saouma