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June 16, 2011
U7-C-NINA-NRC-110081

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville MD 20852-2738

South Texas Project
Units 3 and 4
Docket Nos. 52-012 and 52-013
Response to Request for Additional Information

Attachment 1 is the Nuclear Innovation North America LLC (NINA) response to the NRC staff question 03.07.01-29 included in Request for Additional Information (RAI) letter number 378 related to Combined License Application (COLA) Part 2, Tier 2, Section 3.7.1.

Additionally, during an audit on May 23-27, 2011, the NRC Staff requested that NINA provide additional information to support the review of the COLA. Attachments 2 and 3 provide supplemental responses to NRC staff questions 03.08.04-19 and 03.08.04-30 related to COLA Part 2, Tier 2, Section 3.8.

Where there are COLA markups, they will be made at the first routine COLA update following NRC acceptance of the RAI response.

There are no commitments in this letter.

If you have any questions regarding these responses, please contact me at (361) 972-7136 or Bill Mookhoek at (361) 972-7274.

D091
NRO

STI 32886373

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

Executed on 6/16/11

Scott Head
Manager, Regulatory Affairs
South Texas Project Units 3 & 4

jep

Attachments:

1. RAI 03.07.01-29
2. RAI 03.08.04-19, Supplement 2
2. RAI 03.08.04-30, Supplement 3

cc: w/o attachment except*

(paper copy)

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RAI 03.07.01-29

QUESTION:

The Defense Nuclear Facilities Safety Board (DNFSB) has identified a technical issue in SASSI that when subtraction method is used to analyze embedded structures, the results may be non-conservative. Because the subtraction method has been used for the STP Units 3&4 SSI/SSSI analyses, NINA is requested to demonstrate the acceptability of the subtraction method and the results, or provide a plan and schedule to ensure that the SSCs are designed to meet the requirements of GDC 2. Therefore, the applicant is requested to address the following:

1. For all STP Units 3&4 Seismic Category I structures, compare the In-Structure Response Spectra (ISRS), structural loads, and any other design response quantities developed by using the subtraction method with those using the direct method or modified subtraction method and evaluate the differences.

2. Demonstrate and justify that the differences identified in Item 1 either have no impact on the design of Seismic Category I structures, or revise the design to address the differences.

3. If the modified subtraction method is used to validate the subtraction method, provide a validation program for the modified subtraction method.

4. Provide FSAR mark-up, if any, in the response to document actions taken to address the resolution of the DNFSB's issues with SASSI versions used by STP Units 3&4 analyses.

The staff needs this information to ensure that the STP design basis loads and ISRS will envelop the corresponding ISRS generated from either the direct method or the modified subtraction method.

RESPONSE:

A plan to address the issues identified with the Subtraction Method in the SASSI computer program was discussed with NRC during the audit performed during the week of May 23, 2011. This plan is shown in the following table (reference Action Item Number 3.7-37, Punch List Item Number 71). The plan also includes use of groundwater table at 28 feet MSL in the proposed analyses (reference Action Item Number 3.7-46, Punch List Item Number 91). Our current schedule to submit the results of the analyses included in the table is August 17, 2011.

No COLA revision is required as a result of this response.

Plan to Address issues with Subtraction Method Noted in DOE Letter			
	Category I Structure	**Method Used**	**Plan**
SSI Analysis	DGFOT	Direct	None
	RSW Piping Tunnel	Direct	None
	CB and RB (Shear Wave Velocity Departure Assessment)	Direct	None
	DGFOSV	Subtraction	All analysis cases will be repeated using Modified Subtraction Method (MSM) and ground water level of 28' to assess the impact on spectra, maximum accelerations and any other parameters used for design.
	UHS/RSW Pump House	Subtraction	The impact will be addressed by reanalyzing the UHS/RSW Pump House using MSM with the following parameters: * Coarse mesh * Ground water level of 28' * UB In-situ Soil Case (same soil case used for refined SSI mesh effect) * Full and empty basin cases The spectra and maximum accelerations from the MSM will be compared to those from Subtraction Method and, where required, an additional modification factor will be determined for modification of the results obtained from the Subtraction Method. For generation of the response spectra, the final modification factor at each frequency, to account for cumulative effect of structural mesh, SSI mesh refinement and Subtraction Method will be determined by the product of the three corresponding modification factors. The impact on the maximum accelerations/design will be accounted for by determining a modification factor for each of the element groups used for determination of equivalent accelerations.

Plan to Address issues with Subtraction Method Noted in DOE Letter(continued)			
	Category I Structure	**Method Used**	**Plan**
SSSI Analyses	All SSSI analyses	Subtraction	RB + RSW Piping Tunnel + RWB SSSI Model will be analyzed with upper bound back-fill soil case and lower bound in-situ soil case using Direct Method to assess the impact on calculated total soil pressures.
Project Specific Confirmation	Control Building	Direct	The Control Building Model used for shear wave velocity departure assessment was analyzed using direct method. This model will be reanalyzed for upper bound in-situ soil case using MSM. The analysis results (transfer functions, in-structure response spectra, forces, and maximum accelerations) from the direct method and MSM will be compared for confirmation of MSM.

RAI 03.08.04-19, Supplement 2

QUESTION:

Follow-up to Question 03.08.04-5 (RAI 2965)

The applicant's response to Question 03.08.04-5 regarding placing a chemical agent on the exposed concrete surface of the mudmat provides descriptive explanations of the waterproofing. Per the SRP 3.8.5 guidance, the applicant needs to show that the foundation can transfer the forces from the structure to soil with the proper factor of safety. Also, because a new material is being used, the applicant needs to provide additional data on testing and other relevant information to meet guidance of SRP 3.8.5. Therefore, the applicant is requested to provide the following additional information, and update FSAR as appropriate:

(1) the specific material that will be used for the waterproof membrane; sufficient data showing that the selected waterproofing will adequately protect the concrete foundations against degradation from soil/groundwater conditions at the STP Units 3 and 4 site;

(2) the final thickness of the membrane based on the physical properties of the selected material;

(3) the application procedures for all aspects of the coating application including batch qualification, surface preparation, application techniques, film thickness, cure time, and repairs;

(4) tests demonstrating that the waterproofing requirements and the coefficient of friction required to transfer seismic loads for STP Units 3 and 4 have been met;

(5) methods for testing that simulate field conditions to demonstrate that the minimum required coefficient of friction is achieved by the structural concrete fill-waterproof membrane structural interface; and documentation summarizing the basis for determining that the material will meet the friction factor and waterproofing requirements;

(6) site-specific sliding evaluation for the Reactor Building and the Control Building to demonstrate that the minimum coefficient of friction needed for maintaining the minimum factor of safety against sliding is available at all sliding interfaces between the structures and foundation soil; and,

(7) specification and properties of the structural concrete fill below the RB and CB foundations.

SUPPLEMENTAL RESPONSE:

Supplement 1 of the response to this RAI was submitted with letter U7-C-NINA-NRC-110066, dated April 25, 2011. In this supplement, the requirement for roughening the concrete surfaces is added to the COLA and a clarification is added to the RAI response that the sliding would occur in the soil (Action Item 3.8-29, Punch List Item 77). Minor changes to the Table RAI 03.08.04-19a, submitted with the Supplement 1 response, have also been made.

Table RAI 03.08.04-19a below provides a summary of the coefficient of friction provided for each of the sliding interfaces between the structures and foundation soil.

The coefficients of friction for all interfaces above the soil were raised to 0.75 or above to ensure any sliding would occur in the soil, which is limited by the shear capacity of soil. The equivalent coefficient of friction, based on shear capacity of soil, is equal to or less than 0.7.

Table RAI 03.08.04-19a

Upper Interface Surface	**Lower Interface Surface**	**Minimum Static Coefficient of Friction (□ Provided**	**Basis**
Bottom of reinforced concrete structure	Top of structural concrete fill	>0.75	ACI 349-97, Section 11.7.4.3 (for intentionally roughened joints per Section 11.7.9)
Structural concrete fill	Structural concrete fill at waterproofing membrane	≥0.75	Testing Program per items (4) and (5) described in Revision 1 response of this RAI (see footnote)
Structural concrete fill	Structural concrete fill at a construction joint	>0.75	ACI 349-97, Section 11.7.4.3 (for intentionally roughened joints per Section 11.7.9)
Structural concrete fill	Top of gravel layer	≥0.75	Discussion in Revision 1 response of this RAI (see footnote)
Bottom of gravel layer	Soil	Limited by the shear capacity of the soil	Discussion in Revision 1 response of this RAI (see footnote)

Note: Revision 1 of the response to this RAI was submitted with STPNOC letter U7-C-STP-NRC-100093, dated April 29, 2010.

COLA Part 2, Tier 2, Section 3.8.6.1 will be revised as shown below. These mark-ups are based on COLA Rev. 5 and subsequent mark-ups provided in RAI responses submitted through March 25, 2011.

3.8.6.1 Foundation Waterproofing

The coefficient of friction of the waterproofing material will be determined with a qualification program prior to procurement of the material. The qualification program will be developed to demonstrate that the selected material will meet the waterproofing and friction requirements. The qualification program will include testing to demonstrate that the waterproofing requirements and the coefficient of friction required to transfer seismic loads have been met. Testing methods will simulate field conditions to demonstrate that the minimum required static coefficient of friction of ~~0.60~~0.75 is achieved by the structural concrete fill - waterproof membrane structural interface. The material will meet the required friction factor. Also, to achieve a minimum coefficient of friction of 0.75 to prevent sliding at the construction joints in the structural concrete and concrete fill, the concrete surfaces will be roughened in accordance with the provisions of Section 11.7.9 of ACI 349-97.

RAI 03.08.04-30 Supplement 3

QUESTION:

Follow-up to Question 03.08.04-23

In response to staff question requesting additional information (Letter U7-C-STP-NRC-100036, dated February 10, 2010) about how various steel and concrete elements of site-specific structures are designed, and the design results, the applicant provided some analysis and design information. The applicant also referred to the Supplement 2 response to Question 03.07.01-13 (Letter U7-C-STP-NRC-090230, dated 12/30/09) for pertinent design summary information. In order for the staff to conclude that the design of site-specific structures meet the requirements of GDC 2 by meeting the guidance provided in SRP 3.8.4 and 3.8.5, or otherwise, the applicant is requested to provide the following additional information:

1. The applicant states in the response that a three dimensional finite element analysis (FEA) is used for structural analysis and design of the UHS/RSW Pump House. FSAR Section 3H.6.6.1 states that analysis for the seismic loads was performed using equivalent static loads and the induced forces due to X, Y, and Z seismic excitations were combined using the SRSS method of combination. However, the applicant did not describe how the equivalent static loads due to seismic excitation were determined and applied to the static FEA model from the results of soil structure interaction (SSI) analysis used for determination of seismic response. Therefore, the applicant is requested to provide details of how seismic response analysis results from dynamic SSI analysis were transferred to the static FEA model, including how the effects of accidental torsion were included in the analysis and design of UHS/RSW Pump house. Please also update FSAR with the information, as appropriate.

2. The applicant stated in its response that the modulus of subgrade reaction for static loading was calculated as the average of the local values at nine locations under the foundation. The applicant is requested to provide these nine values, and explain why it is considered appropriate to use the average value. Please also explain how the foundation subgrade modulus was used for calculating nodal springs for the FEA model, and how the effect due to coupling of soil springs was considered in the analysis.

3. For seismic loading, the applicant has outlined a hand-calculated procedure that utilizes published formulas and charts to estimate the foundation spring constants. According to this procedure, the equivalent modulus and Poisson's ratio of a layered soil system are first estimated using the cumulative strain energy method. The resulting values are then used in the equations for computation of the spring constants for a rigid foundation of an arbitrary shape embedded in a uniform half-space. The shear moduli used for individual layers are strain compatible values, and include the mean, upper bound, and lower bound soil cases. The approximate procedure outlined above for developing the foundation spring constants does not take into account the pressure distribution under the base slab. Furthermore, this procedure does not account for the

frequency dependence of these springs. As such, the applicant is requested to provide a justification for not considering the effects of pressure distribution and system frequency in developing the foundation dynamic springs including describing the impact on the calculated results.

4. The applicant's response does not provide details as to how the soil springs calculated under static and seismic loadings are inputted to the 3-D static FEA model to calculate the design stresses. Therefore, the applicant is requested to describe in detail how the static and seismic soil springs are inputted into the FEA model, and how the results are obtained for stress evaluations. Specifically, the applicant is requested to explain if the two sets of springs were used in a single model, and how the two sets were combined to a single set of springs. Otherwise, if the two sets of springs were applied to separate FEA models, describe how the load combinations were performed. The applicant is also requested to provide sufficient detail to assist staff in understanding how static and seismic soil springs are used in the FEA model and results combined for stress evaluations.

5. In the FSAR mark-up of Sections 3H.6.6.3.1 and 3H.6.6.3.2 provided with the response, the applicant identifies the method used by the applicant for combining forces and moments. In this method, for each reinforcing zone, the maximum force or moment is coupled with the corresponding moment or force for design for the same load combination. It is not clear if this method of combining forces and moments for design will envelop the worst combination of forces and moments for all elements in a reinforcing zone. Therefore, the applicant is requested to describe the method of combining forces and moments used by the applicant with a typical example of a reinforcing zone, and demonstrate that this method of combination will yield the worst combination of forces and moments that should be considered for design.

6. The staff notes that in the FSAR mark-up of Section 3H.6.6.3.1 provided with the response, the reported values of soil springs for the RSW Pump House are significantly larger than those for the UHS basin. The applicant is requested to confirm these values, and explain the reason for the large difference.

7. The response did not include any information about the maximum static and dynamic bearing pressures under the foundations of UHS/RSW Pump House. The applicant is requested to provide the maximum static and dynamic bearing pressure under the foundations of UHS/RSW Pump House, compare these values with the maximum allowable static and dynamic bearing pressures, and include this information in the FSAR.

8. In its response to Question 03.07.01-19 (letter U7-C-STP-NRC-100129, dated June 7, 2010), the applicant provided analysis and design information for the seismic category I Diesel Generator Fuel Oil Storage Vault (DGFOSV) a which was not previously included in the FSAR. The information included in the response does not describe how structural analysis and design of the structure was performed. Also,

reference is made to FSAR Section 3H.6.4 for design loads. FSAR Section 3H.6.4 has been updated several times in various responses, and it is not clear where this information can be found. Therefore, the applicant is requested to provide complete structural analysis and design information for the DGFOSV to ensure it meets acceptance criteria 1 through 7 of SRP 3.8.4 and 3.8.5. The staff needs this information to conclude that the DGFOSV is designed to withstand seismic loads and meet GDC 2. Include in the response an updated version of Appendix 3H where structural analysis and design information for all seismic category I structures can be found.

9. While reviewing this response, and other responses referenced in this response, the staff noted that the applicant has used different values of coefficient of friction for sliding stability evaluation; e.g., the value 0.3 was used for the RSW Pump House, 0.4 was used for UHS basin, 0.58 was used DGFOSV, and for the Reactor Building (RB) and the Control Building (CB), it was stated to be more than 0.47. It is not clear if these values are the required coefficient of friction, or the minimum coefficient of friction available. The applicant is requested to clearly specify the minimum coefficient of friction at various locations of the site, if they are different, and explain how these values were determined. Please also clarify this information in the FSAR.

10. The staff noted references to Diesel Generator Fuel Oil Tunnel (DGFOT) in several RAI responses. Please confirm that DGFOT is not a seismic category I structure, and if it is seismic category I, include the analysis and design information to show how the design of the DGFOT meets the acceptance criteria 1 through 7 in the SRP 3.8.4 and 3.8.5 in the FSAR.

SUPPLEMENTAL RESPONSE:

The Supplement 2 response to this RAI was submitted with Nuclear Innovation North America (NINA) letter U7-C-NINA-NRC-110076, dated May 16, 2011. This supplement provides the response to the following action items discussed in the NRC audit performed during the week of May 23, 2011.

a. Revise the response provided in RAI_03.08.04-30, Supplement 1 for justification of Importance Factor for Wind (Audit Action Item 3.8-26, Punch List Item 74)

b. Provide Design Parameters Table (Audit Action Item 3.8-27, Punch List Item 75)

c. Provide legible COLA Figures 3H.6-138 and 3H.6-139 (Audit Action Item 3.8-30, Punch List Item 78)

d. Clarify COLA Section 3H.6.5.3 to specify that Upper Bound (UB) Backfill soil case was used for the cracked and separated Soil-Structure Interaction (SSI) cases (Audit Action Item 3.7-48, Punch List Item 98)

Response to Items a through d:

a. Revise the response provided in RAI 03.08.04-30, Supplement 1 for justification of Importance Factor for Wind (Audit Action Item 3.8-26, Punch List Item 74)

The procedure we used for wind design is consistent with the ASCE 7-05, which is consistent with the Standard Review Plan (SRP) 3.3.1 statement that the procedures used to transform the wind speed into an equivalent pressure to be applied to structures provided in ASCE 7-05 are acceptable. However, our design deviates from one possible literal interpretation of the subsequent guidance provided in the SRP regarding use of Importance Factor. The deviation from this interpretation of the SRP guidance is justified based on the following discussion.

SRP 3.3.1, Acceptance Criterion 3 provides the same formula as in ASCE 7-05 (Equation 6-15) for calculating velocity pressure and states that the design wind speed is as stated in SRP 2.3.1 and the Importance Factor is 1.15. SRP 2.3.1 Acceptance Criterion 4 states that the 100-year return period wind should be based on appropriate standards and cites ASCE 7-05 as an appropriate standard. The commentary in ASCE 7-05, on Importance Factor (comment C6.5.5), indicates that the Importance Factors adjust the 50-year velocity pressure to different annual probabilities of being exceeded, and that Importance Factor 1.15 corresponds to a 100-year mean recurrence interval. Table C6-7 provides factors for converting the 50-year wind speed to other recurrence interval wind speeds. It should be noted that use of the 100-year wind speed, calculated based on the use of factor given in Table C6-7, and Importance Factor of 1.0 in Equation 6-15 yields essentially the same velocity pressure as the use of 50-year wind speed and Importance Factor of 1.15.

As explained above, the combination of Equation 6-15, the definition of "V" and the explanation in Comment C6.5.5 of ASCE 7-05 make clear that the procedure for determining the wind load, or "velocity pressure", due to a 100-year wind is to apply the 1.15 Importance Factor to the wind load calculated for a 50-year wind, or to apply the 1.0 Importance Factor to the wind load calculated for a 100-year wind.

NRC reviews of other applications also have concluded that the procedure described above is consistent with SRP 3.3.1. The DCD for the AP1000, in Section 3.3.1.1, Design Wind Velocity, describes how the Importance Factor of 1.15 is used to adjust the wind speed with an annual probability of occurrence of 0.02 (i.e., the 50-year mean return period wind speed) to an annual probability of occurrence of 0.01 (i.e., the 100-year mean return period wind speed). In Section 3.3.1.2, Determination of Applied Forces, wind velocities are transformed to wind pressures according to ASCE 7-98 guidelines, and there is no mention of applying the Importance Factor of 1.15 again. This procedure to calculate design wind loads for the AP1000 is the same as that used for STP 3 & 4.

The Safety Evaluation Report (SER) for the AP1000 Design Certification, NUREG-1793 (September 2004), accepted the procedure described in the AP1000 DCD, and included the following discussion of wind design criteria:

"The importance factor, I, is a multiplier for basic wind speeds shown in the maps of

ASCE 7-98. The end product is a wind speed with an appropriate recurrence interval. The basic wind speed values of the maps in ASCE 7-98 are for a 50-year mean recurrence interval (annual probability of 0.02). The commentary, Section C6.5.5 of ASCE 7-98, explains that an importance factor of 1.15 is associated with a mean recurrence interval of 100 years, and is to be used to adjust the structural reliability of a building or other structures to be consistent with building classification. ... The use of an importance factor of 1.15 is conservative."

Similarly, the DCD for the ESBWR describes the same procedure as used by AP1000 and STP 3 & 4. In Section 3.3.1.1 it states, "Seismic Category I and II structures are designed to withstand the design wind velocity listed in Table 2.0-1. The recurrence interval listed in Table 2.0-1 is equivalent to an importance factor of 1.15 based on Category IV building." In Section 3.3.1.2, Determination of Applied Forces, there is no mention of using an Importance Factor of 1.15.

In Section 3.3.1.3 of the Advanced Final Safety Evaluation Report for the ESBWR, the NRC Staff accepted the procedure described in the ESBWR DCD, and stated that in Revision 3 of SRP 3.3.1 the NRC staff accepted these provisions of ASCE 7-05 for transforming wind speed into equivalent pressure to be applied to structures and portions of structures.

Based on the above, the use of Importance Factor of 1.0 with the 100-year wind speed in ASCE Equation 6-15 is consistent with both ASCE 7-05 and the intent of SRP 3.3.1.

The COLA Part 2, Tier 2 Section 3H.6.4.3.2 will be revised as shown in Enclosure 1.

b. Provide Design Parameters Table (Audit Action Item 3.8-27, Punch List Item 75)

   See new COLA Section 3H.8 in Enclosure 1, where the Design Parameters Table has been added.

c. Provide legible COLA Figures 3H.6-138 and 3H.6-139 (Audit Action Item 3.8-30, Punch List Item 78)

   Legible copies of Figures 3H.6-138 and 3H.6-139 have been provided as COLA mark-up in Enclosure 1.

d. Clarify COLA Section 3H.6.5.3 to specify that UB Backfill soil case was used for the cracked and separated SSI cases (Audit Action Item 3.7-48, Punch List Item 98)

   See COLA mark-up provided in Enclosure 1.

Enclosure 1

COLA will be revised as shown in this enclosure. These mark-ups are based on COLA Rev. 5 and subsequent mark-ups provided in RAI responses submitted through March 25, 2011.

3H.3 Radwaste Building

The RWB is classified as RW-IIb (Hazardous) in accordance with RG 1.143. A summary of the extreme environmental design parameters is presented in Table 3H.8-1.

The analysis and design of the Radwaste building are based on the following:

A) Criteria for Design Basis:

- Design basis analysis and design are per requirements of Revision 2 of RG 1.143 for RW-IIb classification.
- Loads, load combinations, codes & standards, and capacity criteria are in accordance with Tables 1, 2, 3, and 4 of RG 1.143.
- Design of structural components is per ACI 349-97 and AISC/N690 (1984).
- ~~Earthquake loading is per ASCE 7-95 Category III.~~

3H.6.1 Objective and Scope

The details of analysis and design for Items (1) and (2) are provided in Sections 3H.6.~~3~~2 through 3H.6~~.6~~.6. The details for Item (3) are provided in Section 3H.6.7.

3H.6.2 Summary

A summary of the extreme environmental design parameters is presented in Table 3H.8-1.

For the design of the UHS basin and the pump house of each unit, the seismic effects were determined by performing a soil-structure interaction (SSI) analysis, as described in Subsection 3H.6.5. The free-field ground response spectra used in the analysis are described in Subsection 3H.6.5.1.1.1. The resulting seismic loads were used in combination with other applicable loads to develop designs of the structures. Hydrodynamic effects of the water in the basin were considered. The following results for the UHS/RSW Pump House are presented in tables and figures, as indicated. Results for the RSW Piping Tunnel are presented in Sections 3H.6.5.3 and 3H.6.6.2.2.

3H.6.4.3.2

Importance Factor .... ~~1.15~~ 1.0

3H.6.5.3

The Specifics of this 2D SSI model are as follows:

- Analysis cases also include one case with cracked concrete (50% concrete modulus value) and one case with soil separation (20 ft depth). Backfill upper bound soil case was used in these analyses.

3H.6.7 Diesel Generator Fuel Oil Storage Vaults (DGFOSV)

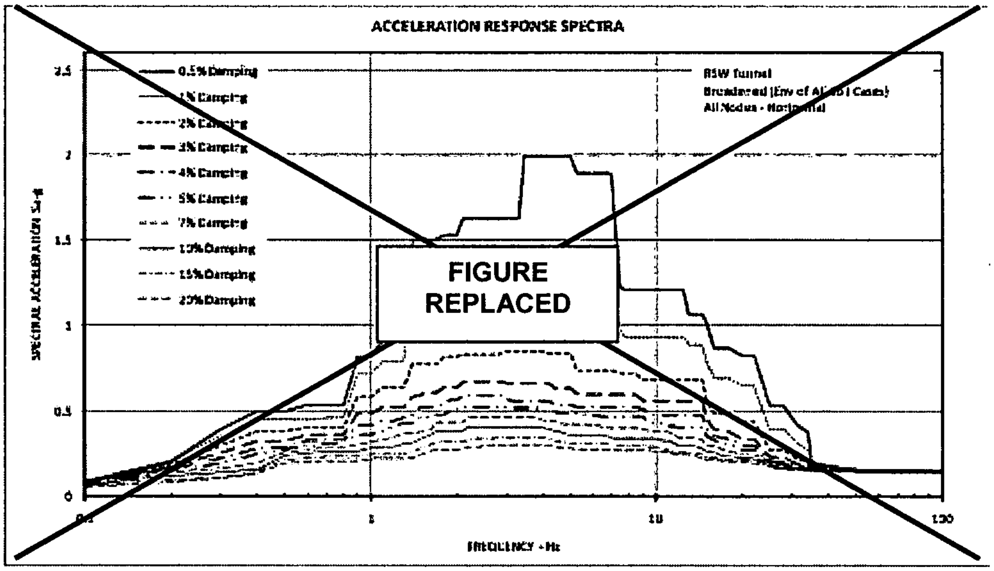
The Diesel Generator Fuel Oil Storage Vaults (DGFOSV) are reinforced concrete structures, located below grade with an access room above grade. The DGFOSV house fuel oil tanks and transfer pumps. The DGFOSV are buried in the structural back-fill. The embedment depth to the bottom of the 2 ft thick mudmat is approximately 45 ft, the maximum height from the bottom of the mudmat is approximately 61 ft, and the basemat dimensions are approximately 81.5 ft by 48 ft. Properties of the backfill are described in Section 3H.6.5.2.4.

A summary of the extreme environmental design parameters is presented in Table 3H.8-1.

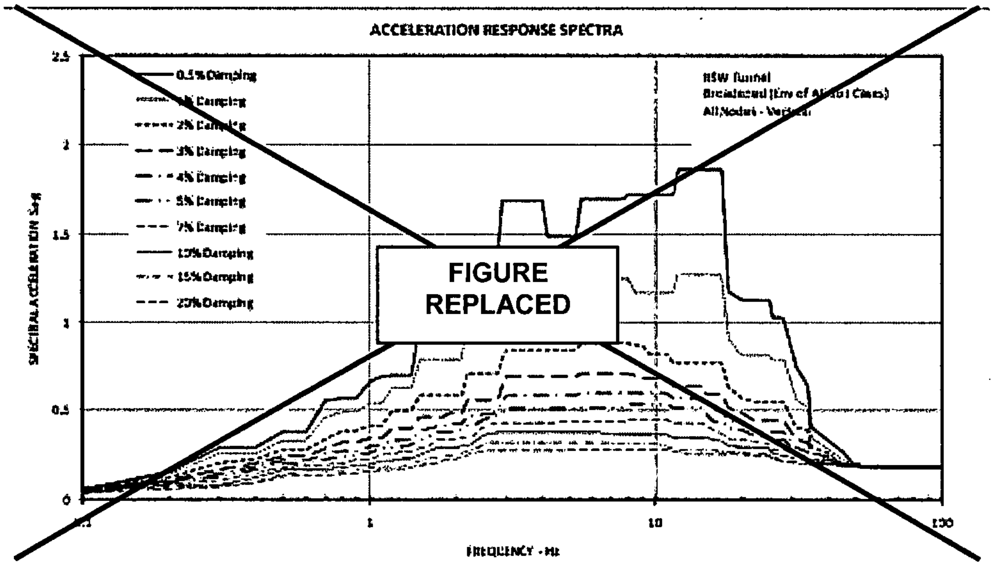
Two DGFOSV are located about 53 feet away from the south face of the Reactor Building (RB), which is a heavy multistory structure. The third DGFOSV is located approximately 40 feet away from the north face of the Reactor Service Water (RSW) Pump House. Figure 3H.6-221 shows the DGFOSV locations relative to other structures. Considering the soil profile at the STP Units 3 & 4 site, the induced acceleration at the foundation level of the DGFOSV during a safe-shutdown earthquake (SSE) event may be amplified due to their close proximity to the RB (for the two) or the RSW Pump House (for the third). To establish the input motion for the soil-structure interaction (SSI) analysis of the DGFOSV, considering the impact of the nearby heavy RB (for the two) and RSW Pump House (for the third) structures, an analysis as described below was performed.

3H.8 Extreme Environmental Design Parameters for Seismic Analysis, Design, Stability Evaluation and Seismic Category II/I Design

Table 3H.8-1 shows the extreme environmental design parameters used for seismic analysis, structural design, stability evaluation, and Seismic Category II/I design for the Ultimate Heat Sink/Reactor Service Water Pump House, Reactor Service Water Piping Tunnel, Diesel Generator Fuel Oil Storage Vault, Diesel Generator Fuel Oil Tunnel, Radwaste Building, Control Building Annex, Turbine Building, and Service Building.



~~Figure 3H.6-138: RSW Piping Tunnel, Horizontal Response Spectra~~



~~Figure 3H.6-139: RSW Piping Tunnel, Vertical Response Spectra~~

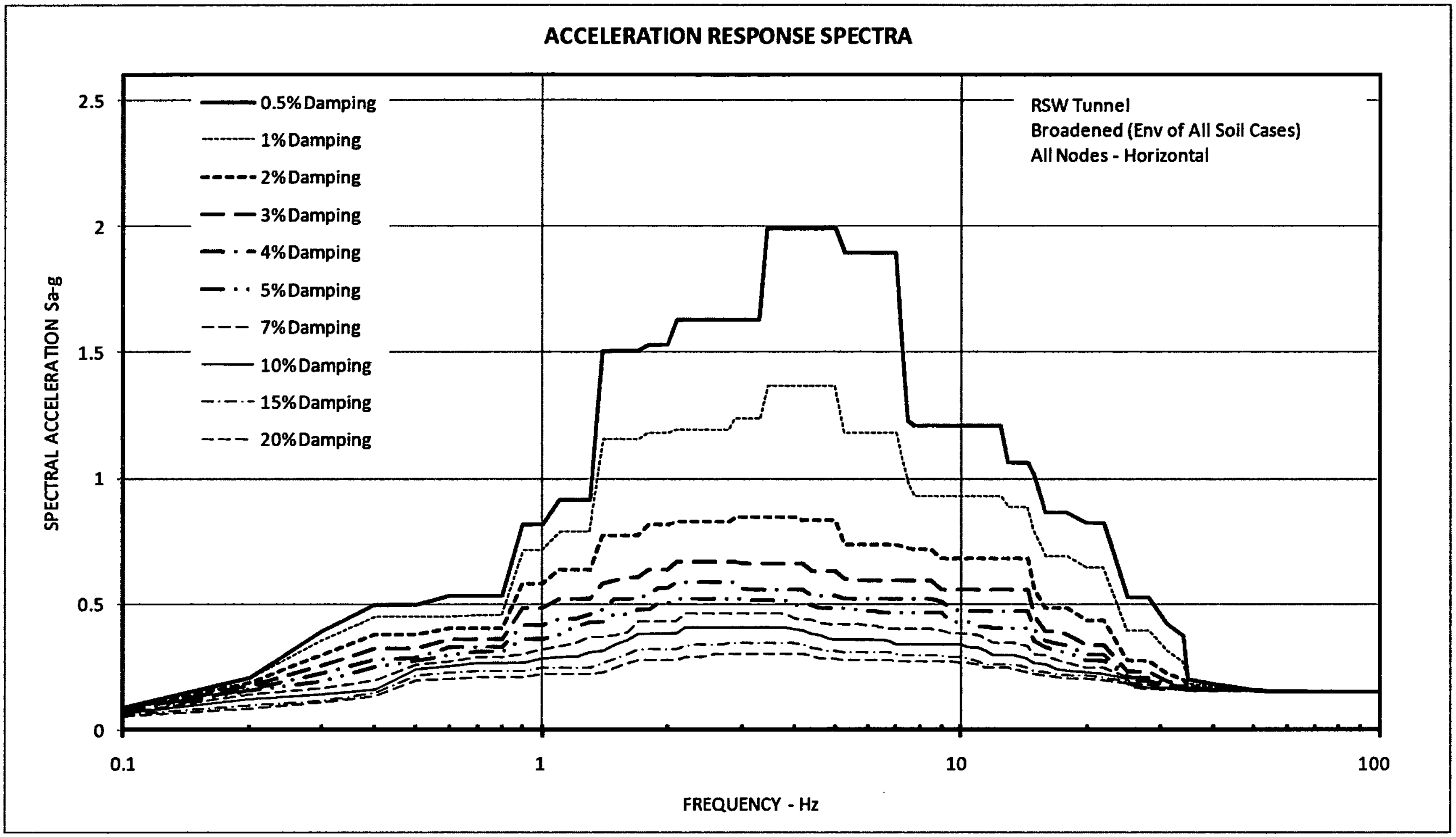


Figure 3H.6-138: RSW Piping Tunnel, Horizontal Response Spectra

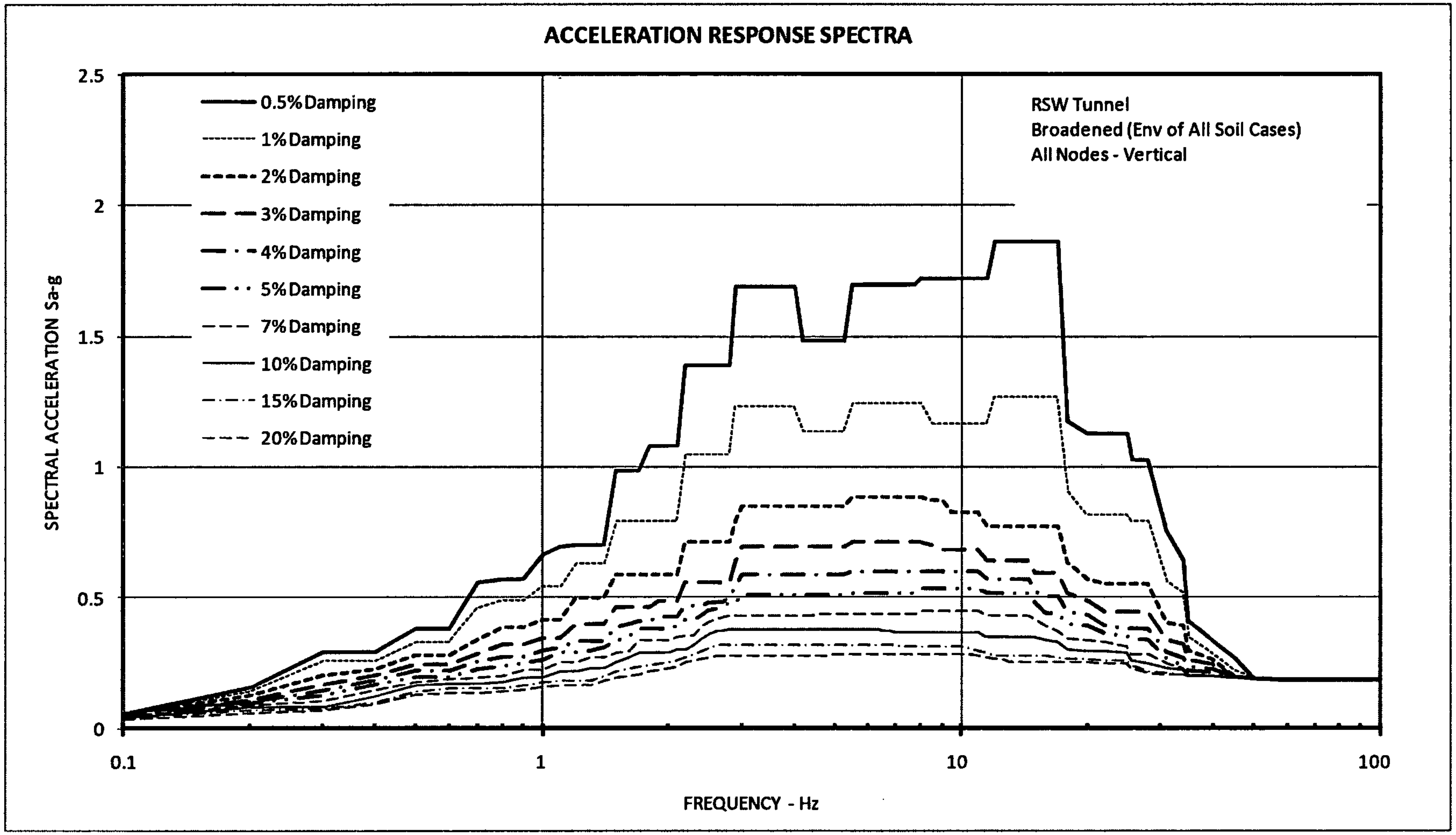


Figure 3H.6-139: RSW Piping Tunnel, Vertical Response Spectra

Table 3H.8-1 Extreme Environmental Design Parameters for Seismic Analysis, Design, Stability Evaluation and Seismic Category II/I Design

Structure	Seismic Analysis					Design									Design for II/I			
	SSI			SSSI		Structure				Stability								
	Input Motion	Soil Type	Structural Damping for Generation of ISRS	Input Motion	Soil Type	Seismic	Tornado	Tornado Missiles	Flood	Seismic	Tornado	Tornado Missiles	Flotation	Coeff. Of Friction for Waterproofing Membrane	Seismic	Tornado	Tornado Missiles	Flood
Diesel Generator Fuel Oil Tunnels (DGFOT)	Envelope of Amplified[1] Site-Specific SSE & 0.3g RG 1.60	DCD & Site-Specific	4% for all SSI analysis cases	Site-Specific SSE	Site-Specific	Envelope of Amplified[1] Site-Specific SSE & 0.3g RG 1.60	DCD Tornado Wind Parameters (As described in Table 5.0 of DCD/Tier 1)	DCD Missile Spectrum 1 as defined in Table 5.0 of DCD/Tier 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade) • Drag Effect 44 psf (above grade) • Impact of Floating Debris per COLA Section 3.4.2 • Wind Generated Wave Action per COLA Figure 3.4-1 (only hydrodynamic portion)	Amplified[1] Site-Specific SSE	Site-Specific Tornado Wind Parameters (Region II, RG 1.76 Rev. 1)	Site-Specific Tornado Missile Spectrum for Region II as shown in Table 2 of RG 1.76 Rev 1 (Note 2)	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade)	Site-Specific	NA	NA	NA	NA
UHS/RSW Pump House	Site-Specific SSE	Site-Specific	4% for all SSI analysis cases	Site-Specific SSE	Site-Specific	Site-Specific SSE	Site-Specific Tornado Wind Parameters (Region II, RG 1.76 Rev. 1)	Site-Specific Tornado Missile Spectrum for Region II as shown in Table 2 of RG 1.76 Rev 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade) • Drag Effect 44 psf (above grade) • Impact of Floating Debris per COLA Section 3.4.2 • Wind Generated Wave Action per COLA Figure 3.4-1 (only hydrodynamic portion)	Site-Specific SSE	Site-Specific Tornado Wind Parameters (Region II, RG 1.76 Rev. 1)	Site-Specific Tornado Missile Spectrum for Region II as shown in Table 2 of RG 1.76 Rev 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade)	Site-Specific	NA	NA	NA	NA
RSW Piping Tunnels	Amplified[1] Site-Specific SSE	Site-Specific	4% for all SSI analysis cases Except 7% for Cracked Case	Site-Specific SSE	Site-Specific	Amplified[1] Site-Specific SSE	Site-Specific Tornado Wind Parameters (Region II, RG 1.76 Rev. 1)	Site-Specific Tornado Missile Spectrum for Region II as shown in Table 2 of RG 1.76 Rev 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade) • Drag Effect 44 psf (above grade) • Impact of Floating Debris per COLA Section 3.4.2 • Wind Generated Wave Action per COLA Figure 3.4-1 (only hydrodynamic portion)	Amplified[1] Site-Specific SSE	Site-Specific Tornado Wind Parameters (Region II, RG 1.76 Rev. 1)	Site-Specific Tornado Missile Spectrum for Region II as shown in Table 2 of RG 1.76 Rev 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade)	Site-Specific	NA	NA	NA	NA
Diesel Generator Fuel oil Storage Vault (DGFOSV)	Envelope of Amplified[1] Site-Specific SSE & 0.3g RG 1.60	Site-Specific	4% for all SSI analysis cases	Site-Specific SSE	Site-Specific	Envelope of Amplified[1] Site-Specific SSE & 0.3g RG 1.60	Site-Specific Tornado Wind Parameters (Region II, RG 1.76 Rev. 1)	Site-Specific Tornado Missile Spectrum for Region II as shown in Table 2 of RG 1.76 Rev 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade) • Drag Effect 44 psf (above grade) • Impact of Floating Debris per COLA Section 3.4.2 • Wind Generated Wave Action per COLA Figure 3.4-1 (only hydrodynamic portion)	Amplified[1] Site-Specific SSE	Site-Specific Tornado Wind Parameters (Region II, RG 1.76 Rev. 1)	Site-Specific Tornado Missile Spectrum for Region II as shown in Table 2 of RG 1.76 Rev 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade)	Site-Specific	NA	NA	NA	NA
Radwaste Building (RWB)	NA	NA	NA	Site-Specific SSE	Site-Specific	1/2 of 0.3g RG 1.60 SSE for RW-IIa Classification, 4% Damping	Per Table 2 of RG 1.143 Rev. 2 for RW-IIa Classification	Per Table 2 of RG 1.143 Rev. 2 for RW-IIa Classification	Flood El 33' MSL RW-IIb Classification	Amplified[1] Site-Specific SSE, 7% Damping	Site-Specific Tornado Wind Parameters (Region II, RG 1.76 Rev. 1)	Site-Specific Tornado Missile Spectrum for Region II as shown in Table 2 of RG 1.76 Rev 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade)	Site-Specific	Envelope of Amplified[1] Site-Specific SSE & 0.3g RG 1.60, 7% Damping	DCD Tornado Wind Parameters (As described in Table 5.0 of DCD/Tier 1)	DCD Missile Spectrum 1 as defined in Table 5.0 of DCD/Tier 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade) • Drag Effect 44 psf (above grade) • Impact of Floating Debris per COLA Section 3.4.2 • Wind Generated Wave Action per COLA Figure 3.4-1 (only hydrodynamic portion)
Control Bldg. Annex (CBA)	NA	NA	NA	NA	NA	IBC 2006	NA	NA	NA	Amplified[1] Site-Specific SSE	Site-Specific Tornado Wind Parameters (Region II, RG 1.76 Rev. 1)	Site-Specific Tornado Missile Spectrum for Region II as shown in Table 2 of RG 1.76 Rev 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade)	Site-Specific	Envelope of Amplified[1] Site-Specific SSE & 0.3g RG 1.60	DCD Tornado Wind Parameters (As described in Table 5.0 of DCD/Tier 1)	DCD Missile Spectrum 1 as defined in Table 5.0 of DCD/Tier 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade) • Drag Effect 44 psf (above grade) • Impact of Floating Debris per COLA Section 3.4.2 • Wind Generated Wave Action per COLA Figure 3.4-1 (only hydrodynamic portion)
Turbine Building (TB)	NA	NA	NA	NA	NA	IBC 2006	NA	NA	NA	Site-Specific SSE	Site-Specific Tornado Wind Parameters (Region II, RG 1.76 Rev. 1)	Site-Specific Tornado Missile Spectrum for Region II as shown in Table 2 of RG 1.76 Rev 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade)	Site-Specific	0.3g RG 1.60 SSE	DCD Tornado Wind Parameters (As described in Table 5.0 of DCD/Tier 1)	DCD Missile Spectrum 1 as defined in Table 5.0 of DCD/Tier 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade) • Drag Effect 44 psf (above grade) • Impact of Floating Debris per COLA Section 3.4.2 • Wind Generated Wave Action per COLA Figure 3.4-1 (only hydrodynamic portion)
Service Building (SB)	NA	NA	NA	NA	NA	IBC 2006	NA	NA	NA	Amplified[1] Site-Specific SSE	Site-Specific Tornado Wind Parameters (Region II, RG 1.76 Rev. 1)	Site-Specific Tornado Missile Spectrum for Region II as shown in Table 2 of RG 1.76 Rev 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade)	Site-Specific	Envelope of Amplified[1] Site-Specific SSE & 0.3g RG 1.60	DCD Tornado Wind Parameters (As described in Table 5.0 of DCD/Tier 1)	DCD Missile Spectrum 1 as defined in Table 5.0 of DCD/Tier 1	Flood El 40' MSL, Water Density 63.85 lb/ft^3 (above grade) • Drag Effect 44 psf (above grade) • Impact of Floating Debris per COLA Section 3.4.2 • Wind Generated Wave Action per COLA Figure 3.4-1 (only hydrodynamic portion)

General Notes:

1) Amplified Site-Specific SSE accounts for the influence of nearby heavy Reactor Building, Control Building, and/or UHS/RSW Pump House.

2) For stability under tornado loading with tornado missile, restraints are required at top of DGFOT access regions.

3) NA: Not Applicable