Advisory Committee on Reactor Safeguards

C-10 Presentation; Technical

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Sept. 4, 2024

1. Chronology
2. Q1: Revisit Operating Basis Earthquake (OBE) & Safe Shutdown Earthquake (SSE); Correct Analysis Model
3. Q2: Air Leakage Test; Revisit Testing Frequency
4. Q3: Crack Indices (CI), Public Right to Know

Chronology

2009 ASR discovered in Tunnel (Bravo-1) at Seabrook.
2010 Seabrook placed under special NRC oversight.
2012 Nuclear Energy Institute suggests an (up to) 15 years intervals (in lieu of 10) for type A performance leakage rate tests of CBE.
2016 NextEra files a License Amendment Request (LAR)16-03.
Regarding seismic analysis, we note the following:

Eathquake levels: No change of OBE & SSE

[W]hen ASR loads are amplified by a threshold factor of 1.2 to account for future ASR expansion[, t]he as deformed condition does not significantly impact the dynamic properties of the structure, and therefore the maximum seismic acceleration profiles for OBE and SSE excitation used in original design of the CEB remain valid.

Seabrook, License Amendment Request 16-03 - Revise Current Licensing Basis to Adopt a Methodology for the Analysis of Seismic Category I Structures with Concrete Affected by Alkali-Silica Reaction.

NextEra-ML16216A240 (2016)

Chronology

Oversimplified Analysis

Seismic loads are applied using a static equivalent method utilizing the design-basis maximum acceleration profiles, which were computed during original design from response spectra analysis. Amplify ASR loads by a threshold factor to account for potential future ASR expansion.

...

Response spectra analysis was performed using a simplified "stick" model.

Evaluation and Design Confirmation of As-Deformed CEB, 150252CA-02," Revision 0, July 2016 (Seabrook FP#100985)

Simpson Gumpertz & Heger-ML16279A049 (2016)

Comments Below

2016 NextEra files a Request to Extend to 15 years leakage test of CBE. It alleges that

Chronology

NextEra's justification

- Containment's three directional steel reinforcement arrangements, which inhibits ASR expansion,
- The very limited localized areas of ASR detected on the containment surface, and
- Previous UT inspections of the containment liner local to areas of ASR in which no anomalies or corrosion were identified

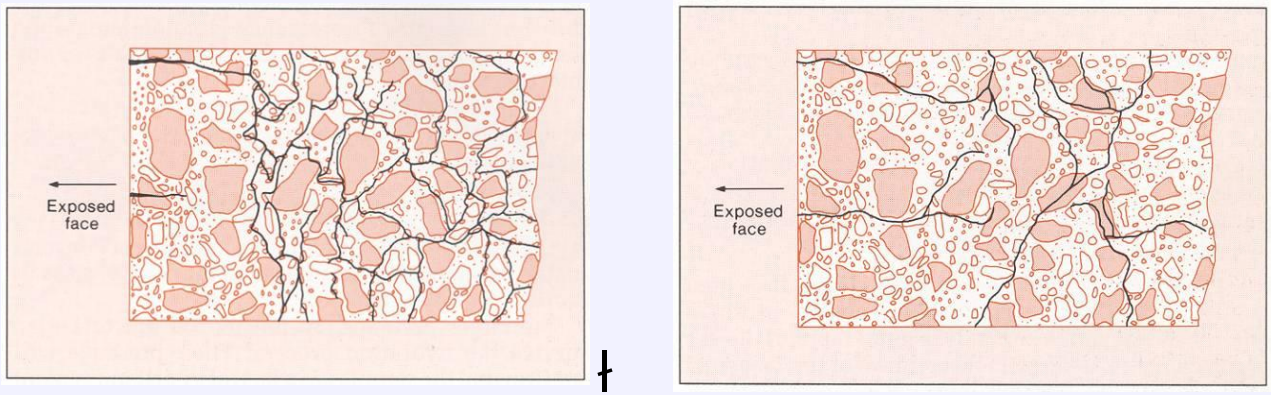
Supplement to License Amendment Request 16-01 Request to Extend Containment Leakage Test Frequency

NextEra Energy (2016)

Chronology

C-10 Comments

- ASR causes cracks and microcracks, which not always visible. These may coalesce and create a continuous pathway for gas release.
- There is three-directional reinforcement only around the base, while "skin" reinforcement is applied only on the intrados and extrados.



Report on the Diagnostis, Prognosis, and Mitigation of Alkali-Silica Reaction (ASR) in Transportation Structures
FHWA (2010)

Chronology

2019 Professor Saouma visits Seabrook.
2019 Consolidated documents filed by Dr. Victor Saouma
2019 Proposed Findings of Fact and Conclusions of Law: C-10, NRC, and NextEra.

2020 Atomic Safety Licensing Board (ASLB) Ruling (includes):

... NextEra has not persuaded us that it is properly accounting for the possibility of delamination.
The Board finds that NextEra does not have an adequate screening procedure to detect internal cracking and delamination in Seabrook's concrete." (pg 184)
...[t]he Board is concerned about the potential for sudden significant, localized damage due to shear failure, given that all parties agreed that there may be localized excursions of Seabrook Unit 1 into the nonlinear structure plastification regime." (pg 184)
Thus, the Board finds that NextEra has not shown, by a preponderance of the evidence, that there is reasonable assurance that the continued operation of Seabrook Unit 1 will not endanger the health and safety of the public with regard to this particular issue of delamination." (pg 185)

In the Matter of NEXTERA ENERGY SEABROOK, LLC (Seabrook Station, Unit 1); Initial Decision
Atomic Safety License Board (2020)

Observations

- In 2010, knowledge about ASR was insufficient, but significant advancements were made by 2020.
- Some premises that initially supported the license renewal were later shown to be incorrect.
- The ASLB comments partially validated this assertion.
- Given the stakes, it is urgent to reconsider two key issues.
  - OBE & OSE
  - Air leakage test

Explanation follows

Q1: Revisit Operating Basis Earthquake (OBE) & Safe Shutdown Earthquake (SSE); Correct Analysis Model

- We have reviewed the dynamic analysis procedure performed by SGH and found it dangerously simplistic.
- The term *significantly* is too vague given the potential impact on the safety of the CEB.
- The reliance on the stick model, a method from the 1970s, is not only outdated but also inadequate; In the 21st century the NRC must demand the adoption of a more accurate model.
- The ASR modeling blatantly disregards well-established principles, directly conflicting with what is universally accepted in the field of modeling.
- Program to simulate ASR not validated.
- The **Capacity** is grossly miscalculated.

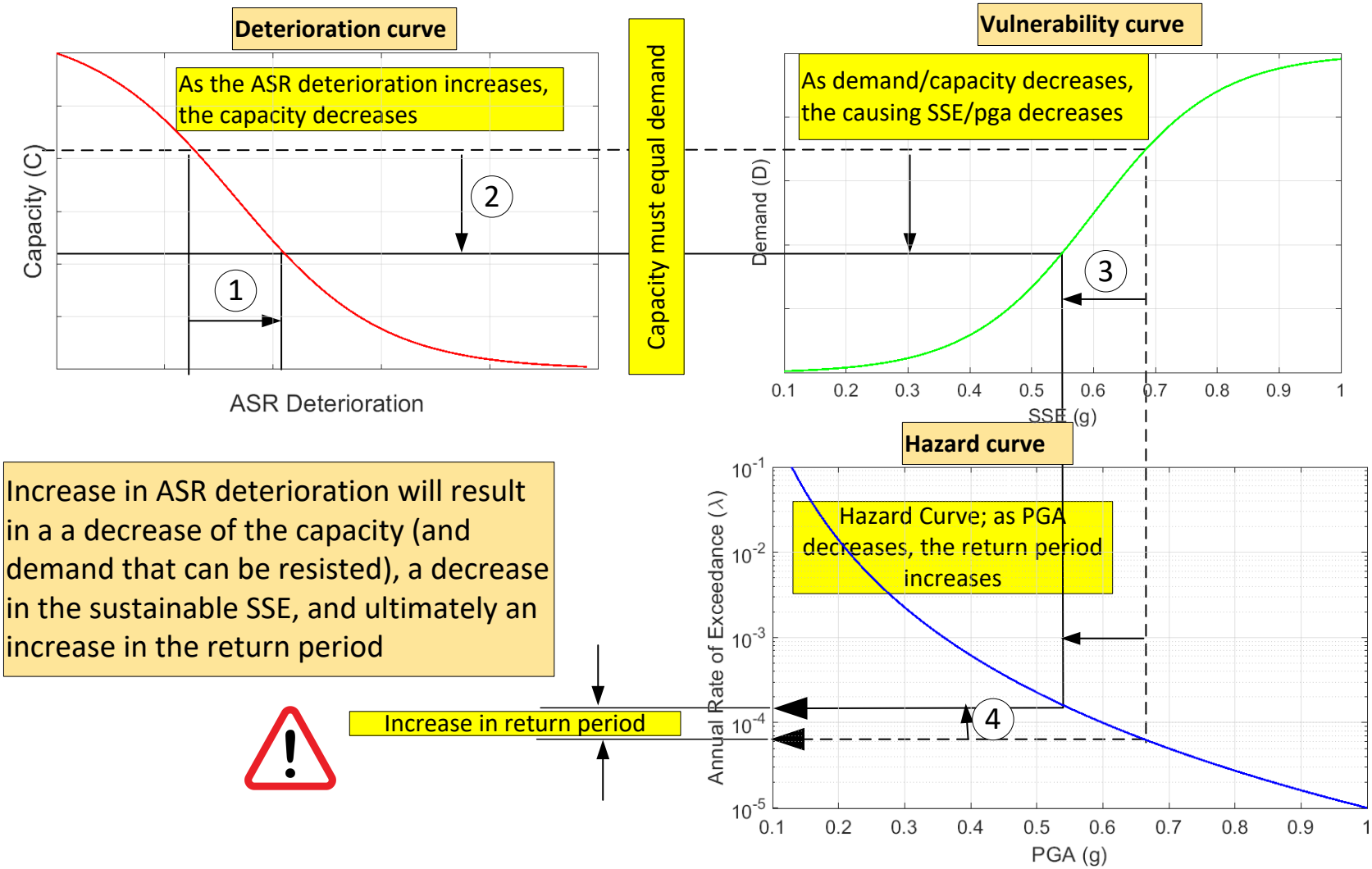
The Myth of No Shear Strength Loss from AAR

Results from the Shear Test Program indicate that there is no reduction of shear capacity in ASR-affected concrete with through-thickness expansion levels up to [redacted]% or volumetric expansion levels [redacted]%, which are the maximum expansion levels exhibited by the test specimens.

Seabrook Station - Approach for Determining Through-Thickness Expansion from Alkali-Silica Reaction
NextEra-ML18141A785 (2016)

- The persistent myth that there is no shear reduction due to AAR in the CEB has been conclusively disproven by findings from two separate NRC-funded research programs.
- AAR will lead to significant shear reduction, critically undermining resistance to earthquake excitation.
- The **Demand** is grossly underestimated

Why the SSE should be updated



Increase in ASR deterioration will result in a a decrease of the capacity (and demand that can be resisted), a decrease in the sustainable SSE, and ultimately an increase in the return period

Q2: Air Leakage Test; Revisit Testing Frequency

Air Leakage Test

- The ASLB firmly asserts that NextEra has no reliable control over where and when cracking will occur.
- This directly undermines NextEra's claim that 15 years cycles for leakage testing are sufficient.
- By 2020, ASR has not only been identified as a critical threat to Seabrook, with hidden cracks often going undetected, but NextEra has also demonstrated a consistently poor record in managing ASR.
- As the years pass areas known to have ASR,and countless unknown areas are experiencing ASR degradation.
- Consequently, we strongly recommend that the full air tightness test schedule be drastically shortened from the current 15 years to a performance-based schedule.

Q3: Crack Indices (CI), Public Right to Know

Public Right to Know Some Data

- The public has a fundamental right to access information that affects their safety and well-being.
- Transparency in sharing data helps build trust between the reactor operator, regulatory agencies, and the public. When data is openly available, it demonstrates that the operator is committed to safety and is accountable for maintaining the highest standards.
- Public access to safety data enables independent experts, researchers, and advocacy groups to analyze the information, potentially identifying issues that may be overlooked by the operator or regulators.
- We understand that NextEra may consider the data confidential; however, we assert that we assert that raw measurement data should be treated as public domain, however we recognize that NextEra's modeling is proprietary.

What Data?
Acceptance criteria for CI measurements

Tier	Structures monitoring program	Recommendation for individual concrete components	Criteria
3	Unacceptable (requires further evaluation)	• Structural evaluation • Implement enhanced ASR monitoring such as through-wall expansion monitoring using Extensometers	1.0 mm/m (0.1%) or greater strain measurement (CCI or pin-pin)
2	Acceptable with deficiencies	Quantitative monitoring and trending	• 0.5 mm/m (0.05%) or greater strain measurement (CCI or pin-pin) • CI or pin-pin measurement of greater than 0.5 mm/m (0.05%) in the vertical and horizontal direction
		Qualitative monitoring	Any area with visual presence of ASR (as defined in [930] accompanied by a CI of less than 0.5 mm/m (0.05%) in the vertical and horizontal directions
1	Acceptable	Routine inspection as prescribed by the Structural Monitoring Program	Area has no indication of pattern cracking or water ingress; No visual symptoms of ASR

Seabrook Station - Approach for Determining Through-Thickness Expansion from Alkali-Silica Reaction
NextEra-ML18141A785 (2016)

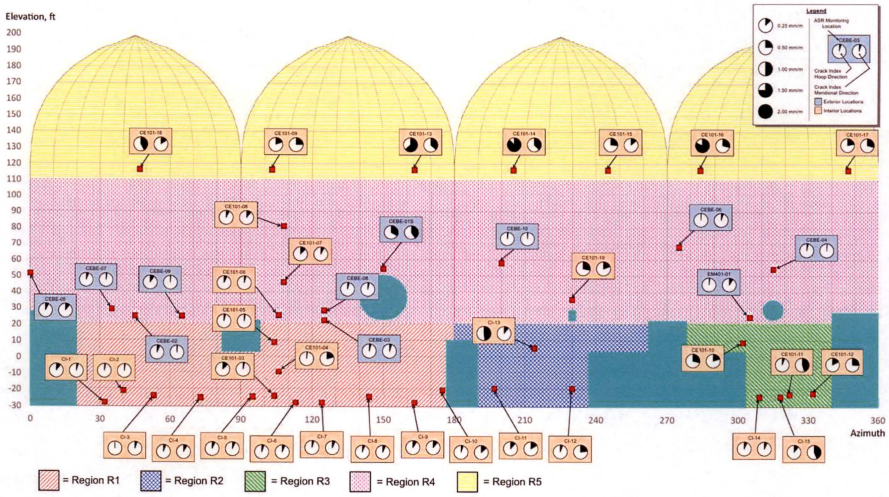
Need to Communicate with the Public

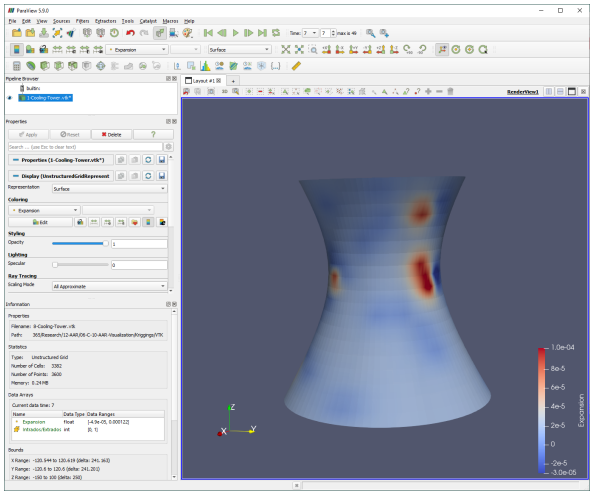
- We ask the NRC to obtain from NextEra and share with the public all measurements related to the crack index

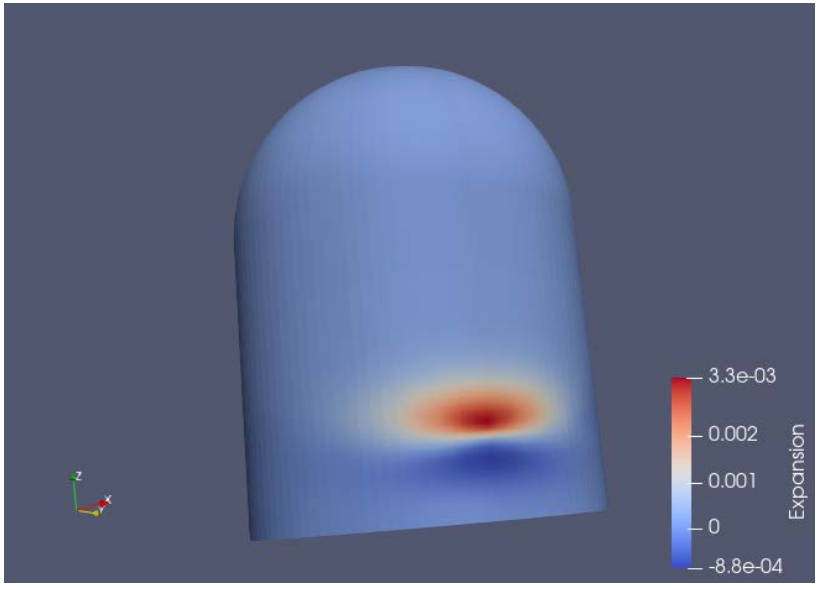
Date	Tier	CI	Location	Ref Values

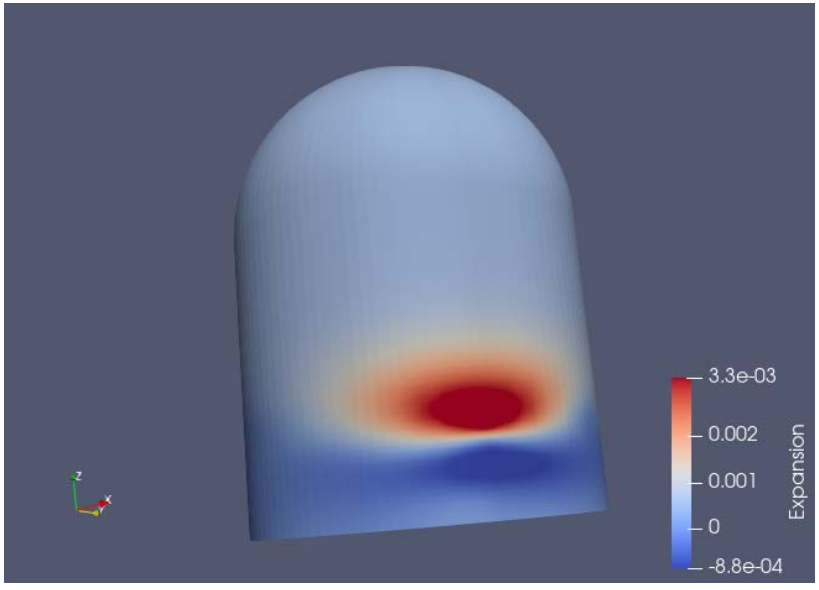
  Ref Value: Location of the closest concrete sample cast during construction with known compressive strength f'_c
- C-10 has built a data visualizer that we would like to share with the NRC. It is based on the premises that
  - ASR has both a spatial and temporal variation.
  - It is measured pointwise, yet its impact is spread over volumes
  - We only have limited point measurements at discrete times.
  - Need to
    1. Map
    2. Visualize
    3. Analyze (and predict)

Visualize

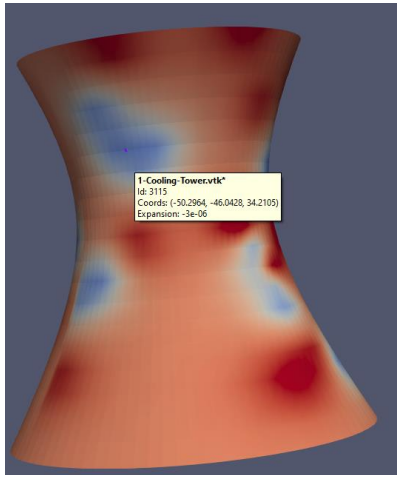

Elevation, ft
Azimuth
= Region R1
= Region R2
= Region R3
= Region R4
= Region R5

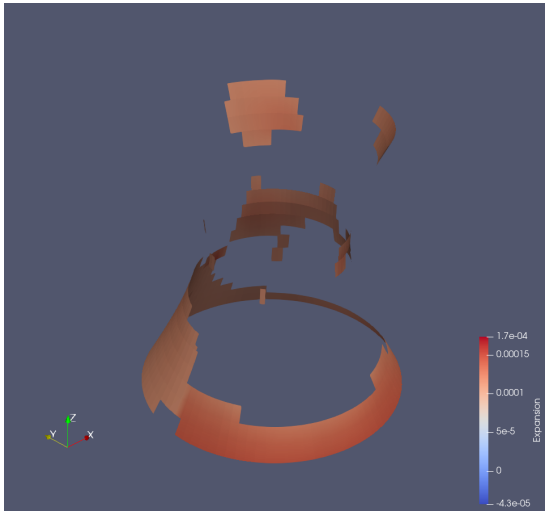


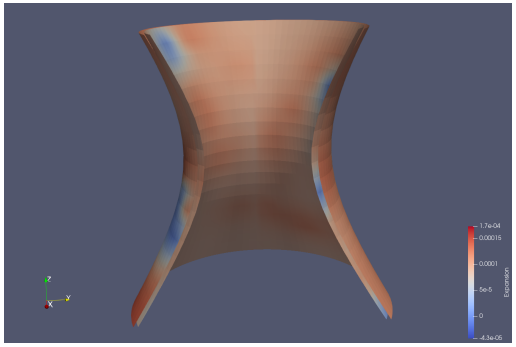

3.3e-03
0.002
0.001
0
-8.8e-04
Expansion

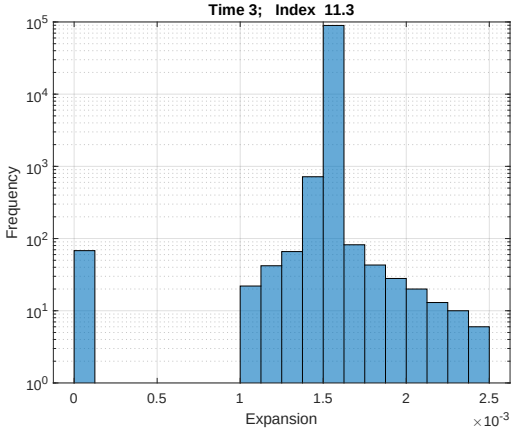

3.3e-03
0.002
0.001
0
-8.8e-04
Expansion

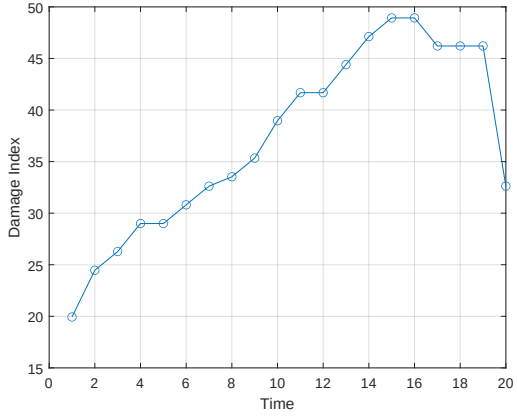
Analyze











Can Quantify structural damage over time.

- Atomic Safety License Board (2020). *In the Matter of NEXTERA ENERGY SEABROOK, LLC (Seabrook Station, Unit 1); Initial Decision*. Docket No. 50-443-LA-2, ASLB No 17-953-02-LA-BD01.
- FHWA (2010). *Report on the Diagnostis, Prognosis, and Mitigation of Alkali-Silica Reaction (ASR) in Transportation Structures*. Tech. rep. FHWA-HIF-09-004. Federal Highway Administration.
- NextEra Energy (May 2016). *Supplement to License Amendment Request 16-01 Request to Extend Containment Leakage Test Frequency*.
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- NextEra-ML18141A785 (2016). *Seabrook Station - Approach for Determining Through-Thickness Expansion from Alkali-Silica Reaction*. Redacted Document.
- Simpson Gumpertz & Heger-ML16279A049 (2016). *Evaluation and Design Confirmation of As-Deformed CEB, 150252CA-02," Revision 0, July 2016 (Seabrook FP#100985)*. Online; accessed 2024-07-16.