NorthAnnaRAIsPEm Resource

From: Patel, Chandu
Sent: Thursday, April 07, 2011 3:58 PM
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Cc: Weisman, Robert; NorthAnnaRAIsPEm Resource
Subject: RAI Letter No. 64, RAI 5544 and 5546, Sections 3.7.1 and 3.7.2, North Anna 3 COLA
Attachments: NA RAI LTR 64.doc

By letter dated November 26, 2007, Dominion Virginia Power (Dominion) submitted a Combined License Application for North Anna, Unit 3, pursuant to Title 10 of the *Code of Regulations,* Part 52. The U.S. Nuclear Regulatory Commission (NRC) staff is performing a detailed review of this COLA.

The NRC staff has identified that additional information is needed to continue portions of the review and a Request for Additional Information (RAI), is enclosed. To support the review schedule, Dominion is requested to respond within 30 days of the date of this request. If the RAI response involves changes to the application documentation, Dominion is requested to include the associated revised documentation with the response.

Sincerely,
Chandu Patel
Lead Project Manager for NA3 COLA

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Request for Additional Information Letter No. 64
4/7/2011
North Anna, Unit 3
Dominion
Docket No. 52-017
SRP Sections: 03.07.01 - Seismic Design Parameters, and
03.07.02 – Seismic System Analysis
Application Sections: FSAR 3.7.1 and 3.7.2

QUESTIONS for Structural Engineering Branch 1 (AP1000/EPR Projects) (SEB1)

Request for Additional Information No. 5544

03.07.01-3

A basic assumption in a SASSI (computer code) based seismic soil structure interaction (SSI) analysis is that the subsurface layers involved are horizontally infinite and uniform. However, the North Anna Unit 3 (NA3) FSAR site is characterized by significant horizontal variability in subsurface condition and use of fill concrete beneath the proposed Category I structures and across the site, in general; see Figures 2.5.229 – 2.5.234 of the NA3 FSAR. The staff concern is that the presence and non-uniformity of the concrete fill layer may amplify seismic demands. To address this concern, the staff requests the COL applicant to identify the results of any sensitivity studies conducted to demonstrate that the lateral uniformity assumption is applicable to the site-specific seismic SSI analyses of all Category I structures at the NA3 site.

03.07.01-4

Section 3.7.1.2 of the NA3 FSAR states that the SSE damping values are used for the calculation of seismic structural demands and in-structure response spectra (ISRS). However, RG 1.61, “Damping Values for Seismic Design of Nuclear Power Plants” sets forth guidance that OBE damping values should be used in calculating ISRS unless a plant-specific technical basis for use of damping values higher than the OBE damping values is submitted. The staff concern is that the use of a higher SSE damping values (if unjustified) may lead to an under-prediction of seismic demands. To address this concern, the staff requests the technical basis for using damping values higher than the OBE damping values in calculating ISRS for Category I structures at the Unit 3 site.

Request for Additional Information No. 5546

03.07.02-2
Dominion performed site-specific SSI analyses of the Unit 3 Reactor Building (R/B) complex using the lumped-mass stick model developed by MHI and used for US-APWR standard plant seismic design. However, staff review of US-APWR DCD Sections 3.7 and 3.8 is ongoing. A staff’s concern is that Dominion’s dynamic analysis model may not reflect the current US-APWR design. To address this concern, the applicant is requested to indentify a technical approach that it will use for SSI model reconciliation between the US-APWR DCA and the Unit 3 COLA and corresponding update of site-specific SSI analyses of Unit 3 R/B complex.

03.07.02-3
The SRP (NUREG-0800) Section 3.7.2, "Seismic System Analysis," and the Interim Staff Guidance on “Seismic Issues Associated with High Frequency Ground Motion in DC and COL Applications” (ISG-DC/COL-01, 2008) provide guidance the staff will use in evaluating the technical adequacy of the seismic design that takes into account the effects of soil-structure interaction. The NA3 FSAR does not provide sufficient information for the staff to determine the technical adequacy of the seismic SSI analyses of the standard plant Category I structures under the guidance. To address this issue, the applicant is requested to provide the following information:

1) A summary of modal characteristics in the fixed-base condition, including the natural frequencies, effective modal masses, percent of mass participation, cumulative percent of mass participation, total number of modes included in the analysis, and method used to account for missing mass modes, for each of the standard plant Category I structures.

2) The SSI analysis method selected (e.g., flexible volume method, flexible interface method, etc.) and a technical justification for the selection.

3) The cut-off frequencies for each of the SSI analyses performed.

4) The analysis frequencies for each of the SSI analyses performed and basis for the selection of these frequencies.

5) Description of and basis for the selection of transfer function interpolation and smoothing methods.

6) Description of and basis for the selection of phase adjustment option in incoherent SSI analyses.

7) Demonstration of the sufficiency of the number of simulations used in stochastic incoherent SSI analyses.

8) Details of the wave passage effect, if taken into consideration, in incoherent SSI analyses.

9) Details of soil deposit modeling including determination of soil layer thicknesses in view of the minimum cut-off frequency addressed in the guidance.

10) Details of the half-space simulation and the number of generated layers in simulating the half-space.

11) Demonstration of the adequacy of the “selected locations” at which Unit 3 site-specific seismic demands are compared with US-APWR standard design seismic demands. The selected locations should be sufficient to represent various locations throughout the building and should include responses at peripheral locations to detect rocking and torsion, particularly from incoherent ground motion. The selected locations should also include responses to check overturning and sliding stability of the structures.
12) Verification of the adequacy of the Foundation Input Response Spectra (FIRS) as SSI input motions ("NEI Check" as described in FSAR, Section 3OO.1.4) for all embedded structures.

03.07.02-4
The SRP Section 3.7.2, "Seismic System Analysis," and the Interim Staff Guidance on “Seismic Issues Associated with High Frequency Ground Motion in DC and COL Applications” (ISG-DC/COL-01, 2008) provide guidance the staff will use in evaluating the technical adequacy of the seismic design that takes into account the effects of soil-structure interaction. The NA3 FSAR does not provide sufficient

information for the staff to determine the technical adequacy of the seismic SSI analyses of Unit 3 site-specific Category I structures under the guidance. To address this issue, the applicant is requested to provide the following information:

1) A summary of modal characteristics in the fixed-base condition, including the natural frequencies, effective modal masses, percent of mass participation, cumulative percent of mass participation, total number of modes included in the analysis, and method used to account for missing mass modes, for each of the Unit 3 site-specific Category I structures.

2) The SSI analysis method selected (e.g., flexible volume method, flexible interface method, etc.) and a technical justification for the selection.

3) The cut-off frequencies for each of the SSI analyses performed.

4) The analysis frequencies for each of the SSI analyses performed and basis for the selection of these frequencies.

5) Description of and basis for the selection of transfer function interpolation and smoothing methods.

6) Details of soil deposit modeling including determination of soil layer thicknesses in view of the minimum cut-off frequency addressed in the guidance.

7) Details of the half-space simulation and the number of generated layers in simulating the half-space.

8) Demonstration of the adequacy of the “selected locations” at which the seismic demands of Unit 3 site-specific Category I structures are computed. The selected locations should be sufficient to represent various locations throughout the building and should include responses at peripheral locations to detect rocking and torsion. The selected locations should also include responses to check overturning and sliding stability of the structures.

9) Verification of the adequacy of FIRS as SSI input motions ("NEI Check") for all embedded structures.

03.07.02-5
The NA3 FSAR on Page 3-196 states, “The shell elements of the walls extend into the basemat solid elements to enable transmittal of nodal rotations. Rigid 3D beam elements connect the top of the basement shear walls with lumped-mass stick model representing the above ground portion of the R/B and FH/A. This modeling approach enables the R/B-FH/A to be connected to the flexible part of the building basement and decoupled from the thick central part that serves as foundation to the PCCV and containment internal structure part of the building.”

The description in the paragraph quoted above does not address the full range of possible element connectivity in a 3D model for all Category-I structures. To address this issue, the staff requests the applicant to provide detailed information accompanied by appropriate illustrations that address connectivity between different types of elements used in the analysis models, including connectivity between shells and solids, beams and solids, and shells and beams, and show how applicable degrees of freedom are transmitted at these connections.

03.07.02-6
The NA3 FSAR states on page 3-194, “The mesh size of the subgrade is sufficiently refined to capture the transmittal of seismic waves with frequencies up to 50 Hz through the subgrade and the base of the foundation. For the embedded SSI model, the mesh size affects the accuracy of the SSI model to capture the transmittal of high frequency seismic input motion through the relatively soft embedment

soil. This limits the accuracy of the ISRS results in the high-frequency range for the embedded conditions. However, the SSI analyses of embedded foundations capture the critical effects of the embedment in the lower frequency range, up to 10 Hz."

Tables 3NN-15 and 3NN-16 in the NA3 FSAR indicate that the cut-off frequencies for analysis of embedded structures are far below 50 Hz which is the cut-off frequency addressed in the NRC Interim Staff Guidance on "Seismic Issues Associated with High Frequency Ground Motion" (DC/COL-ISG-01, May 2008). Also, the number of frequencies in the analysis shown in these Tables for embedded structures is significantly smaller than those for non-embedment cases.

A staff's concern is that having a model cut-off frequency less than 50 Hz may underestimate seismic demands in the high-frequency range. To address this concern, the applicant is requested to provide technical justification for the use of SSI models having cut-off frequencies lower than 50 Hz and to address the potential impact of the limited accuracy of ISRS calculations in the high-frequency range for embedded conditions on the evaluation of the applicability of the US-APWR standard design for Unit 3. The staff also requests the applicant to provide technical justification for the use of a lower number of frequencies in the analysis for embedded conditions.

03.07.02-7
On page 3-206 of the NA3 FSAR, it states, "Three sets of broadened ISRS are developed that represent the enveloped response for different site conditions considered that are obtained from SSI analyses of: 1) surface foundation with coherent motion, 2) embedded foundation with coherent motion, and 3) surface foundation with incoherent motion. The ISRS obtained from the SSI analyses using coherent input ground motion are compared to quantify the amplification of the ISRS due to the embedment effects. The final broadened incoherent ISRS curves are obtained by adjusting the ISRS developed from the SSI analyses of surface foundation with incoherent input ground motion to incorporate the amplifications that are due to the embedment effects. These ISRS that include foundation embedment and ground motion incoherency effects define the site-specific seismic demands for Seismic Category I and II SSCs and subsystems."

The technical basis for the approach of combining embedded and incoherent response mentioned above is not clear to the staff. To address this concern, the staff requests the applicant to provide technical justification for the use of an embedment amplification factor and to demonstrate that the ISRS thus obtained realistically reflect the combined effects of embedment and incoherence.

03.07.02-8
The SRP Section 3.7.2, "Seismic System Analysis" provides guidance that the procedures used in the SSI analysis to account for the effects of adjacent structures on structural response should be reviewed. The applicant is requested to provide technical analysis that adequately addresses the effects of seismic structure-soil-structure interaction (SSSI) between the R/B complex and adjacent structures including the Auxiliary Building, the Power Source Buildings (PS/Bs), and the Turbine Building.

03.07.02-9
The staff understands that the dynamic soil-structure interaction analyses presented in the NA3 FASR do not account for potential separation and sliding between soil and structure under the design-basis earthquake ground motion. The SRP Section 3.7.2, "Seismic System Analysis" provides guidance

that appropriate sensitivity studies should be performed to identify important parameters and to assist in judging the adequacy of the final results. These sensitivity studies can be performed by the use of well-founded and properly substantiated simple models to give better insight. The applicant is requested to provide information that addresses the effects of soil-structure separation and sliding on the results of seismic SSI analyses, including dynamic soil pressure and stability analyses, of Category I structures at the Unit 3 site.