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UniStar
NUCLEAR ENERGY

10 CFR 50.4
10 CFR 52.79

August 13, 2009

UN#09-339

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: UniStar Nuclear Energy, NRC Docket No. 52-016
Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3,
RAI No. 65, Seismic System Analysis, Question 03.07.02-6

References:
1) John Rycyna (NRC) to Robert Poche (UniStar Nuclear Energy), "RAI No. 65 SEB2 1971.doc (PUBLIC)" email dated February 18, 2009

2) UniStar Nuclear Energy Letter UN#09-329, from Greg Gibson to Document Control Desk, U.S. NRC, Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3, RAI No. 58, Seismic Design Parameters and RAI No. 65, Seismic System Analysis, dated July 29, 2009

The purpose of this letter is to respond to the request for additional information (RAI) identified in the NRC e-mail correspondence to UniStar Nuclear Energy, dated February 18, 2009 (Reference 1). This RAI addresses Seismic Design and Analysis, as discussed in Section 3.7 of the Final Safety Analysis Report, as submitted in Part 2 of the CCNPP Unit 3 Combined License Application (COLA), Revision 5.

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Enclosure 1 provides the current status of responses to the RAI questions for Seismic Analysis RAI Nos. 58, 65, and 112. Enclosure 2 provides a partial response to RAI No. 65, Question 03.07.02-6, as committed in Reference 2.

The response to RAI No. 65, Question 03.07.02-6 does not include revised COLA content and does not include any new regulatory commitments.

If there are any questions regarding this transmittal, please contact me at (410) 470-4205, or Mr. Michael J. Yox at (410) 495-2436.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on August 13, 2009

Joseph A Stuhrlah
for Greg Gibson

Greg Gibson

Enclosures:

1) Response Summary for Requests for Additional Information, RAI No. 58, Seismic Design Parameters; RAI No. 65, Seismic System Analysis; and RAI No. 112, Seismic Design Parameters; Calvert Cliffs Nuclear Power Plant Unit 3

2) Response to NRC Request for Additional Information, RAI No. 65, Seismic System Analysis, Question 03.07.02-6, Calvert Cliffs Nuclear Power Plant, Unit 3

cc: John Rycyna, NRC Project Manager, U.S. EPR COL Application
Laura Quinn, NRC Environmental Project Manager, U.S. EPR COL Application
Getachew Tesfaye, NRC Project Manager, U.S. EPR DC Application (w/o enclosure)
Loren Plisco, Deputy Regional Administrator, NRC Region II (w/o enclosure)
Silas Kennedy, U.S. NRC Resident Inspector, CCNPP, Units 1 and 2
U.S. NRC Region I Office

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Enclosure 1

**Response Summary for Requests for Additional Information,
RAI No. 58, Seismic Design Parameters,
RAI No. 65, Seismic System Analysis, and
RAI No. 112, Seismic Design Parameters;
Calvert Cliffs Nuclear Power Plant Unit 3**

Response Summary for Requests for Additional Information

RAI Set 58 Question	Description of RAI Item	Response Date
03.07.01-1	Justify assumptions of rigid basemat in SSI analysis of Nuclear Island including lower bound soil properties (where shear wave velocity is less than 1000 fps)	September 15, 2009
	Identify impact on the SSI analysis results and on the design of the foundation mat and supported superstructure.	September 15, 2009
03.07.01-2	See UniStar Nuclear Energy letter UN#09-320, dated July 15, 2009	Response submitted
03.07.01-3	For EPGB and ESWB, provide methodology to calculate FIRS at grade elevation computed from the GMRS which were determined at an applicable elevation 41 ft below grade.	August 29, 2009
	Describe computer codes, soil column model, and the basis for the shear wave velocity of the structural backfill that supports both the EPGB and ESWB and the impact of this backfill on the development of the FIRS.	December 29, 2009
	Provide in the FSAR the spectra at the foundation level of each structure meeting Appendix S requirements.	December 29, 2009
	Provide in the FSAR a comparison of the FIRS at the foundation level of each structure meeting the requirements of Appendix S to the CSDRS provided in the U.S. EPR FSAR.	December 29, 2009
	Provide the basis for not performing confirmatory analysis for the EPGB and ESWB similar to that for NI. See UniStar Nuclear Energy letter UN#09-329, dated July 29, 2009.	Response submitted
03.07.01-4	See UniStar Nuclear Energy letter UN#09-320, dated July 15, 2009	Response submitted
03.07.01-5	For Ultimate Heat Sink Electrical Building, provide and include in the RAI response FSAR the horizontal and vertical spectra depicting design spectra and applicable envelope.	August 29, 2009
	Provide in the FSAR a reconciliation of the design response spectrum with the horizontal foundation input response spectra (FIRS) for this structure which meets the minimum requirements of 10 CFR Part 50,	December 29, 2009

Response Summary for Requests for Additional Information

RAI Set 58 Question	Description of RAI Item	Response Date
	Appendix S.	
	Include a description of how the FIRS are developed including the soil model, soil properties, backfill properties, computer programs and analysis assumptions.	December 29, 2009
03.07.01-6	Provide in the FSAR how the design response spectrum and assumed soil properties used in the analysis of the UHS MWIS will be reconciled with the FIRS that meets the requirements of Appendix S and the final soil properties determined from the site final geotechnical studies.	September 14, 2009
	Include in the FSAR a comparison of the FIRS with the design response spectra used in the analysis.	December 29, 2009
	Include a description of how the FIRS are developed including the soil model, soil properties, computer programs, and analysis assumptions.	December 29, 2009
03.07.01-7	Provide in the FSAR a discussion of the site-specific spectra that were considered for buried utilities.	December 29, 2009
	Provide justification for the use of the EUR soft soil spectrum including possible displacement and velocity differences that may exist with the use of this spectrum as opposed to using a site specific spectrum.	December 29, 2009
	Provide a comparison of the EUR soft soil spectrum with appropriate site specific spectra that are applicable to buried utilities.	December 29, 2009
03.07.01-8	See UniStar Nuclear Energy letter UN#09-228, dated May 1, 2009	Response submitted
03.07.01-9	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.01-10	State explicitly or by reference design ground motion time histories for Nuclear Island, EPGB and ESWB structures.	September 15, 2009
	What are the site specific design ground motions and their bases that apply to these structures? Provide this information in Section 3.7.1.1.2 of the FSAR.	December 29, 2009

Response Summary for Requests for Additional Information

RAI Set 65 Question	Description of RAI Item	Response Date
03.07.02-1	See UniStar Nuclear Energy letter UN#09-228, dated May 1, 2009	Response submitted
03.07.02-2	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-3	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-4	Provide results of SSI analysis for Ultimate Heat Sink Electrical Building that meet the acceptance criteria 4.A.vii of SRP 3.7.1 and acceptance criteria 4 of SRP 3.7.2 using subgrade model of final soil and backfill properties or justify alternative.	December 29, 2009
	Include SSSI effects from UHS MWIS.	December 29, 2009
	Reconcile with the results of assumed seismic response and ISRS.	December 29, 2009
03.07.02-5	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-6	Describe how the SSI analysis performed for Ultimate Heat Sink Makeup Water Intake Structure (UHS MWIS) meets the acceptance criteria and 4.A.vii of SRP 3.7.1 or justify alternative.	December 29, 2009
	Provide a figure depicting the soil-structure model used for the seismic analysis.	December 29, 2009
	Provide the basis for the assumed soil properties and profile used to calculate the frequency independent impedance functions.	This Letter – See Enclosure 2.
	Provide the method and formulas used to calculate the values of the soil springs under the foundation as well as the lateral soil springs that represent the embedment effects.	This Letter – See Enclosure 2.

Response Summary for Requests for Additional Information

RAI Set 65 Question	Description of RAI Item	Response Date
	State whether the soil properties used in the analysis are strain dependent or simply the low strain values. If these are low strain values, justify their use and quantify the impact of not using strain dependent properties on the results of the analysis. If the soil properties are strain dependent, describe how the final soil properties are determined in the analysis.	This Letter – See Enclosure 2.
	For large values of Poisson's ratio, the dynamic stiffness and damping are frequency dependent. Provide justification for assuming that the impedance functions of the supporting foundation are frequency independent.	This Letter – See Enclosure 2.
	Confirm that the control motion is applied at the base of the soil structure analysis model.	This Letter – See Enclosure 2.
	Provide a reconciliation of the final soil properties and the foundation input response spectra (FIRS) that are based on these properties with the seismic analysis results described in the FSAR.	December 29, 2009
03.07.02-7	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-8	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-9	See UniStar Nuclear Energy letter UN#09-126, dated March 19, 2009	Response submitted
03.07.02-10	See UniStar Nuclear Energy letter UN#09-228, dated May 1, 2009	Response submitted
03.07.02-11	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-12	Provide results of a structure-to-structure interaction analysis between UHS MWIS and EB.	December 29, 2009
03.07.02-13	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-14	See UniStar Nuclear Energy letter UN#09-228, dated May 1, 2009	Response submitted

Response Summary for Requests for Additional Information

RAI Set 65 Question	Description of RAI Item	Response Date
03.07.02-15	See UniStar Nuclear Energy letter UN#09-320, dated July 15, 2009	Response submitted
03.07.02-16	See UniStar Nuclear Energy letter UN#09-126, dated March 19, 2009	Response submitted
03.07.02-17	The interaction of non-seismic Category I structures with Seismic Category I systems is described in FSAR Section 3.7.2.8. In this section on page 3.0-41, it states that fire protection SSCs are categorized as either Seismic Category II-SSE, meaning the SSC must remain functional during and after a Safe Shutdown Earthquake (SSE), or Seismic Category II, meaning the SSC must remain intact after an SSE without deleterious interaction with a Seismic Category I or Seismic Category II-SSE SSC. In the U.S. EPR FSAR on page 3.7-95, it states that Seismic Category II is designed to the same criteria as Seismic Category I structures. In SRP 3.7.2, SRP Acceptance Criteria 8, which addresses the interaction of non-Category I structures with Category I SSCs, it states that when non-Category I structures are designed to prevent failure under SSE conditions; the margin of safety shall be equivalent to that of the Seismic Category I structure. • Describe how this margin of safety is achieved for the Seismic Category II-SSE and Seismic Category II portions of the fire protection system. Include in your response the seismic inputs, loading combinations, codes and acceptance criteria. What are the differences in the method of design for these two seismic categories? • Describe the basis and provide figures in the FSAR of the design response spectra used to analyze above ground seismic Category II and seismic Category II-SSE fire protection SSCs including the fire protection tanks. • What are the methods of analysis and acceptance criteria for both the buried and above ground portions of the fire protection system that are Seismic Category II-SSE that will ensure that these portions of the system will remain functional following an SSE event? • What are the modeling and analysis methods used for the fire protection tanks and to what extent do the fire protection tanks meet the acceptance criteria of SRP 3.7.3, SRP Acceptance Criteria 14.A. thru J? When the tank analysis does not meet the acceptance criteria, provide the technical justification for not doing so.	October 16, 2009

Response Summary for Requests for Additional Information

RAI Set 65 Question	Description of RAI Item	Response Date
03.07.02-18	Clarify the seismic classification of fire protection tank and building. See UniStar Nuclear Energy letter UN#09-329, dated July 29, 2009.	Response submitted
	Reconcile the U.S. EPR seismic analysis for NAB with the site-specific soil properties and foundation input response spectra (FIRS)	September 15, 2009
	Demonstrate in the FSAR that the displacement of this structure relative to the nuclear island common basemat structure is enveloped by the results of the U.S. EPR analysis.	September 15, 2009
03.07.02-19	In FSAR Section 3.7.2.8 on page 3.0-42 it states that the conventional seismic switchgear building, conventional seismic grids systems control building, the conventional seismic circulating water intake structure and the Seismic Category II retaining wall surrounding the CCNPP Unit 3 intake channel could potentially interact with Seismic Category I SSCs. For each of the above structures, describe in the FSAR how the seismic interaction acceptance criteria of SRP 3.7.2, SRP Acceptance Criteria 8 are met, or justify an alternative. If they are intended to meet criterion B, provide the technical basis for the determination that the collapse of the non-Category I structure is acceptable. For criterion C, confirm that the structure will be analyzed and designed to have a margin of safety equivalent to that of a Category I structure and state how this will be accomplished.	October 16, 2009
03.07.02-20	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-21	See UniStar Nuclear Energy letter UN#09-228, dated May 1, 2009	Response submitted
03.07.02-22	See UniStar Nuclear Energy letter UN#09-126, dated March 19, 2009	Response submitted
03.07.02-23	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted
03.07.02-24	Per COLA item 3.7-1, address that the seismic response of the nuclear island common base mat structures, seismic Category II structures, the Nuclear Auxiliary Building and the Radioactive Waste Processing Building is within the parameters of Section 3.7 of U.S. EPR FSAR.	September 15, 2009

Response Summary for Requests for Additional Information

RAI Set 65 Question	Description of RAI Item	Response Date
	Provide a summary for each structure, either directly or by reference, which describes how the COL item is met.	September 15, 2009
03.07.02-25	See UniStar Nuclear Energy letter UN#09-228, dated May 1, 2009	Response submitted
03.07.02-26	See UniStar Nuclear Energy letter UN#09-291, dated June 12, 2009.	Response submitted

RAI Set 112 Question	Description of RAI Item	Response Date
03.07.01-11	Provide a definition of site SSE and explain how it meets regulation requirements..	September 15, 2009
	Consistent with the site SSE, provide the FIRS in the free field at the foundation level of each structure meeting the requirements of Appendix S, and describe how each is determined.	September 15, 2009 (NI) December 15, 2009 (EPGB, ESWB)
	For the U.S. EPR Certified Design structures, provide a comparison of the results of the site seismic September 15, 2009 (NI) analyses using the FIRS input motion defined at the foundation level of each structure, with the analyses results documented in the U.S. EPR FSAR.	September 15, 2009 (NI) December 15, 2009 (EPGB, ESWB)
	For the EPGS and ESWS, describe how the effect of structure-soil-structure interaction has been accounted December 29, 2009 for in the analysis of these buildings.	December 29, 2009 (EPGB, ESWB)

Enclosure 2

**Response to NRC Request for Additional Information,
RAI No. 65, Seismic System Analysis, Question 03.07.02-6,
Calvert Cliffs Nuclear Power Plant, Unit 3**

RAI No. 65

Question 03.07.02-6

FSAR Section 3.7.2.4 (Soil-Structure Interaction) starting on page 3.0-37 describes soil-structure-interaction (SSI) for the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS). The basis for this analysis is ASCE 4-98 which has not been endorsed by the staff for performing SSI analysis. Describe how the analysis performed meets the guidance provided in SRP 3.7.1, SRP Acceptance Criteria 4.A.vii. for performing SSI analysis or provide justification for an alternative. Also for the analysis described, provide in the FSAR the following information:

- A figure depicting the soil-structure model used for the seismic analysis.
- The basis for the assumed soil properties and profile used to calculate the frequency independent impedance functions.
- The method and formulas used to calculate the values of the soil springs under the foundation as well as the lateral soil springs that represent the embedment effect.
- State whether the soil properties used in the analysis are strain dependent or simply the low strain values. If these are low strain values, justify their use and quantify the impact of not using strain dependent properties on the results of the analysis. If the soil properties are strain dependent, describe how the final soil properties are determined in the analysis.
- For large values of Poisson's ratio, the dynamic stiffness and damping are frequency dependent. Provide justification for assuming that the impedance functions of the supporting foundation are frequency independent.
- FSAR Section 3.7.2.4 on page 3.0-37 indicates that the control motion is applied at the bottom of the basemat. Confirm that this is intended to state that the control motion is applied at the base of the soil structure analysis model and revise the FSAR accordingly.
- Provide a reconciliation of the final soil properties and the foundation input response spectra (FIRS) that are based on these properties with the seismic analysis results described in the FSAR.

Response

As summarized in Enclosure 1, the following responses to this RAI question are provided herein:

Provide the basis for the assumed soil properties and profile used to calculate the frequency independent impedance functions.

A uniform soil profile, up to a depth of 73.5 feet below the basemat (El -26.5 feet to El -100.0 feet), was used to calculate the impedance functions for the Ultimate Heat Sink (UHS)

Makeup Water Intake Structure (MWIS) foundation. A shear wave velocity (V_s) of 900 feet/sec, a Poisson's ratio (ν) of 0.47 and a unit weight (γ) of 110 pcf were used.

Dynamic soil properties at the location of the UHS MWIS were estimated by correlation with those at the Nuclear Island (NI) location. The ground elevations of the power block and the UHS MWIS areas differ by about 90 feet. Therefore, the P-wave and S-wave (P-S) logging data from the Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 power block area corresponding approximately to the upper 90 feet are not applicable; and the data for the remaining depths were assumed applicable to the subsurface conditions at the UHS MWIS. To obtain an estimate of the shear wave velocity (V_s) for the UHS MWIS, a relationship was developed between measured shear wave velocity (V_s) values in borings B-301 and B-401 (FSAR Figure 2.5-131) and the corresponding Standard Penetration Tests (SPT) N-values from these borings. This relationship is as indicated by Eq-1; where V_s is the shear wave velocity in feet/sec and N_{SPT} is the SPT N-value in blows/ft. SPT N-values from boring B-701 in UHS MWIS area (FSAR Figure 2.5-134) were used to estimate the shear wave velocity profile at the UHS MWIS. Poisson's ratio and unit weight were also estimated by correlation with those at NI location from El -26.5 feet to El -100.0 feet.

$$V_s = 20N_{SPT} + 750 \qquad \text{Eq-1}$$

Final site specific soil properties are being developed at the location of UHS MWIS. Once final properties become available, randomized soil profiles will be developed and used to obtain strain compatible best estimate (BE), lower bound (LB) and upper bound (UB) soil properties corresponding to CCNPP Unit 3 safe shutdown earthquake (SSE). These strain compatible properties will be used in the soil-structure interaction analyses, using SASSI, for the seismic reconciliation of the UHS MWIS.

Provide the method and formulas used to calculate the values of the soil springs under the foundation as well as the lateral soil springs that represent the embedment effect.

The soil impedances are calculated per Section 3.3.4.2.2 of ASCE 4-98 (Reference 3 of FSAR Section 3.7.2.16). In this methodology, the foundation impedances are first calculated without considering embedment effects. Table 1 depicts the equations used in this first step, and Figure 1 shows the beta (β) factors required during the calculations. Lateral soil springs are not used at the soil-wall interfaces to represent the embedment effect. The increase in stiffness due to embedment effects is included by multiplying the stiffness coefficients calculated in the first step by the modification factors listed in Table 2. The increase in the damping coefficients due to embedment was conservatively neglected, as stated in FSAR Section 3.7.2.4.

The validity of these assumptions will be verified during the seismic reconciliation of the UHS MWIS structure. During the seismic reconciliation, embedment effects will be accounted for in the SSI analysis using SASSI.

Table 1: Lumped Foundation Impedances for Rectangular Basemats (ASCE 4-98)

Motion	Spring Coefficient	Equivalent Radius	Damping Coefficient
Horizontal	$k_h = 2(1+\nu)G\beta_x\sqrt{BL}$	$R = \sqrt{BL/\pi}$	$c_h = 0.576k_hR\sqrt{\rho/G}$
Rocking	$k_\psi = \frac{G}{1-\nu}\beta_\psi BL^2$	$R = \sqrt[4]{BL^3/3\pi}$	$c_\psi = \frac{0.30}{1+B_\psi}k_\psi R\sqrt{\rho/G}$ where $B_\psi = 3(1-\nu)I_0/8\rho R^5$
Vertical	$k_z = \frac{G}{1-\nu}\beta_z\sqrt{BL}$	$R = \sqrt{BL/\pi}$	$c_z = 0.85k_zR\sqrt{\rho/G}$
Torsion	$k_t = \frac{16GR^3}{3}$	$R = \sqrt[4]{BL(B^2+L^2)/6\pi}$	$c_t = \frac{\sqrt{k_tI_t}}{1+2I_t/\rho R^5}$

Notes: ν = Poisson's ratio of foundation medium; G = shear modulus of foundation medium; R = radius of circular basemat; ρ = mass density of foundation medium; I_0 = total mass moment of inertia of structure and basemat about the rocking axis at the base; and I_t = polar mass moment of inertia of structure and basemat.

Table 2: Stiffness Modification Factors to Account for Embedment Effects (ASCE 4-98)

Motion	Stiffness Increase Ratio
Horizontal	$1+1.3\delta$
Vertical	$1+0.8\delta$
Rocking	$1+3.2\delta$
Torsion	$1+2.8\delta$

where:

$\delta = H/R$, H is the embedded depth, and R is the equivalent radius from Table 1

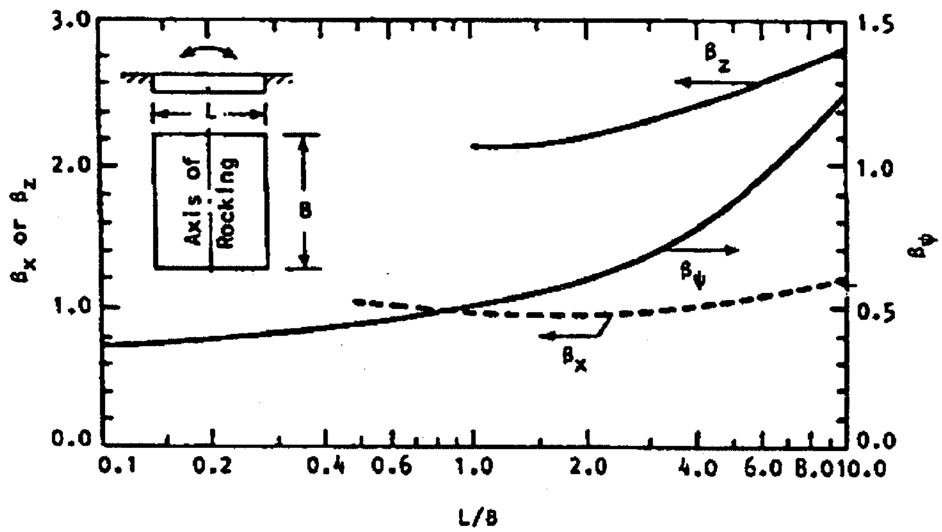

Figure 1: Beta (β) Factors for Foundation Impedance Calculations (ASCE 4-98)

State whether the soil properties used in the analysis are strain dependent or simply the low strain values. If these are low strain values, justify their use and quantify the impact of not using strain dependent properties on the results of the analysis. If the soil properties are strain dependent, describe how the final soil properties are determined in the analysis.

As described in FSAR Section 3.7.2.4, low strain soil properties were used during the seismic analysis of the UHS MWIS. However, a large coefficient of variation (COV = 1.0) was applied to these properties for calculating the lower and upper bound soil properties at the UHS MWIS site to address uncertainty in soil properties as well as their strain dependency.

The validity of these assumptions will be verified during the seismic reconciliation of the UHS MWIS structure. The SSI model for the seismic reconciliation analysis will use strain compatible properties calculated as described above.

For large values of Poisson's ratio, the dynamic stiffness and damping are frequency dependent. Provide justification for assuming that the impedance functions of the supporting foundation are frequency independent.

Frequency independent impedances were used based on ASCE 4-98 Section 3.3.4.2.2, which states that frequency-independent soil spring and dashpot constants, as shown in Table 1, may be used, when the soil below the foundation basemat is relatively uniform to a depth equal to the largest foundation dimension.

The validity of this assumption will be verified during the seismic reconciliation of the UHS MWIS structure. The seismic reconciliation will be performed using frequency dependent impedances consistent with SRP 3.7.2 "Specific Guidelines for SSI Analysis."

FSAR Section 3.7.2.4 on page 3.0-37 indicates that the control motion is applied at the bottom of the basemat. Confirm that this is intended to state that the control motion is applied at the base of the soil structure analysis model and revise the FSAR accordingly.

The control motion is applied at the base of the soil-structure analysis model. FSAR Section 3.7.2.4 will be revised accordingly once the seismic reconciliation of the UHS MWIS is completed.

COLA Impact

FSAR sections will be modified once the seismic reconciliation analysis of UHS MWIS is completed as indicated in Enclosure 1 for this RAI question.