SeabrookLANPEm Resource

From: Browne, Kenneth <Kenneth.J.Browne@nexteraenergy.com>
Sent: Thursday, November 16, 2017 4:15 PM
To: Poole, Justin
Subject: [External_Sender] NEE_PublicMeeting-Responses to RAI 11-13-17 (2017 11 16 final).pdf
Attachments: NEE_PublicMeeting-Responses to RAI 11-13-17 (2017 11 16 final).pdf

Justin,
Here is the slide deck for tomorrow's public meeting

Ken

Hearing Identifier: Seabrook_LA_NonPublic
Email Number: 1171

Mail Envelope Properties (98e54e84b3f744358a6dc5a9e0203f47)

Subject: [External_Sender] NEE_PublicMeeting-Responses to RAI 11-13-17 (2017 11 16 final).pdf
Sent Date: 11/16/2017 4:15:20 PM
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From: Browne, Kenneth

Created By: Kenneth.J.Browne@nexteraenergy.com

Recipients:
"Poole, Justin" <Justin.Poole@nrc.gov>
Tracking Status: None

Post Office: nexteraenergy.com

Files	**Size**	**Date & Time**
MESSAGE	72	11/16/2017 4:15:29 PM
NEE_PublicMeeting-Responses to RAI 11-13-17 (2017 11 16 final).pdf	411918	

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Seabrook Station ASR Methodology LAR: Structural Deformation

LAR 16-03

Methodology and Responses to RAIs D2-D8

November 17, 2017

The foundation for everything we do are the Values and Core Principles of our Nuclear Excellence Model

Nuclear Excellence Model

Vision: We are a team that delivers consistent excellent performance

Mission: We will produce energy in a safe, reliable, cost effective way, while caring for our employees, communities and the environment

Values

- Conduct all activities to demonstrate a deep respect for Nuclear Safety
- Live the Safety Guiding Principles
- Be a Self-Improving Culture & Learning Organization
- Maximize the time spent on Prevention and Detection to minimize / eliminate Correction activities
- Foster a work environment where we are the employer of choice

Core Principles

Operationally Focused	Passion for Excellence	Engaged Leaders	Standardized Processes	Responsive to Stakeholders	Effective Workforce Planning
Engaged Employees	Effective Long-Range Planning	Strong Teamwork	Strong Ownership & Accountability	Effective Supervisors	Worklife Balance

Strategic Focus Areas

Operational Excellence

Organizational Effectiveness

Generation Reliability

Effective Business & Financial Performance

NEXTera ENERGY NUCLEAR FLEET

- **NextEra Energy Seabrook**
  - Ken Browne — Licensing Manager
  - Jeff Sobotka — Design Engineering Manager
  - Ed Carley — Engineering Supervisor
  - Jaclyn Hulbert — Engineer – ASR Program Owner
- **Simpson Gumpertz and Heger**
  - Dr. Said Bolourchi — Senior Principal
  - Dr. Andrew Sarawit — Senior Project Manager
- **MPR**
  - John Simons — General Manager

Overview of Methodology Document

- Provides
  - Analysis and evaluation approach for all Seismic Category I structures and all stages.
  - Sufficient details provided for consistent application and repeatability for all three stages of analyses.
  - Acceptance based on meeting the Codes of record as supplemented.
  - Supplements to the Codes with justifications.
  - Monitoring parameters and threshold limits.
  - Actions when ASR deformations approach limits.
- Allows knowledgeable structural engineers to implement methodology in a consistent and repeatable manner.

ASR Evaluation Process

License Amendment Request
- Stage 1, 2, and 3 analyses
- Material properties

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Methodology Document
- Repeatable process for Stage 1, 2, and 3 analyses

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Structural Analysis & Evaluation
- Demand calculations
- Compliant to ACI 318-71 and ASME Code as supplemented

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Threshold Limits
- Establish design margin for potential future ASR expansion

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Structures Monitoring Program
- Monitoring parameters and frequency
- Trending
- Action if approaching threshold limits

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Contents of Methodology Document

- Characteristics and Measurement of ASR
- Loads and Load Combinations
- Analysis Approach
- Acceptance Criteria
- ASR Threshold Limits and Monitoring
- Evaluation for Approaching Threshold limits

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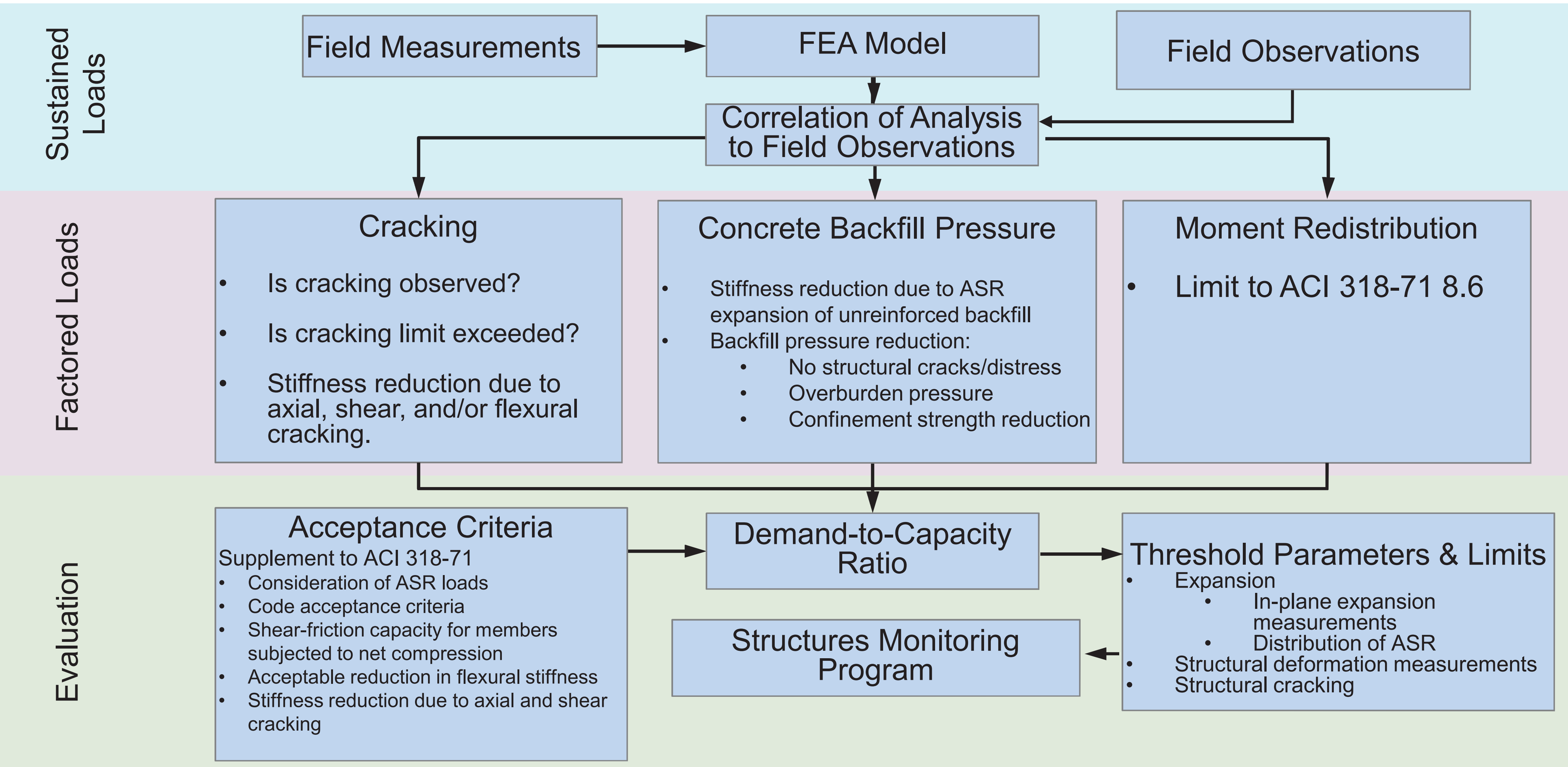
Loads and Load Combinations

- Loads and factored load combinations are
  - as defined in the current UFSAR and
  - supplemented by LAR 16-03 to include ASR loads and load factors.
- ASR load factors provide safety margins consistent with the original codes of record.

Stage Three Evaluation Process



Methodology Document Summary

- **Provides detailed analysis approach for all stages of analyses described in the LAR 16-03.**
- **Allows knowledgeable structural engineers to implement methodology in a consistent and repeatable manner.**

RAI-D2

Request - Provide a detailed explanation of how the Stage 3 analysis methods will be implemented in a consistent, repeatable manner. Identify deviations from the design code of record.

Response

- **Methodology Document establishes an approach to perform a Stage 3 analysis in a consistent, repeatable manner.**
- **Supplements to the codes of record**
  - Supplement 1 - Consideration of ASR loads
  - Supplement 2 - Code acceptance criteria
  - Supplement 3 - Shear-friction capacity for members subjected to net compression
  - Supplement 4 - Flexural cracked section properties
  - Supplement 5 - Axial and shear cracked section properties
- **UFSAR markup will be revised to reflect these supplements**

RAI-D3

Request - Explain with sufficient technical detail how the proposed moment redistribution approach meets specific requirements of ACI 318-71.

Response

- **The Methodology Document limits the use of moment redistribution for all structures to be in accordance with ACI 318-71 Section 8.6.**
- **The CEB evaluation is being revised in accordance with the Methodology Document.**
  - Eliminate the use of moment redistribution.
  - Consider cracked section properties.

RAI-D4

Request - Explain with sufficient technical detail how the "simplified moment redistribution" method is applied.

Response

- **As discussed in response to RAI-D3 moment redistribution will be limited to ACI 318-71 section 8.6.**
- **The CEB evaluation is being revised without the use of moment redistribution methods. Appendix L of the CEB Evaluation will be superseded. The same structural model and boundary conditions were used in previous analysis.**

RAI-D5 (a)

Request - Clarify what the threshold factor represents in Stage 3 analyses and how the factor will be determined for future analyses.

Response

- **Threshold factor is design margin expressed as the amount ASR loads can increase and still meet ACI criteria.**
  - Threshold factor is an output of the evaluation, not an input to the methodology.
  - A unique threshold factor is calculated for each building based on the available margin.
  - Used to establish threshold limits for monitored parameters.
  - This margin is available to account for potential future ASR expansion without reducing the code inherent margin of safety.
- **Threshold factor may be revised based on further analysis, by using additional inspection and measurement data, and/or using a more refined structural analysis method without reducing the code inherent margin of safety.**

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RAI-D5(b)

Request - Explain if there is a limit imposed on the extent of analysis that can be used to modify the demands upon a structure and if this impacts the specification of the threshold factor.

Response

- **Threshold factor is an output of an evaluation (see RAI-D5(a)).**
- **There is no limit on re-evaluation provided evaluation satisfies ACI Code as supplemented.**
  - Moment redistribution is limited per ACI Code.
- **Re-evaluations would use additional inspection and measurement data, and/or use a more refined structural analysis method in accordance with the Methodology Document.**
- **Structural modification may be required to reestablish margin.**

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RAI-D6

Request - Clarify whether the 100-40-40 method will be implemented in equivalent static analyses for ASR-affected structures. If so, provide the technical basis for using the method in conjunction with equivalent static analysis.

Response

- **The 100-40-40 method will be deleted from the proposed methodology**
  - The CEB evaluation is being revised to use the square-root- of-the-sum of-the-squares (SRSS) method in conjunction with the equivalent static analysis method consistent with the original design calculation approach.
- **UFSAR markups will be revised to remove references to 100-40-40.**

RAI-D7(a)

Request - Provide an explanation of how multiple load components (e.g., axial force and moment) are combined to perform code interaction checks.

Response

- **The Methodology Document only allows the use of SRSS method for calculation of seismic demands.**
  - The CEB evaluation is being revised without the use of the 100-40-40 method.
- **For conditions with multiple components (e.g., axial force and moment P-M interaction), the Methodology Document requires**
  - All components are calculated by the SRSS method.
  - The SRSS calculated ±P and ±M will be used for P-M interaction evaluation.

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RAI-D7(b)

Request - Explain why the combination of E_O, and H_e in some cases is less than E_O, alone. If the explanation assumes a phase relationship between E_O, and H_e, provide the technical basis for the assumed phase relationship.

Response

- For the CEB calculation, the seismic inertia force, E_O, and soil pushing the embedded part of the CEB, H_e, are modeled in-phase.
- In-phase modeling maximizes base shear and overturning moment when the static equivalent method and the SRSS responses are used.
- The out-of-plane bending response in CEB is influenced by the presence of large penetrations, and location of applied loads including dynamic soil loads. The dynamic soil response and inertial response may counteract each other at limited small locations.
- Analyses consider seismic motion in opposite directions. Results at each location are enveloped, therefore the localized areas are covered.

RAI-D8

Request - Explain, with sufficient technical detail, how the proposed method of evaluation for ASR-affected structures verifies that the stresses and strains in the concrete and reinforcement remain within elastic limits based on realistic behavior under normal operating (service) load conditions, including ASR load.

Response

- **Compliance with the ACI Code, as supplemented by the Methodology Document, ensures structures behave elastically, and the rebar and concrete stresses and strains remain within acceptable limits.**

RAI-D8

Response (continued)

- **Performed two parametric studies to examine rebar stresses.**
  - Scope
    1. Effect of increasing ASR expansion for member subjected to external load.
    2. Impact of increasing load on ASR-affected member.
  - Preliminary results for discussion
    -- Rebar stresses remain in elastic range for normal operating (service) loads.
- **Assessed rebar stresses for Seabrook structures.**
  - Scope
    -- Structures evaluated to date
  - Preliminary results for discussion
    -- Stresses and strains in the Seabrook structures are shown to be within elastic limits under normal operating load conditions (unfactored loads) when ASR loads are considered.

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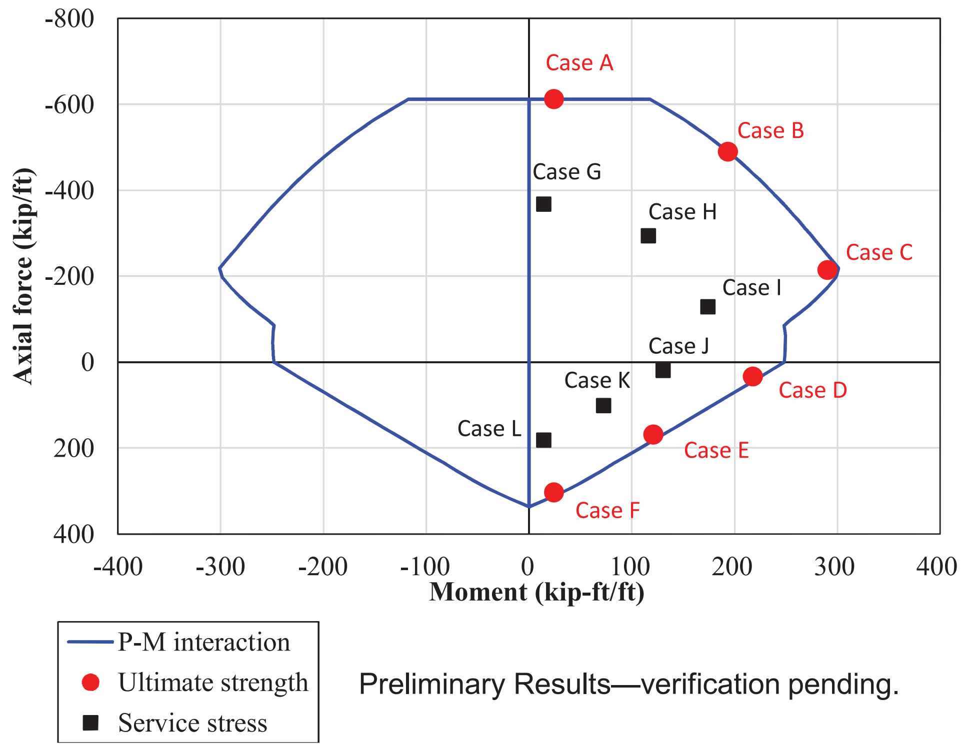
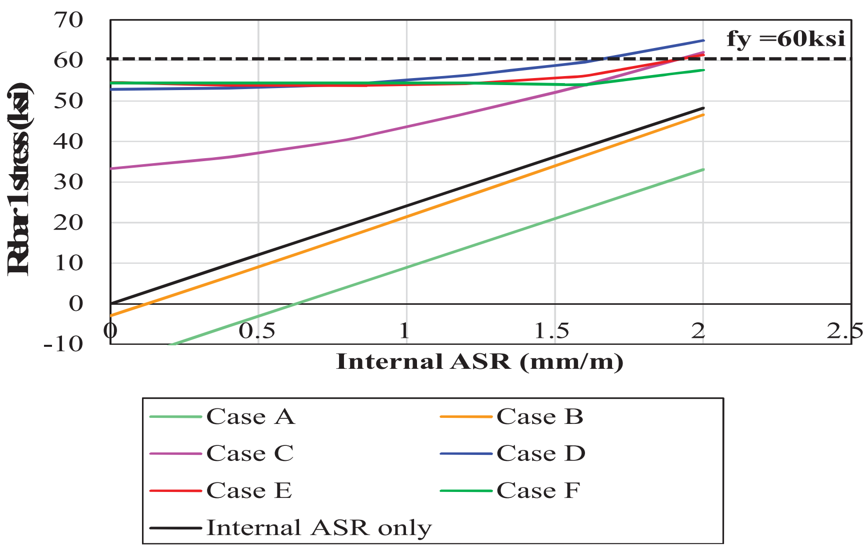
Parametric Study 1- Stress in tension rebar of typical 2 ft thick member subjected to P-M and increasing ASR strain

P-M Combinations Cases

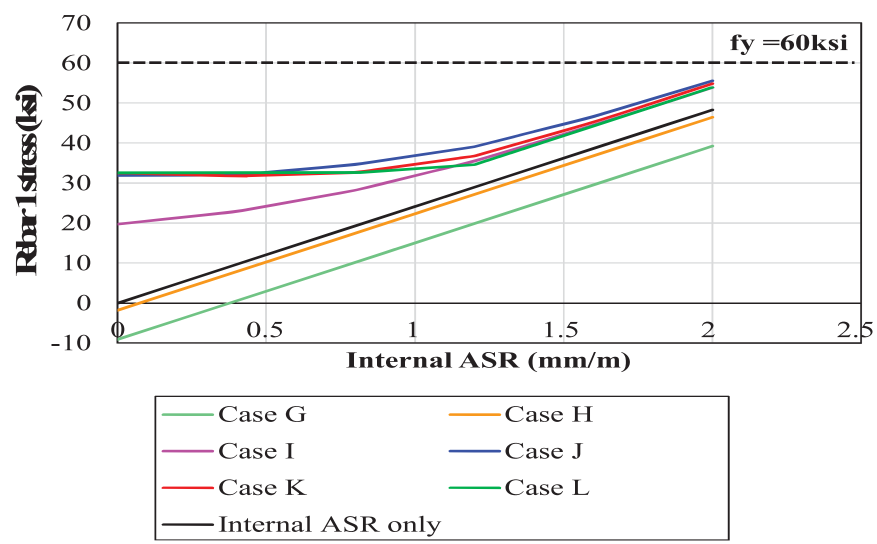


Preliminary Results—verification pending.

Parametric Study 1 - Stress in tension rebar of typical 2 ft thick member subjected to P-M and increasing ASR strain



Factored load



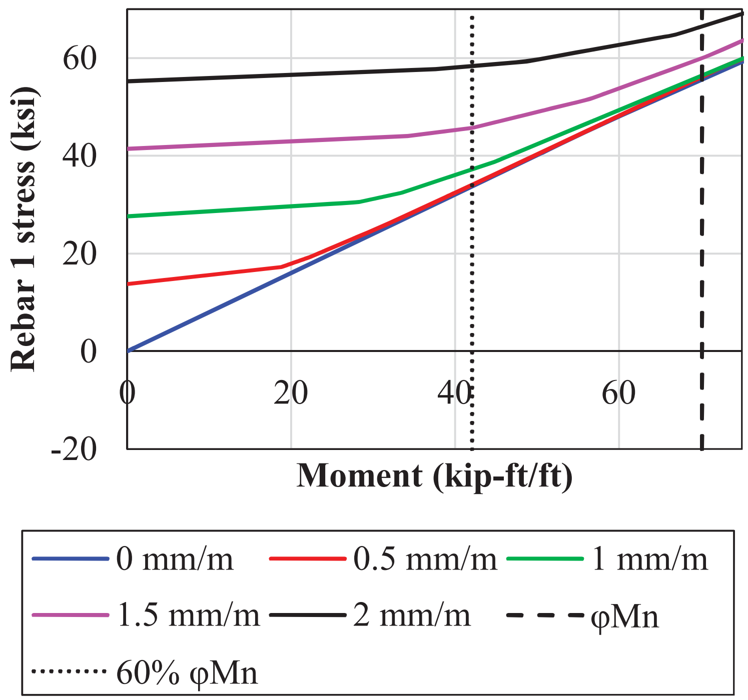
Service load

Preliminary Results—verification pending.

- The tensile stress in the rebar increases after ASR expansion is sufficient to close structural cracks around the tensile rebar.
- For sections with already high levels of external load (factored level loads), high levels of ASR are needed to cause additional tensile stress in rebar.

Parametric Study 2 - Stress in tension rebar of typical 2 ft thick ASR-affected member with increasing moment

- **Self-straining concrete compressive stress effect will unload before rebar tensile stress increases. This is because the concrete section is much stiffer than the steel based on the reinforcement ratio.**
- **Stresses and strains in steel rebar are less than the elastic limits at service load conditions, provided that ASR strain is less than steel yield strain (2 mm/m).**



Preliminary Results—verification pending.

Stresses in Seabrook Structure due to Service Load

- **The stresses for the structures that are completed or being completed have been calculated for the following two service load conditions:**
  - in situ condition: $D + L + E + T_o + S_a$
  - in situ condition plus operating basis earthquake and potential future ASR expansion up to threshold limit: $D + L + E + T_o + E_o + H_e + F_{THR} \cdot S_a$
- **For the above realistic unfactored service load combinations, stresses in rebar are below yield, and concrete strains are less than 0.001 and are less than the 0.003 ACI Code maximum usable strain for concrete compression**

Maximum steel rebar tensile stress and concrete compressive stress for in situ condition: D + L + E + T_o + S_a

Structure	Analysis Stage	ASR (mm/m)	Component	Maximum tensile stress in rebar (ksi)	Maximum compressive stress in concrete (ksi)	Maximum compressive strain in concrete
CRMAI	3	0.99	Base Mat	27.8	-0.28	-0.00009
RHR	3	0.75	East exterior wall	47.0	-1.8	-0.00058
CSTE	2	0.43	Tank wall	16.0	-0.66	-0.00018
CEHMS	1	0.72	East wing wall	31.3	-0.78	-0.00025
CEVA	1	0.31	Base slab	32.8	-0.88	-0.00028
CEB	3	0.60	Wall between Mech. & Elec. Penetration	24.6	-2.19	-0.00065
WPC/PH	2	0.24	North wall	6.5	-0.49	-0.00016
EMH	1	0.25	W13/W15 walls	7.3	-0.03	-0.00001

Preliminary Results—verification pending.

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Maximum steel rebar tensile stress and concrete compressive stress for in situ condition plus operating basis earthquake and future ASR expansion up to threshold limit: $D + L + E + T_o + E_o + H_e + F_{THR} \cdot S_a$

Structure	Analysis Stage	ASR (mm/m)	Component	Maximum tensile stress in rebar (ksi)	Maximum compressive stress in concrete (ksi)	Maximum compressive strain in concrete
CRMAI	3	0.99 x 1.4	Base Mat	39.1	-0.37	-0.00012
RHR	3	0.75 x 1.2	East exterior wall	56.5	-2.1	-0.00067
CSTE	2	0.43 x 1.6	Tank wall	26.7	-1.11	-0.00031
CEHMS	1	0.72 x 1.5	East wing wall	41.6	-1.52	-0.00049
CEVA	1	0.31 x 3.0	Base slab	44.0	-1.08	-0.00035
CEB	3	0.60 x 1.3	Wall between Mech. & Elec. Penetration	44.0	-2.8	-0.00091
WPC/PH	2	0.24 x 1.8	North wall	23.2	-0.85	-0.00027
EMH	1	0.25 x 3.7	W13/W15 walls	26.8	-0.11	-0.00004

Preliminary Results—verification pending.

Summary

- The Methodology Document provides the approach for performing all three stages of analyses described in the LAR can be implemented in a consistent and repeatable manner by a knowledgeable structural engineer.
- Use of moment redistribution for structures will be in accordance with ACI 318-71 Section 8.6.
- The 100-40-40 method will not be considered for calculating seismic demands for any Seismic Category I structures at Seabrook. The UFSAR markup will be revised to use the original SRSS methods.
- Compliance with the ACI Code, as supplemented by the Methodology Document, ensures structures behave elastically, and the rebar and concrete stresses and strains remain within acceptable limits.

Building Deformation Analyses (1 of 2)

Structure	Schedule	Percent Complete	Incorporated to SMP
Condensate water storage tank	Complete	100%	Complete
Containment enclosure building (revision)	4Q2017	80%	Complete **2/2018(Rev1)**
Containment enclosure ventilation area	Complete	100%	Complete
Containment structure	Complete	100%	Complete
Equipment hatch missile shield	Complete	100%	Complete
Control room make-up air intake	Complete	100%	Complete
Electrical cable tunnels	Complete	100%	Complete
Pre-action valve building	4Q2017	80%	2/2018
RHR equipment vault	Complete	100%	Complete
Containment internal structures	4Q2017	90%	2/2018
Main steam and feed water east pipe chase Hydrogen recombiner structure	4Q2017	70%	2/2018
Stage 1 Safety-related electrical duct banks and manholes	1Q2018	80%	4/2018
Stages 2 and 3 Safety-related electrical duct banks and manholes	1Q2018	40%	4/2018
Emergency feedwater pump building	1Q2018	50%	4/2018
Fuel storage building	4Q2017	80%	2/2018

Structures that are/expected to be Stage 3

Building Deformation Analyses (2 of 2)

Structure	Schedule	Percent Complete	Incorporated to SMP
Control Building Diesel Generator Building	1Q2018	30%	4/2018
Mechanical Penetration Personnel hatch area	1Q2018	40%	4/2018
Main steam and feed water west pipe chase	4Q2017	90%	2/2018
Primary auxiliary building	4Q2017	30%	2/2018
Service water cooling tower incl. switchgear rooms	1Q2018		4/2018
Service water access (inspection) vault	1Q2018		4/2018
Circulating water pumphouse (below el. 21') Service water pumphouse	2Q2018		7/2018
Piping (RCA) Tunnels	2Q2018		7/2018
Tank farm area	2Q2018		7/2018
Waste processing building	2Q2018		7/2018

Structures that are/expected to be Stage 3

Questions?