SeabrookLANPEm Resource

From:	Poole, Justin
Sent:	Monday, March 12, 2018 10:31 AM
To:	Browne, Kenneth
Subject:	RE: Site Visit Plan for the Week of March 19th
Attachments:	Seabrook ASR LAR Site Visit Plan - Attachment 3.pdf

Ken,

As I mentioned the other day, the staff has developed some additional items for discussion. These expand on some of the issues that were already identified in the site visit plan we previously provided.

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From: Poole, Justin
Sent: Tuesday, February 27, 2018 9:15 AM
To: Browne, Kenneth
Subject: Site Visit Plan for the Week of March 19th

Ken,

Attached is the staff's site visit plan for our audit the week of March 19th. If you have any need for clarification in preparing for our visit, please let me know. Thanks.

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From: Poole, Justin

Created By: Justin.Poole@nrc.gov

Recipients:
"Browne, Kenneth" <Kenneth.J.Browne@nexteraenergy.com>
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Attachment 3: Additional Discussion Topics

Licensing Basis Documents

Several RAI responses appear to include future commitments or information that may need to be more formally captured. Examples include a description of the corroboration study and periodic ASR behavior assessment, and the code “supplements” or “deviations to the codes of record.” Explain how this will be accomplished.

Compression Limit State

The following paragraphs provide summaries or quotes from different docketed Seabrook documents discussing the compression limit state.

Response to RAI-M2, Request #3 (letter SBK-L-17156 dated October 3, 2017): “In-plane expansion can adversely affect the axial compression limit state, which NextEra Energy Seabrook explicitly evaluates as part of building-specific structural analyses.” Page 12 of Appendix A, under the heading “Additional Comment on Compression,” states:

> As discussed in MPR-4288 (Reference 20), in-plane expansion may adversely affect capacity for the compression limit state. NextEra Energy Seabrook structural evaluations assess the effect of observed in-plane expansion on compression capacity, but do not rely on structural test data from the MPR/FSEL test programs. The MPR/FSEL test programs did not address the compression limit state, and the monitoring criteria for through-thickness expansion and volumetric expansion that are derived from the test results do not apply for the evaluation of compression.

Supplement 2 in the response to RAI-D2, and Section 5.6 of the Methodology Document, (letter dated December 11, 2017):

> Supplement 2 – Code acceptance criteria: Strength of reinforced concrete sections affected by ASR can be calculated using the codes of record (ASME 1975 and ACI 318-71) and the minimum specified design concrete strength, provided that through-thickness ASR expansion is within the limits stated in report MPR-4273 [Reference 4].
>
> Basis: Report MPR-4288 [Reference 5] provides the basis for Supplement 2; the report conclusions are supported by the MPR/FSEL large-scale test programs described in report MPR-4273.

In stating that strength of concrete affected by ASR can be calculated using the codes of record, and the code of record includes the compression limit state, Supplement 2 appears to assume no adverse ASR effect on the compression limit state. NextEra stated that its basis for that conclusion was the MPR/FSEL testing program, however NextEra also stated that the compression limit state was not addressed in the MPR/FSEL LSTP.

LAR Section 3.2.1 “Structural Limit States” states in part: “The effect of ASR on compressive strength was not assessed in the large-scale test program. Reference 24 [MPR-4288] includes an evaluation of compression using existing data from published literature sources. The evaluation concluded that ASR expansion in reinforced concrete results in compressive load [additional ASR demand] that should be combined with other loads in design calculations. However, ASR does not reduce the structural capacity of compression elements.” However, this explanation is missing technical basis to justify the conclusion that ASR does not reduce capacity for the compression limit state for structural members with 2-dimensional reinforcement.

Based on the above statements, there appears to be information in MPR-3727, the LAR, the response to RAI-M3, and the Methodology Document (response to RAI-D2) which is inconsistent, incomplete and/or not clearly justified, specifically for ASR-affected structural members with 2-dimensional [no through-thickness] reinforcement subject to axial compression and/or combined axial compression and flexure. For Seabrook ASR-affected structures with two-dimensional reinforcement and subject to axial compression and/or combined axial compression and flexure, (a) clearly state and clarify the technical position in the proposed method of evaluation in the LAR with regard to ASR effect on load carrying capacity for the compression limit state; and (b) provide the supporting technical basis for that position.

Flexural and Shear Stiffness

Supplement 4 in the response to RAI-D2 and Section 5.6 of the Methodology Document state: "the ratio of cracked over uncracked moment of inertia for flexural behavior can be calculated using ACI 318-71 equation 9-4 or it is acceptable to define the cracked moment of inertia as 50% of the gross moment of inertia as discussed below." In the basis for Supplement 4, the licensee states that the ratio of cracked to uncracked (gross) moment of inertia of 0.5 is consistent with the provisions of ACI 318-14 Section 6.6.3.1.2, ASCE 43-05 Table 3-1, and ASCE 4-16 Table 3-2.

The MPR/FSEL LSTP-generated experimental data that provides insights on flexural stiffness and potentially shear stiffness of ASR-affected test specimens. Section 6.3.1 of Report MPR-4288 states, in part: "… [t]he flexural stiffness of ASR-affected test specimens was….. larger than the control specimen, with stiffness generally increasing with through-thickness expansion." Section 6.3.5 of Report MPR-4288 states, in part: "For heavily loaded reinforced concrete members in flexure, the Seabrook design analyses would consider some reduction factor to account for flexural cracking. Results from the tests of ASR-affected specimens demonstrated that the flexural rigidity increases with the severity of ASR. The increased rigidity could be viewed as an improvement for the seismic response." Section 5.3.4 of Report MPR-4273 states, in part: "Figure 5-10 shows that the stiffness in ASR-affected test specimens is clearly greater than the control specimen and there is an increasing trend with respect to through-thickness expansion." Figure 5-5 and Figure 5-7 of Report MPR-4273 also provide insights on shear stiffness and flexural stiffness, respectively, in the ASR-affected test specimens.

It appears that results and data from the LSTP was not considered in the proposed procedure for developing cracked section properties in the method of evaluation of Seabrook ASR-affected structures. No technical justification is provided for the applicability and validity of the supplement 4 proposed equations for ASR-affected concrete. The 'internal prestressing' effect noted in the LSTP would result in the observed increase in stiffness and delay in the onset of flexural cracking. This is considered when developing the ASR load (demand), Sa, in the proposed method of evaluation for ASR-affected concrete; however, it appears that there has been no consideration of the ASR prestressing effect in calculating the cracking moment (M_{cr}) in the proposed procedure for implementing cracked section properties.

Considering the Issues listed above with regard to ASR effects of flexural and shear stiffness in the context of implementing cracked section properties: Explain how relevant experimental data (e.g., Force-Deformation, Load-Displacement) obtained in the LSTP, is considered in the procedure in the Methodology Document (Supplement 4 in Section 5.6, Section 4.4.5 and Appendix A) for determining reduced flexural stiffness and shear stiffness for implementing cracked section properties for Seabrook ASR-affected structures. Clearly state and justify what region(s) of the Force-Deformation curve are proposed to be used for determining cracked section stiffness properties for the Methodology Document; and, explain the treatment of ASR prestressing effect in calculating cracking moment and cracking strain for ASR-affected members.

Rebar Yielding

Parametric Study 1 in, response to RAI-D8, states: “Stresses and strains in steel rebar are less than the elastic limits at service load conditions, provided that ASR strain is less than 2 mm/m.” The staff notes that this is consistent with the approximate strain level at which rebar is expected to yield (i.e., f_y/E_S = 60 ksi/29000 ksi = 0.0021 mm/mm or 2.1 mm/m). ASR expansion to this level could be indicative of rebar slip due to loss of bond between concrete and steel reinforcement. ASR in-plane expansion could increase with ASR progression under service conditions and, based on field monitoring, the structural analysis may need to include the ASR Severity Zone 4 (CI greater than 2 mm/m) defined in Table 2 of the Methodology Document. There is no criteria or upper limit of in-plane expansion in the method of evaluation that would trigger an action for evaluation of the implications of potential rebar yielding or slip if cracking levels are in Severity Zone 4. It is not clear if and how a structure will be evaluated for rebar yielding or slip if field monitoring data indicates a structure is in ASR Severity Zone 4.

With regard to the parametric study, the strain compatibility equation, $F_{thr}{*}\varepsilon_{CI} = \varepsilon_{o.steel} - \varepsilon_{o.conc}$, used to determine initial concrete and rebar strain from ASR prestress appears to assume slip between rebar and concrete. Strain compatability typically means strain in concrete = strain in rebar = CI. Please clarify.