North Anna 3

North Anna 3 COLA

Slides for Discussion with NRC

Response to NRC March 9, 2016

Question 1 (Follow-up to RAI 04.02-1)

March 10, 2016

Dominion

Question 1 (Follow-up to RAI 04.02-1)

Title 10 of the Code of Federal Regulations, Part 50, Appendix A, Criterion 2, requires that SSCs important to safety are designed to withstand the effects of earthquakes without the loss of capability to perform their safety functions. The design bases for these SSCs shall reflect: (1) the severity of the historical reports, with sufficient margin to cover the limited accuracy, quantity, and time period for the accumulated data, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (3) the importance of the safety functions to be performed. SRP Section 4.2 Appendix A (II)(2) provides review guidance regarding the review of methods used to analyze the design loads and component capacity.

In December 2013, Dominion submitted the North Anna Unit 3 COL application for review and approval. During the Fuel System review, the staff noted that there were no departures or supplements for FSAR Section 4.2 related to the fuel seismic response analysis, even though the North Anna Unit 3 site-specific seismic ground motion exceeded the DCD ground motion, as noted in Departure 3.7-1. On July 24, 2014, the staff requested in RAI 04.02-1 for analyses demonstrating that the NAPS fuel assembly and control rod blade mechanical analyses in the ESBWR certified design remain applicable. In December 2015, NAPS submitted a response to RAI 04.02-1.

Dominion

Question 1 (Follow-up to RAI 04.02-1) (a.)

The response to RAI 04.02-1 provides an evaluation to demonstrate that the site-specific fuel assembly and control blade assembly loads do not exceed the component capacity. IN 2012-09 notified the industry that the NRC became aware of operating experience which challenged existing NRC guidance regarding the impacts of end of life assembly characteristics on fuel assembly seismic response analyses. It is unclear from the response if end of life assembly characteristics were considered in the analysis which supported the response to RAI 04.02-1.

Describe the effects of end of life conditions on the North Anna Unit 3 site-specific fuel seismic response analysis and demonstrate that the referenced site-specific fuel accelerations bound both beginning of life and end of life conditions for the load analysis and capacity limits.

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Question 1 (Follow-up to RAI 04.02-1) (a.) response:

- No evaluation at EOL performed in DCD or NA3. BOL is considered bounding.

- NRC SER for NEDC-33240P-A Revision 1 incorporated by reference in ESBWR DCD section 3.1.2 Assembly Component Structural Evaluation Spacer (page 6):
  "Consistent with past practice, testing was performed on unirradiated fuel assembly components to simulate beginning-of-life conditions (i.e., before irradiation hardening). In its response to RAI 4.8-6 (Reference 8), on the use of unirradiated material conditions, GEH discussed the potential embrittlement of spacer grids as a result of hydrogen uptake. Testing on spacers precharged with hydrogen was completed to simulate the effects of in-reactor corrosion. These tests confirm that the spacers maintain fracture resistance up to very high hydrogen levels. While these impact tests were completed to evaluate handling loads, they provide evidence of end-of-life performance during postulated accidents. Based on the applicant's response, RAI 4.8-6 was resolved."

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Question 1 (Follow-up to RAI 04.02-1) (b.)

The response to RAI 04.02-1 includes a reference to WG3-002N9544, which is a North Anna Unit 3 site-specific analysis supplement to topical report NEDC-33240P-A, and a reference to 002N8005, which is the North Anna Unit 3 site-specific control rod seismic analysis. The staff noted that the site-specific analyses only describes SSE accelerations. In order to assure compliance with GDC 2 and evaluate adherence with the approved referenced methodology, the effects of normal and accident conditions should be appropriately combined with the effects of the natural phenomena.

Clarify whether or not accident loads (e.g. LOCA or safety relief valve discharge loads, etc.) were considered in combination with SSE loads when calculating the maximum accelerations and displacements for the North Anna Unit 3 site-specific fuel assembly response and control rod insertability seismic analyses.

Question 1 (Follow-up to RAI 04.02-1) (b.) response:

- WG3-002N9544 revision 0 presented maximum North Anna Unit 3 site-specific maximum peak SSE accelerations for the fuel assemblies consistent with the information presented in NRC SER for NEDC-33240P-A Revision 1 (incorporated by reference in ESBWR DCD) section 3.1.2 Assembly Component Structural Evaluation Spacer (page 6):
  "ESBWR standard plant seismic analysis shows peak safe shutdown earthquake (SSE) accelerations of [[ ]] in the horizontal direction and [[ ]] in the vertical direction. These accelerations are less than the demonstrated capability of the GE14 fuel. The shorter ESBWR fuel assembly length results in additional margin to the seismic and dynamic load criteria for GE14E fuel. It is concluded that GE14E fuel assemblies, including spacers, are qualified for the seismic and dynamic loads defined by the ESBWR standard plant seismic analysis. Based on the applicant's response, RAI 4.8-8 was resolved."

Question 1 (Follow-up to RAI 04.02-1) (b.) response (cont.):

- NRC FSER agreed with the fuel seismic/dynamic approach (page 8):

  Seismic/Dynamic Loading

  Section 3.4.1.11 of NEDC-33240P (Reference 1) describes the structural capability of the GE14E assembly and assembly components to withstand seismic/dynamic loading. GEH relied upon testing and analyses previously completed for the GE14 design. As described in section 3.1.2 of this report under the heading "Spacer" it was concluded in the response to RAI 4.8-8 that GE14E fuel assemblies are qualified for the seismic and dynamic loads defined by the ESBWR standard plant seismic analysis. Therefore, based on the applicant's response, RAI 4.8-8 was resolved.

  With respect to assembly lift, GEH has incorporated acceptance criteria in DCD Tier 1, Table 2.1.1-3 stating the initial fuel to be loaded into the core will be able to withstand fuel lift and seismic and dynamic loads under normal operation and design basis conditions.

Question 1 (Follow-up to RAI 04.02-1) (c.)

The response to RAI 04.02-1 includes a reference to WG3-002N9544, which is a North Anna Unit 3 site-specific analysis supplement to topical report NEDC-33240P-A. This supplement includes a reference to SER-DMN-019, Shimizu Engineering Report, "GE Hitachi Nuclear Energy, Dominion NA3 ESBWR Project, RB/FB Seismic Analyses Bounding Results and In-Structure Response Spectra". The staff reviewed this reference and noted that the finite element analysis model for the fuel assemblies differs from the model used in the referenced approved methodology as presented in NEDC-21175-3-P-A.

Identify any differences between the finite element analysis model used in the North Anna Unit 3 site-specific analysis and the finite element analysis model used in the referenced methodology, NEDC-21175-3-P-A. Provide justification for these deviations.

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Question 1 (Follow-up to RAI 04.02-1) (c.) response:

- The NA3 RPV structural model in SER-DMN-019 of which the fuel assemblies are part is identical to the DCD RPV model (nodes 801 – 872) in DCD Fig. 3A.7-4. RB/FB Complex Seismic Model. The exception was the need to include OBE damping for site specific analysis see subsequent slide from 11/19/2014 NRC presentation
- NEDE 21175-3-P-A model is used for fuel lift only
  - Fuel lift analysis has not been done for the GE14E fuel
    - ITAAC Table 2.1.1-3 Item 15 requires that the initial fuel to be loaded in to the core will be able to withstand fuel lift and seismic and dynamic loads under normal operation and design basis conditions
- NRC FSER agreed with the fuel seismic/dynamic approach (slide 7)

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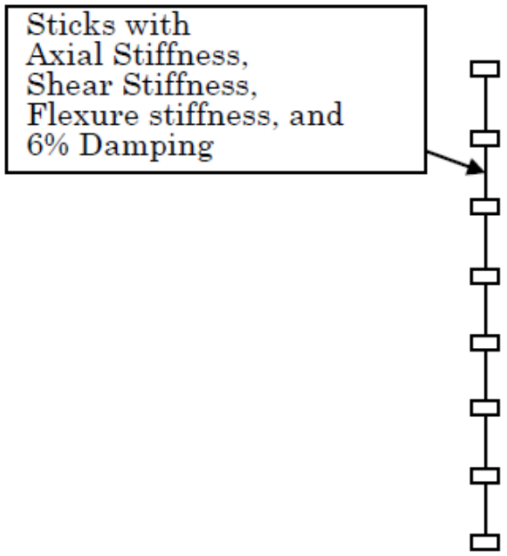
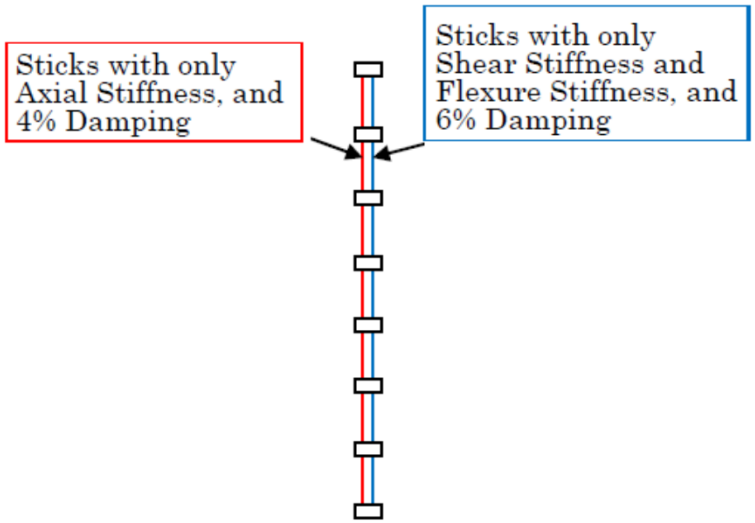
Question 1 (Follow-up to RAI 04.02-1) (c.) response (cont.):

- RB/FB standard design dynamic model is modified in order to enable modeling of different OBE damping values for the fuel in horizontal and vertical direction
  - Two sets of stick elements are used for fuel in RB/FB LMSM providing separate representations of fuel axial and flexure stiffness



Fuel Model for
Standard Design Analysis



Fuel Model for
Site-Specific Analysis

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Question 1 (Follow-up to RAI 04.02-1) (d.)

The response to RAI 04.02-1 includes a reference to WG3-002N9544, which is a North Anna Unit 3 site-specific analysis supplement to topical report NEDC-33240P-A. It is unclear to the staff from the information provided how the site-specific conditions are incorporated into the finite element analysis input for the North Anna Unit 3 fuel assembly seismic analysis.

Provide a plot of the lower core plate response spectra used in the North Anna Unit 3 site-specific fuel assembly response analysis and compare it with the similar lower core plate response spectra used in the ESBWR certified design.

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Question 1 (Follow-up to RAI 04.02-1) (d.) response:

- No other internals were evaluated as part of the DCD except the fuel and blades.
- The lower core plate response spectra was not used in the DCD or North Anna Unit 3 site-specific fuel assembly response analysis
- The fuel core is modeled as a single, equivalent fuel bundle in SER-DMN-019. The equivalent fuel bundle is composed of beam elements and lumped masses along with hydrodynamic coupling to the shroud. The equivalent fuel bundle is pinned at the top guide and core plate. This model is used to generate the horizontal and vertical inertial loads

Dominion

Question 1 (Follow-up to RAI 04.02-1) (e.)

The response to RAI 04.02-1 includes a reference to 002N8005, "North Anna 3 Control Rod Seismic Analysis." In 002N8005, the applicant states the site specific maximum fuel channel oscillation is [[ ]]; however, 002N8005 does not provide justification for this value. In a clarification phone call between the applicant and the NRC held on February 24, 2016, the applicant stated that the site-specific maximum fuel channel oscillation was calculated in SER-DMN-019. The staff reviewed SER-DMN-019 and could not determine if the results presented therein were calculated using a previously approved methodology. What methodology was used to calculate the North Anna Unit 3 maximum fuel channel oscillation of [[ ]]?

Dominion

Question 1 (Follow-up to RAI 04.02-1) (e.) response:

- The same DCD methodology is used in which the fuel channel displacements are calculated directly from the seismic SSI analysis using the same DCD stick model for the RPV model (nodes 801 – 872) in DCD Fig. 3A.7-4. RB/FB Complex Seismic Model

Questions?

For purposes of discussion with NRC.

Dominion