



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

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Review of Selected Documents Pertaining to the
Structural Evaluation of
Seabrook Nuclear Power Plant

By

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Submitted to

C-10 RESEARCH AND EDUCATION FOUNDATION
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1 Introduction and Executive Summary

This report presents my evaluation of the large-scale testing of concrete specimens at the Ferguson Structural Engineering Laboratory (FSEL) at the University of Texas for the purpose of evaluating the effects of Alkali-Silica reaction at the Seabrook nuclear power plant on the ability of the containment to withstand a design-basis earthquake. I have also reviewed the finite element assessment of Seabrook conducted by SGH, a consultant to NextEra Energy Seabrook, LLC.

The FSEL test program suffers from multiple flaws that cannot provide a solid basis for the author's far-reaching conclusions. Three major concerns are noted:

First, as discussed in Section 2.3, concrete used in the FSEL tests is not representative of the concrete at Seabrook. This lack of representativeness cuts across virtually every level of the test, including characteristics of the materials tested, test conditions, and assumptions about the behavior of concrete under finite element simulations.

Second, as discussed in Section 3.3, the Shear tests do not have the proper boundary conditions. They are also limited to out-of-plane shear, and some large unexplained cracks may have corrupted the test results. In addition, there is no evidence that the limit state (i.e. failure shear force) was captured and thus there is no evidence that shear failure was indeed captured as claimed.

Finally, as discussed in Section 4.3, the crack index measurements relied on by the author cannot provide a reliable assessment of the *in-situ* ASR expansion, because a crack index measured on the surface (where the concrete is relatively dry) is not representative of what is happening inside the specimen where the relative humidity (essential for ASR) is much higher.

Of equal – if not greater – concern is the finite element assessment of Seabrook conducted by Simpson, Gumpertz, & Heger (SGH). The numerical technique followed by SGH is a deterministic, linear and simplistic method that is used for the design of new structures. It is very regretful that SGH did not employ in addition to their minimalist analysis the probabilistic risk assessment method pioneered by the NRC. Whereas this would have required a nonlinear static and seismic analyses, SGH could have obtained a much more accurate assessment commensurate with the needs for such a critical structure. This probabilistic method was pioneered by the NRC and is well-accepted as a useful tool for analyzing the complex interactions of phenomena in nuclear safety analyses. My own independent research, conducted on behalf of the NRC between 2014 and 2017, confirms that probabilistic analysis of ASR yields more credible results than the type of linear and deterministic analysis used by SGH.

The test program at FSEL was executed by a researcher well versed with large-scale testing and reinforced concrete in general. However, his prior exposure to ASR seems to have been limited to a past test program for the Texas Department of Transportation (testing large scale beams with ASR) in collaboration with Prof. Folliard, an internationally known and respected researcher on the matter of ASR. But Dr. Folliard did not participate in the FSEL test program.

In summary, it is my professional opinion that both the FSEL test program and the SGH finite element analysis 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.

Finally, as a researcher and a concerned citizen, it is disturbing that when the NRC was for the first time confronted with such a complex issue it has not subjected the various studies to an independent review panel of international experts. While NRC has stated that it conducted an internal peer review, by its own terms an internal peer review is not independent.

1.1 Disclosure

I was the recipient of NRC Grant No: NRC-HQ-60-14-G-0010 titled *Experimental and Numerical Investigation of Alkali Silica Reaction in Nuclear Reactors* from September 30, 2014 to Dec. 30, 2017, and have conducted this evaluation *pro-bono*.

Other qualifications described in separate document.