This petition calls for the NRC to issue an order to the Seabrook licensee requiring immediate implementation and enforcement of ACI 349.3R and ASTM C 856-11 code standards requiring core sampling, and petrographic testing for the mechanical properties of tensile strength, Poisson's ratio, modulus of elasticity, and compressive strength—specifically for walls of the Containment Building and Spent Fuel Pool at Seabrook Station.

I. INTRODUCTION

Provision "G" of Seabrook Station's operating license (1990 as amended 11-02-2015 per ML053130320) states "The issuance of this license will not be inimical to common defense and security or to the health and safety of the public." However, this declaration of assurance by the Nuclear Regulatory Commission (NRC) has been undermined since 2009, when Alkaline Silica Reaction (ASR) was first detected during an on-site inspection. ASR continues to spread through the concrete structures of the reactor complex, and in so doing degrades their structural integrity. C-10 Research and Education Foundation has studied ASR and concludes that its presence at Seabrook is indeed inimical to public health and safety. To date, the NRC and NextEra have not determined the rate or extent of the ASR degradation, or confirmed the presence of ASR in the Containment Building. What is known is that ASR is a progressive and irreversible condition. Quoting NRC: *"…affected SSC* [structures, systems, and components] *should be considered operable but degraded, and below full qualification… Full qualification will be attained when the testing and analysis plans developed to address the ASR issues are completed and the long-term resolution is incorporated into the UFSAR* [Updated Final Safety Analysis Report]*."* (from revised NRC OP October, 2011; excerpted from email to D. Grinnell, C-10 11/21/13.) Since the revelation of ASR in 2009, Seabrook has never achieved "full qualification" for operability – nor are they likely to do so, because Seabrook's ASR has caused its concrete structures continually to degrade and fall further below full qualification. Unfortunately, to-date *"research in this topic exists, but it has not reached a level that would allow the repair and prediction of service life."* (Page 50, NIST / ANSI Codes and Standards for the Repair of Nuclear Power Plant Structures")

In 2014, C-10 filed a Petition for Rulemaking with NRC, to require that all licensees comply with the American Concrete Institute (ACI) standard 349.3R "Evaluation of Existing Nuclear Safety-Related Concrete Structures," and American Society for Testing and Materials (ASTM) standard C 856-11, "Standard Practice for Petrographic Examination of Hardened Concrete". This would ensure that inspection frequency and methodology for ASR detection be standardized throughout the US

commercial reactor fleet. As of today, use of these industry standards is merely recommended, not mandated by NRC.

II. PURPOSE AND JUSTIFICATION

As of this filing, NRC has taken no action to require NextEra to follow ACI and ASTM codes. In the case of NextEra's investigation into the extent of ASR at Seabrook, there are aspects of these standards that they appear to ignore. One consequence of the lack of adherence to these codes might be the adoption by NextEra of several assumptions that have proven to be scientifically inaccurate.

NRC staff made note of the lack of regulatory guidance, on September 19, 2014, before NRC's Advisory Committee on Reactor Safeguards (ACRS): *"…goals [under 10 CFR 50.65] be established commensurate with safety and, where practical, take into account industry-wide operating experience. In practice, for concrete structures, this usually translates into periodic visual inspection; however, specific inspection criteria related to ASR are generally not included."* Meanwhile, as far back as ten years, NRC made note of concrete degradation at the Seabrook reactor: *"…visual examination of concrete containment surface (VT-3C) performed in October 2005…. identified numerous areas of spalled concrete that equal or exceed a depth of 1 inch. According to evaluation criteria in ACI 349.3R-02, Sect.5.1 spalled areas that exceed a depth of 3/8in. and 4 in. in any direction must be evaluated.*" (RAI B.2.1.28-2, p. 30)

Furthermore, NUREG/CR -7171, "A Review of the Effects of Radiation on Microstructure and Properties of Concretes Used in Nuclear Power Plants" highlights the inadequacy of visual inspection: *"The primary method utilized for detection of ASR is through visual examinations indicating evidence of expansion, relative movements between structural elements, and cracking. ASR capable of being detected visually, however, is probably in a fairly advanced stage of development.*"

Because the standards contained within ACI 349.3R and ASTM C 856-11 represent the accumulated wisdom of "industry-wide operating experience" for concrete structures ostensibly sought after by NRC, NRC staff helps to make our argument for adoption and enforcement of these standards.

In the absence of regulatory enforcement for ASR testing, NextEra gives every appearance of avoiding the on-site (that is, at the reactor) testing that is an accepted and crucial part of proper petrographic analysis. In

testimony before the ACRS / Plant License Review (PLR) Subcommittee, July 10, 2012, Office of Nuclear Reactor Regulation's Senior Structural Engineer, Abdul Sheikh noted the 22 percent reduction in compressive strength found in certain safety-critical buildings at Seabrook Station. He points out that this reduction in strength may in fact be considered much greater, when we consider that in the absence of ASR, the concrete *should have strengthened by more than 20*% since construction. (When compared to the expected higher strength value of 4800 psi, the tested strength reflected more than a 30% reduction.) Sheikh further states, *"Since then the applicant has not performed any test to determine the rate of degradation of shear, tensile strength, bond strength on the concrete in the last 18 months. They haven't, as I pointed out before, they haven't extracted any cores from the containment… And it is a well-known fact that the visual examination cannot rule out the presence of ASR. You have to do some confirmatory tests."* (NRC ML 122070)

In the specific case of the Containment Building walls, C-10 is very concerned that the destructive power of the radiation from the reactor core may have a "coupling" impact, along with ASR, in accelerating the deterioration of this most vital safety structure. NUREG/CR-6927, "Primer on Durability of Nuclear Power Plant Reinforced Concrete Structures – A Review of Pertinent Factors," Oak Ridge National Laboratory, makes several references to this issue: (p.25) *"Nuclear heating occurs as a result of energy introduced into the concrete as the neutrons or gamma radiation interact with the molecules within the concrete material. The heat generated may have detrimental effects on the physical, mechanical, and nuclear properties of the concrete.… Determination of whether any deterioration that may occur in concrete properties is due to radiation damage or thermal effects can be difficult." (p.26) "…gamma radiation may cause a reduction in compressive strength… tensile strength of concrete is significantly reduced… with the decrease of tensile strength caused by neutron radiation more pronounced than the decrease in compressive strength…" Furthermore, there is an indication that nuclear radiation can significantly increase the reactivity of silica-rich aggregates to alkali (i.e. alkali-silica reaction)."*

Even with the abundance of evidence for the need of thorough strength testing for the Containment Building, Mel Gray, Branch Chief for Engineering, NRC Region 1, remarked to C-10's Debbie Grinnell, in an email dated 8/5/14: "*…My staff is not aware of any cores taken from the Seabrook... containment structure."*

C-10's expert witness on this matter, Dr. Paul Brown, Professor of Ceramic Sciences and Engineering at Penn State University, underscored the vital importance of tensile strength testing for concrete in his 9/19/14 testimony before the ACRS / PLR Subcommittee. He stated, in

part: *"…we can't simply rely on someone giving us some compressive strength data to really understand what's going on in the structure…a deteriorated concrete is characterized both for its compressive and its tensile strength... And you can understand it fairly simplistically. If you take a solid metal object and you just squeeze on it, you take a roll of quarters and you squeeze on it, the mechanical properties in compression may not be significantly compromised. But if you try and do a tensile test, you'll see a very, very different set of results."*

C-10's Ms. Grinnell asked Dr. Brown a few simple questions in preparation for this petition—via email, 11/20-21/15. These exchanges follow, with Dr. Brown's answers in italics:

(D.G.) "Is there a professional reason that cores done in a nuclear plant containment building would not show data that would reveal reliable results?" (P.B.) *"There is no reason."*

(D.G.) "Is there a reason cores cannot be done in a nuclear plant containment building as containment is too massive a building to draw a core safely?" (P.B.) "*There is no reason*."

(D.G.) "Do you know if a core is removed from a containment wall, would it damage the building?" (P.B.) *"No it will not have a meaningful effect on the building…No good technical reason not to do cores."*

After six years of study and analysis of ASR at Seabrook Station – Seabrook being the first commercial atomic plant in United States known to be so affected – NRC has not yet required that standard code testing be performed, in order to discover the full extent of the concrete degradation in walls supporting the two most safety-critical areas of the facility: the atomic reactor containment structure and the highly radioactive spent fuel pool. Insistence on such testing is in fact NRC's obligation. In part, this lack of oversight may be due to the inexperience of NRC with the phenomenon of ASR – and the absence of ASR-specific regulations within the larger framework of NRC codes and standards. In the view of the petitioner, the lack of action to discover and report the extent of ASR within Seabrook's safety-critical structures is also the result of a seeming unwillingness on the part of NRC to mandate the steps needed to determine the actual current material properties of concrete (determined for tensile strength, Poisson's ratio, modulus of elasticity, and compressive strength as stated above) in those locations within the facility whose structural integrity is most crucial to the public health and safety.

Seabrook's containment must remain an extremely robust concrete structure, in order to limit the radiation leaking out. Excessive leakage can expose plant workers to radiation and prevent or impede their efforts to mitigate an accident. Excessive leakage can expose members of the public to radiation and increase their chances of experiencing radiation-

induced illnesses and fatalities. In light of the fact that both the aforementioned structures contain and must isolate from the biosphere some of the deadliest and long-lived toxins on earth, any realistic "aging management program" must begin with an accurate assessment of the damage already done by ASR.

NextEra has elected to pursue a large scale, off-site research test program to resolve Seabrook's containment non-conformance to design basis with reduced margins, rather than do standard code testing in Seabrook Station's actual in-situ concrete containment building. The NRC has not required NextEra to take core samples from the plant's structures or test specimens. (email to D Grinnell from NRC's Seabrook Project Manager Glen Dental., October 12, 2015)

Several with the NRC Region 1 staff, NRR staff and experts have stated repeatedly that many of NextEra's assumptions were scientifically unfounded, and that the NRC should declare its "…Action Plan—to provide a commitment and schedule to obtain core samples from all Category 1 concrete structures to confirm the presence or absence of ASR concrete degradation" (comments by WJR on Draft TIA for ASR at Seabrook, 2011.)

David Wright of the Union of Concerned Scientists carefully explained several of NextEra's false assumptions in a letter to NRC dated 11/4/13, "Continuing Problems with Monitoring Concrete Damage at Seabrook," co-signed with C-10 Executive Director Sandra Gavutis. For instance, reliance on the "crack width index" as an "unjustified measure of ASR"; the pursuit of "replica tests" at the University of Texas in the place of tests which could be performed on the actual concrete structures from Seabrook Unit 2; the premature conclusion that the steel reinforcement is not corroding, given the presence of "*potentially aggressive water migration through the concrete…*;" these are just some of Dr. Wright's points. Concerning NextEra's avoidance of Seabrook in situ core extraction and testing, Dr. Wright quotes Dr. Paul Brown, C-10's expert witness cited above: *"It is well understood that drilled cores are extracted from an existing structure and have been subjected to the service environment associated with that structure. This in no way invalidates the result of the testing. The results of core testing are generally understood within the relevant engineering community. The NextEra preposition misuses the cautionary language of ASTM C42 and appears to be an attempt to avoid accumulating data which might be regarded as problematic."*

Although the NRC has stated that NextEra's off-site research test program must represent the actual in-situ conditions of Seabrook's containment, NextEra has refused the NRC Region I staff, NRR staff, and

experts' recommendations that code testing should and must be done. NextEra continues to state assumptions that are not scientifically supported as their basis to refuse to do core sample code testing on Seabrook's Containment Building, a seismic Category 1 structure. Without the actual in-situ core testing, no one can know the extent or rate of ASR within the reactor containment at Seabrook.

Therefore, we request this Emergency Enforcement Action. As Emeritus Professor of Engineering from UMass Lowell, and member of the guidance system development team for the Apollo space program Dudley Shepard stated in his 3/25/15 comment in support of C-10's Petition for Rulemaking, "Each of the players must be responsible for their role in the solution… Without NRC enforcement oversight, the solution process breaks down, and the problem remains. There is no other way."

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