PMNorthAnna3COLPEmails Resource

From: Patel, Chandu
Sent: Monday, June 13, 2011 4:07 PM
To: 'na3raidommailbox@dom.com'
Cc: Weisman, Robert; NorthAnna3COL Resource; Ma, John; Thomas, Vaughn; Galvin, Dennis
Subject: RAI Letter No. 74, RAI 5604, Section 3.8.4, North Anna 3 COLA
Attachments: RAI Letter 74 RAI 5604.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 45 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

Hearing Identifier: NorthAnna3_Public_EX
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6/13/2011
North Anna, Unit 3
Dominion
Docket No. 52-017
SRP Section: 03.08.04 - Other Seismic Category I Structures
Application Section: 3.8.4

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

Request for Additional Information No. 5604

03.08.04-1
NAPS COL 3.8(19), Figures 3.8-202 through 3.8-204 show the cross-sections of the site-specific Cat I structures, including the ESWPT foundation. Provide the interface detail between the seismic Category I ESWPT foundation and the concrete shear keys (pages 3-131 and 3-134). The interface detail should include the length of shear keys, the size and amount of steel reinforcing bars (rebars) and their locations and the type of surface treatment, such as roughened or smoothed, for shear keys.

03.08.04-2
NAPS COL 3.8(19), Subsection 3.8.4.1.3, “EWSPT, UHSRS, PSFSVs, and Other Site-Specific Structures,” the second paragraph (page 3-105), states “The performance specifications for the elastomeric joint or seal materials address requirements for critical characteristics such as bounding the allowable stress-strain properties, durability requirements, and associated material testing.” Provide the performance specification for the expansion/isolation joints that are used to separate each of these structures.

03.08.04-3
NAPS COL 3.8(19), Subsection 3.8.4.1.3.1, “ESWPT,” the fourth paragraph (page 3-106), states “For Segment 1, the dowels and shear key are only present at the portion of the tunnel adjacent to the east PS/B.” Provide a technical justification for providing dowels and shear keys only at the portion of the tunnel adjacent to the east PS/B and not in other areas.

03.08.04-4
NAPS COL 3.8(19), Subsection 3.8.4.1.3.2, “UHSRS,” the second paragraph (page 3-107), states “Each basin rests on a separate foundation, is square in shape, constructed of reinforced concrete, and separated from the adjacent basin by a minimum 4 inch expansion joint.” The separate squared shape foundation is not marked on Figure 3.8-206 (plan view of UHS Basin), and Figure 3.8-210 (section view looking west). Figure 3.8-208 (section view looking north) appears to show that the foundation of the two basins is connected together and the horizontal rebars running continuously through the two basins. Clarify the statement and drawings.

03.08.04-5
NAPS COL 3.8(19), Figure 3.8-210 (section view, page 3-139), shows a 4 feet thick wall located 5 feet above the basemat and 54 feet from the exterior face of the northern exterior wall of the ultimate heat sink D. However, Figure 3.8-206 (plan view), (page 3-135), indicates that the wall is 2 feet thick. Clarify the thickness of the wall and state how the wall is supported.

03.08.04-6

NAPS COL 3.8(29), Subsection 3.8.4.4.3.1, “ESWPT,” (page 3-112), the second paragraph states “The soil stiffness adjacent to the tunnel is not included in the design model in order to transfer the total seismic load through the structure down to the base slab. Embedment effects are included in the SSI model from which the seismic lateral soil pressures and inertia loads are based upon.” The above two sentences appear to be contradictory because the first sentence implies no soil embedment, but the second sentence states that soil embedment is considered. Clarify that statement.

03.08.04-7

NAPS COL 3.8(29), Subsection 3.8.4.4.3.1, “ESWPT,” (page 3-113), the second paragraph states “In the vertical direction, the smaller of the spring stiffnesses that match ASCE 4-98 vertical or rocking stiffness is used.” State how the spring stiffnesses were calculated and why the smaller stiffness was chosen.

03.08.04-8

NAPS COL 3.8(29), Subsection 3.8.4.4.3.1, “ESWPT,” The sixth paragraph (page 3-113), states “The static soil pressures are calculated using at-rest pressures with K_o = 0.36 for the structural fill and Zone IIB saprolite, and K_o = 0.5 for Zone IIA saprolite.” State how the values of K_o = 0.36 for Zone IIB saprolite and 0.5 for Zone IIA saprolite were obtained.

03.08.04-9

NAPS COL 3.8(29), Subsection 3.8.4.4.3.2, “UHSRS,” the third paragraph (page 3-114), states “Since lateral excitation is accompanied by rocking, the magnitude of these springs is calculated based upon an equivalence of overall rocking stiffness. The overall rocking stiffness is calculated in accordance with the methods of the theory of elasticity, assuming a rigid mat resting on a layered elastic half-space.” Explain in detail how the rocking soil springs were calculated.

03.08.04-10

NAPS COL 3.8(29), Subsection 3.8.4.4.3.2, “UHSRS,” (page 3-114), the third paragraph states, “The minimum vertical spring value is used since the smallest value yields the largest bending in the base mat.” The staff believes that the smallest value of vertical soil spring will yield the largest displacement (deformation) of the concrete basemat, but does not necessary yield the largest bending in the base mat, as stated. Thus, the applicant is requested to provide a technical justification for the above statement or perform a parametric study that shows the largest bending and shear in the concrete basemat.

03.08.04-11

NAPS COL 3.8(29), Subsection 3.8.4.4.3.2, “UHSRS,” the fourth paragraph (page 3-115), states “Vertical spectrum analysis requires that the vertical degrees of freedom of the base mat are restrained. Since this condition of restraint prevents bending in the mat, a secondary static analysis is performed with the mat supported by vertical springs. In this secondary static analysis an equivalent vertical acceleration is applied, equal to the total vertical reaction from the response spectrum analysis divided by the total mass of the structure. However, the magnitude of the vertical springs used in this analysis is based upon an equivalence of overall vertical stiffness, obtained in a manner similar to that described above for the rocking springs.” The description and the use of the secondary static analysis, as stated above, is unclear on how they could generate adequate bending moment and shear for the design of the basemat. The staff is also concerned on the discontinuity problems in the soil foundation generated by the use of soil spring, which will alter the true bending moment and shear diagrams for the basemat design. The applicant is requested to clarify that statement.

03.08.04-12

NAPS COL 3.8(29), Subsection 3.8.4.4.3.3, “PSFSVs,” the first paragraph (page 3-116), states “The structural design of the PSFSV is performed using the computer program ANSYS (Reference 3.8-14).” The staff believes that the PSFSV is analyzed using the computer program ANSYS, but should be designed in accordance with ACI codes. Per SRP 3.8.4, compliance with 10 CFR 50.55a requires that SSCs be designed to quality applicable codes, standards and guides to ensure that the SSCs will perform their intended functions. The FSAR did not cite the ACI code and guide used in the design of the site-specific safety-related structures. If the site-specific safety-related structures are not designed in accordance with ACI 349, the applicant is requested to identify the design code used and provide the technical justification for its adequacy.

03.08.04-13

NAPS COL 3.8(29), Subsection 3.8.4.4.3.3, “PSFSVs,” the fourth paragraph (page 3-117), states “For seismic load cases, the shear walls are designed to resist 100% of the applied lateral load in in-plane shear and are also designed for out-of-plane loading due to seismic inertia demands. This can be accomplished in the main vault structure, but due to no transverse shear walls in the tunnel portion, this is not applicable.” The applicant is requested to provide a technical justification as to how the seismic loads are transmitted in the tunnel area.

03.08.04-14

North Anna 3, Combined License Application, Part 11, “Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures,” Section 2.5, “Subgrade Coefficients,” contains values of 6 soil springs: 1670 kip /ft^2 /ft, 6175 kip / ft^2 /ft, 4000 kip / ft^3, 4000 kip / ft^3, 4500 kip / ft^3, and 6800 kip / ft^3. Describe how these values were obtained.

03.08.04-15

In North Anna 3, Combined License Application, Part 11, “Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures,” Section 3.1.2, “Modeling Methodology” (page 56) the fourth paragraph states “In both the SASSI model and the ANSYS model, the walls are modeled using gross section properties at the centerline. All roof slabs and elevated slabs (pump room, fan slab, missile shield protection) are modeled as cracked concrete sections, with out-of-plane flexural stiffness reduced by 50%. These properties are consistent with the response levels.” Provide justifications for using gross section for walls and reducing out-of-plane flexural stiffness by half for the modeling of the slabs.

03.08.04-16

In North Anna 3, Combined License Application, Part 11, “Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures,” Section 3.1.3, “SSI Analysis,” (page 56), states “The depth of the shallow 13 ft thick backfill embedment, which extends from elevation 277 ft to nominal plant grade elevation of 290 ft, is small relative to the height of the UHSRS. Therefore, the SSI analyses neglect the embedment effects of the engineered backfill.” SRP 3.7.1, Section II3, “Supporting Media for Seismic Category I Structures,” states that the description of supporting media for each Category I structure must include foundation embedment depth. Staff believes that neglecting the 13 ft embedment may change the frequency and response of the UHSRS. Applicant is requested to provide a technical justification to show that the SSI analysis model without the embedment will yield conservative results.

3.08.04-17

In North Anna 3, Combined License Application, Part 11, “Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures,” Section 3.1.3, “SSI Analysis,” (page 57) the second paragraph states “The design of reinforced concrete members shows high level of design stresses that justifies the use of higher SSE damping values.” Provide numerical values showing high level of design stresses that justifies the use of higher SSE damping value; and also provide the SSE damping values.

03.08.04-18

In North Anna 3, Combined License Application, Part 11, “Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures,” Section 3.1.5, “Impulsive and Convective Mass Modeling,” (page 58) states “In both the SASSI model and the ANSYS design model, the impulsive mass in each region is modeled with mass elements distributed over the basin walls perpendicular to the direction of seismic excitation.” The staff considers this model incomplete because it does not capture the impulsive effect due to the base rocking motion. Provide numerical data to show that the base rocking motion induced by SSI is negligible to confirm the validity of the assumption of the model. In addition, state whether a dynamic analysis or equivalent static analysis was performed on the ANSYS design model. If it is an equivalent static analysis, the flexibility of the basin wall may not be accounted for properly. Therefore, provide detailed technical information to explain how the analysis was performed for the ANSYS design model.

03.08.04-19

In North Anna 3, Combined License Application, Part 11, “Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures,” Section 3.1.5, “Impulsive and Convective Mass Modeling,” (page 58), states “The specific equations used were those given for rectangular tanks in “Dynamic Pressure on Fluid Containers,” Chapter 6 of *Nuclear Reactors and Earthquakes*, TID-7024 (Reference 19), which is cited in Reference 8.” Per SRP Section 3.8.4, Subsection II.3(A), “Loads and Load Combination,” fluid structure interaction associated with hydrodynamic and earthquake loads should be included in the analysis. Thus, the applicant is requested to provide numerical data for the fundamental frequency of the liquid-tank system and compare the results to that from the equation that had been used to show that the results are conservative.

03.08.04-20

In North Anna 3, Combined License Application, Part 11, “Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures,” Footnote #3 of Table 3.0-1, “UHSRS FE Model Material Properties,” (page 63), states “A constant modal damping ratio equal to 5% of critical was specified in ANSYS.” Provide a technical justification for the use of a constant modal damping ratio equal to 5%.

03.08.04-21

In North Anna 3, Combined License Application, Part 11, “Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures,” Footnote #4 of Table 3.0-1, “UHSRS FE Model Material Properties,” (page 63), states “Steel elements of the SASSI model have zero unit weight and their masses are applied to the concrete elements.” Provide a technical justification for the use of zero unit weight for steel elements.

03.08.04-22

In North Anna 3, Combined License Application, Part 11, “Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures,” Table 3.0-7, “SASSI FE Model Peak Accelerations at Key UHSRS Locations,” (page 69), footnote #2, states “The peak accelerations

include amplification effects due to out-of-plane flexibility of walls and slabs." Describe how the amplification effects due to out-of-plane flexibility of walls and slabs were captured.

03.08.04-23

In North Anna 3, Combined License Application, Part 11, "Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures," Table 3.0-7, "SASSI FE Model Peak Accelerations at Key UHSRS Locations," (page 69) footnote #3, states "An average peak acceleration for the mid portion of the roof slab is presented as representative of the overall seismic response of the slab." Provide the definition for "an average peak acceleration" and "The peak accelerations" in the previous footnote (footnote #2), and explain why there is a need for the two different accelerations.

03.08.04-24

In North Anna 3, Combined License Application, Part 11, "Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures," Table 3.0-10, "Summary of Bearing Pressures and Ratio of Allowable Bearing Capacity to Bearing Pressure," summarized the bearing pressures associated with the UHSRS building. The value of the ratio of allowable bearing capacity to bearing pressure shows a value of 2.1 for the static case. The staff believes it should be 2.75 instead of 2.1. Explain how the value of 2.1 was obtained.

03.08.04-25

In North Anna 3, Combined License Application, Part 11, "Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures," Table 3.0-10, "Summary of Bearing Pressures and Ratio of Allowable Bearing Capacity to Bearing Pressure," (page 73) footnote #4, states "Bearing pressures are based on site-specific groundwater level." State whether the bearing pressures listed in the table are values with or without buoyancy force due to water.

03.08.04-26

In North Anna 3, Combined License Application, Part 11, "Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures," Section 4.0, "PSFSV," the fifth paragraph (page 95), states "The materials and properties of the roof slab in the models are altered to reflect the cracked concrete properties for out of plane bending. The properties are reduced to one-half of the uncracked flexural stiffness. Un-cracked properties are considered for the in-plane stiffness." Provide numerical values with respect to stress or strain of slabs and walls which justifies that the alteration to concrete properties is properly made.

03.08.04-27

In North Anna 3, Combined License Application, Part 11, "Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures," Section 4.0, "PSFSV," (page 96), states "The model includes shell elements for the walls, roof and the basemat, mass elements for non-structural added mass and rigid beam elements for modeling of the emergency power fuel oil tanks and their supports." Per SRP 3.8.4, Subsection II.3(A), "Loads and Load Combination," fluid structure interaction associated with hydrodynamic and earthquake loads should be included in the analysis. The applicant is requested to state whether the fuel-tank interaction was considered in the modeling. If not, the applicant should provide numerical data for the fundamental frequency of the fuel-tank and support system.

03.08.04-28

In North Anna 3, Combined License Application, Part 11, "Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures," Section 4.1.2, "ANSYS Design Static and Fixed Base Response Spectrum Analyses," the third paragraph (page 97), states "The input

response spectra are based on the 5% damping ground response obtained from the site response analysis and do not include the possible SSI effects. Additional margins are introduced in the design of the reinforced concrete members of the PSFSV in order to ensure that the design envelopes the SSI effects." Explain how the additional margins are introduced in the design.

03.08.04-29

In North Anna 3, Combined License Application, Part 11, "Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures," Section 4.1.3, "SASSI SSI Model and Analysis," the first paragraph (page 98), states "The seismic response of the PSFSV results in high stress levels for the reinforced concrete members. That warrants the use of higher SSE damping values to account for the dissipation of energy due to material damping." Provide numerical values with respect to stress, or strain, or ductility of the reinforced concrete members to justify that statement.

03.08.04-30

In North Anna 3, Combined License Application, Part 11, "Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures," Table 5.0-5, "Matrix of ESWPT and UHSRS Pipe Chase SSI Analyses," (pg 135) lists the cut-off frequency associated with ESWPT and the UHSRS Pipe Chase. The table shows that there are two cases that the cut-off frequency for the SSI analysis is at 25 Hz while most of the other cases are at 50 Hz. Justify the adequacy of the cut-off frequency at 25 Hz.

03.08.04-31

In North Anna 3, Combined License Application, Part 11, "Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures," Table 5.0-12, "ESWPT Dynamic Properties," (pgs 142-143) the applicant is requested to add a column for mode shape in Table 5.0-12, ESWPT Dynamic Properties.

03.08.04-32

In North Anna 3, Combined License Application, Part 11, "Model Properties and Seismic Analysis Results For Site-Specific Seismic Category I Structures," Table 5.0-14, "Load Combinations and Factor of Safety for ESWPT," (pg 145) shows that the factor of safety for overturning is 1.1, and for sliding 1.18. State whether these ratios listed in the table are values with or without buoyancy force due to water.

03.08.04-33

In NAPS combined license (COL) 3.8(29) in NA3 COL FSAR, Subsection 3.8.4.4.3.1, "ESWPT," North Anna states, "The (soil) springs are included in the model using three individual, uncoupled uni-directional spring elements that are attached to each node of the base mat. The sum of all nodal springs in each of the three orthogonal directional is equal to the corresponding generalized structure-foundation stiffness in the same direction calculated from ASCE 4-98." The applicant is requested to clarify whether the stiffness of soil spring, which applied to all nodes are the same and how the stiffness in each of the three orthogonal directions was established.