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Your ref: Docket No. 52-006
Our ref: DCP/NRC2154

June 6, 2008

Subject: AP1000 Response to Requests for Additional Information (SRP2.5)

Westinghouse is submitting a response to the NRC requests for additional information (RAIs) on SRP Section 2.5. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in the response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

A response is provided for RAI-SRP2.5-RGS1-01 through -13, as sent in an email from Dave Jaffe to Sam Adams dated April 25, 2008. This response completes all requests received to date for SRP Section 2.5.

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

Robert Sisk, Manager
Licensing and Customer Interface
Regulatory Affairs and Standardization

/Enclosure

1. Response to Requests for Additional Information on SRP Section 2.5

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NRO

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ENCLOSURE 1

Response to Requests for Additional Information on SRP Section 2.5

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP2.5-RGS1-01
Revision: 0

Question:

The second paragraph of Section 2.5.2 states that the AP1000 is also evaluated for a safe shutdown earthquake (SSE) defined by a peak ground acceleration (PGA) of 0.30g and the design response spectra specified in Appendix 3I, and Figures 3I.1-1 and 3I.1-2. Please clarify the following:

(1) The definition of the term "safety shutdown earthquake (SSE)" is not clear: Is it the GMRS or CSDRS shown in Figures 3I.1-1 and 3I.1-2?

(2) If the GMRS is defined as the design response spectra, the PGA as shown in Figures 3I.1-1 and 3I.1-2 is 0.25g instead of 0.3g. Clarification is needed.

Westinghouse Response:

(1) Figures 3I.1-1 and 3I.1-2 show the Hard Rock High Frequency (HRHF) response spectra used in separate evaluations described in Appendix 3I for sites where the nuclear island is founded on hard rock. These evaluations show that the AP1000 is applicable at hard rock sites where the Foundation Input Response Spectra (FIRS) are less than or equal to these HRHF spectra.

(2) The response spectra shown in Figures 3I.1-1 and 3I.1-2 are not the plant design response spectra; they are used for the evaluation for high frequency seismic input to demonstrate that it is non-damaging, and that the AP1000 CSDRS control the AP1000 design.

Design Control Document (DCD) Revision:

Section 2.5.2 will be clarified as given below:

> The AP1000 is designed for ~~a safe shutdown~~an earthquake ~~(SSE)~~ defined by a peak ground acceleration (PGA) of 0.30g and the design response spectra specified in subsection 3.7.1.1, and Figures 3.7.1-1 and 3.7.1-2. The AP1000 design earthquake is referred to as the AP1000 Certified Seismic Design Response Spectra (CSDRS). The AP1000 ~~design response spectra~~ CSDRS were developed using the Regulatory Guide 1.60 response spectra as the base and modified to include additional high frequency amplification at a control point at 25 Hz. The peak ground accelerations in the two horizontal and the vertical directions are equal. The CSDRS also represents the AP1000 FIRS (Foundation Input Response Spectra) at a hard rock site.
>
> The AP1000 is ~~also~~ evaluated at a hard rock site for high frequency input using ~~a safe shutdown earthquake (SSE) defined by a peak ground acceleration (PGA) of 0.30g and~~ the ~~design~~ response spectra specified in Appendix 3I, ~~and~~ Figures 3I.1-1 and 3I.1-2. The seismic response spectra given in Figures 3I.1-1 and 3I.1-2 are bounding GMRS with high frequency content representative of sites where the nuclear island is founded on hard rock, i.e., HRHF GMRS. ~~These design response spectra are applicable to certain east coast rock sites.~~

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP2.5-RGS1-02
Revision: 0

Question:

In DCD Section 2.5.2.1, you state that the site-specific ground motion response spectra (GMRS) should be defined at ground surface in the free field. For sites with soil layers that are to be completely excavated to expose competent material (in-situ material with a shear wave velocity of 1000 ft/sec or higher), the GMRS (a surface motion) should be specified on an outcrop or a hypothetical outcrop that will exist after excavation. For the case of backfill soil to be placed to support the seismic Category I building structures, Please clarify that the outcrop motion is to be calculated with no soil or backfill soil layers above the free-ground surface.

Westinghouse Response:

The second paragraph given in Section 2.5.2.1 is modified to clarify that the outcrop motion is to be calculated with no soil or backfill soil layers above the free-ground surface.

Design Control Document (DCD) Revision:
Revise DCD Subsection 2.5.2.1 as follows:

The site-specific ground motion response spectra (GMRS) for comparison against the CSDRS are determined in the free-field on the ground surface. For sites with soil layers that will be completely excavated to expose competent material, the GMRS is specified on an outcrop or a hypothetical outcrop that will exist after excavation. Motions at this hypothetical outcrop are developed as a free-surface motion, not as an in-column motion~~.~~ with no soil or backfill soil layers above the outcrop. Competent material may be defined as in-situ material having a shear wave velocity equal to or greater than 1000 fps. The Combined License applicant must demonstrate that the proposed site meets the following requirements:

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP2.5-RGS1-03
Revision: 0

Question:

The staff reviewed the COL screen requirements (DCD Section 2.5.2.1) for qualifying a plant site and identified the following issues:

a. In Item 4 of the screening requirements, you state that for a site where the nuclear island is founded on competent rock with shear wave velocity greater than 8000 feet per second and there are thin layers of soft material overlying the rock, the site-specific peak ground acceleration and spectra may be developed at the top of the competent rock and shown at the foundation level to be less than or equal to those given in Figures 3I.1-1 and 3I.1-2. _Please define "thin layers" and "soft layers."

b. In Item 5 of the screening requirements, you state that foundation material layers are approximately horizontal (dip less than 20 degrees), and the median estimate of the low strain shear wave velocity of the soil below the foundation of the nuclear island is greater than or equal to 1000 feet per second. The phrase "the median estimate of the low strain shear wave velocity" should be replaced by "the minimum estimate of the low strain shear wave velocity."

c. In Item 6 of the screen requirements, you state that for sites where the nuclear island is founded on soil, the median estimate of the strain-compatible soil shear modulus and hysteretic damping is compared to the values used in the AP1000 generic analyses shown in Table 3.7.1-4 and Figure 3.7.1-17. Properties of soil layers within a depth of 120 feet below finished grade are compared to those in the generic soil site analyses (soft soil, soft-to-medium soil, and upper bound soft-to-medium soil). For the acceptance of a selected site, please provide, in the DCD, a set of guidelines and acceptance criteria for the COL applicants to follow to show how the comparison is to be completed and provide the basis for the acceptance.

Westinghouse Response:

(a) The qualifier "and there are thin layers of soft material overlying the rock" is not required and is being deleted. This matches the wording used in Item 3.

(b) The suggested word change will be made in the next revision of the DCD.

(c) It is stated in Section 2.5.4.6 of the DCD that "The Combined License applicant will establish the properties of the foundation soils to be within the range considered for design of the nuclear island basemat." In Section 3.7.1.4 of the DCD is provided a description of the soil profiles used for the design of the nuclear island. In this section there is sufficient information for use by the applicant to demonstrate that his

soil material properties are within the range considered for the design of the AP1000 nuclear island. If the site-specific soil profiles are outside of the AP1000 nuclear island design soil profiles, site-specific evaluations can be performed. It is not necessary to provide more guidance to the Combined License applicant.

Design Control Document (DCD) Revision:

Modify Items 4 and 5 in DCD Section 2.5.2.1 to read:

4. In lieu of (1) and (2) above, for a site where the nuclear island is founded on competent rock with shear wave velocity greater than 8000 feet per second ~~and there are thin layers of soft material overlying the rock~~, the site-specific peak ground acceleration and spectra may be developed at the top of the competent rock and shown at the foundation level to be less than or equal to those given in Figures 3I.1-1 and 3I.1-2.

5. Foundation material layers are approximately horizontal (dip less than 20 degrees), and the ~~median~~ minimum estimate of the low strain shear wave velocity of the soil below the foundation of the nuclear island is greater than or equal to 1000 feet per second.

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP2.5-RGS1-04
Revision: 0

Question:

At the end of DCD Section 2.5.2.1, you state that where features of the site are not within the parameters specified for the AP1000, site-specific soil structure interaction (SSI) analyses may be performed using the 2D SASSI models described in Appendix 3G for variations in site conditions that can be represented in these models. Results should be compared to the results of the 2D SASSI analyses described in Appendix 3G. However, the second paragraph of DCD Section 2.5.2.3 states that site-specific SSI analyses are performed using the 3D SASSI models described in Appendix 3G. The site-specific SSI analyses are to use the site-specific soil conditions (including variation in soil properties in accordance with SRP section 3.7.2). The staff's concerns are:

a. Please clarify this inconsistency.

b. For the case where features of the site are not within the parameters specified for the AP1000, the COL applicant needs to perform a 3D SSI analysis instead of 2D SSI analysis to check the adequacy of the AP1000 standard design for the site, especially, for sites with sloping excavations (e.g., Vogtle).

Westinghouse Response:

(a) The last paragraph of DCD subsection 2.5.2.1 is being moved into 2.5.2.3. The title of Subsection 2.5.2.3 is revised to read "site specific evaluations". See DCD revisions below.

(b) The Combined License applicant will identify site specific features and parameters that are not clearly within the guidance provided in Subsection 2.5.2.1. He will develop soil structure interaction models to evaluate the condition. Depending on the condition, these analyses may be either 2D or 3D. He will compare his results to the corresponding 2D or 3D generic analyses. It is stated at the end of 2D SASSI analyses, "If the results are not clearly enveloped then a 3D SASSI analysis may be required." However, it should not be required to have to perform a 3D SSI analysis when a 2D SSI may be appropriate. The adequacy of the 2D SASSI analyses are discussed in RAI-TR85-SEB1-07 and in RAI-TR03-015 is provided a discussion of when 2D SASSI analyses are appropriate to demonstrate that local features are bounded by the design cases.

Design Control Document (DCD) Revision:

Delete last paragraph of DCD subsection 2.5.2.1 and modify the second paragraph of DCD subsection 2.5.2.3 as follows:

2.5.2.3 Site Specific Seismic Evaluation ~~Sites with Geoscience Parameters Outside the Certified Design~~

The Combined License applicant may identify site specific features and parameters that are not clearly within the guidance provided in Subsection 2.5.2.1. These features and parameters may be demonstrated to be acceptable by performing site specific seismic analyses. These analyses may be either 2D or 3D. Results will be compared to the corresponding 2D or 3D generic analyses.

2.5.2.3.1 2D analyses

Where features of the site are not within the parameters specified for the AP1000, site-specific soil structure interaction analyses may be performed using the 2D SASSI models described in Appendix 3G for variations in site conditions that can be represented in these models. Results should be compared to the results of the 2D SASSI analyses described in Appendix 3G. Such analyses may be used to demonstrate that local features, such as soil degradation properties or backfill, are well within the bounds established by the design cases. If the results are not clearly enveloped then a 3D SASSI analysis may be required. These evaluations and comparisons will be provided and reviewed as part of the Combined License application.

2.5.2.3.2 3D Analyses

If the site-specific spectra at foundation level exceed the response spectra in Figures 3.7.1-1 and 3.7.1-2 at any frequency, or if soil conditions are outside the range evaluated for AP1000 design certification, a site-specific evaluation can be performed. This evaluation will consist of a site-specific dynamic analysis and generation of in-structure response spectra at six key locations to be compared with the floor response spectra of the certified design at 5-percent damping. The site design response spectra at the foundation level in the free-field given in Figures 3.7.1-1 and 3.7.1-2 were used to develop the floor response spectra. They were applied at foundation level for the hard rock site and at finished grade level for the soil sites. The site is acceptable ~~for construction of the AP1000~~ if the floor response spectra from the site-specific evaluation do not exceed the AP1000 spectra for each of the locations identified below or the exceedances are justified:

- Containment internal structures at elevation of reactor vessel support — Figure 3G.4-5X to 3G.4-5Z
- Containment operating floor — Figure 3G.4-6X to 3G.4-6Z

• Auxiliary building north east corner at elevation 116′ 6”	Figure 3G.4-7X to 3G.4-7Z
• Shield building at fuel building roof	Figure 3G.4-8X to 3G.4-8Z
• Shield building roof	Figure 3G.4-9X to 3G.4-9Z
• Steel containment vessel at polar crane support	Figure 3G.4-10X to 3G.4-10Z

Site-specific soil structure interaction analyses are performed using the 3D SASSI models described in Appendix 3G. The site-specific soil structure interaction analyses use the site-specific soil conditions (including variation in soil properties in accordance with Standard Review Plan 3.7.2 and site-specific soil degradation models). The three components of the site-specific ground motion time history must satisfy the regulatory requirements for statistical independence and enveloping of the site design spectra at 5% damping. Floor response spectra determined from the site-specific analyses should be compared against the design basis of the AP1000 described above. These evaluations and comparisons will be provided and reviewed as part of the Combined License application.

If the site-specific spectra at foundation level at a rock site exceed the response spectra in Figures 3I.1-1 and 3I.1-2 at any frequency, a site-specific evaluation can be performed similar to that described in Appendix 3I.

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP2.5-RGS1-05
Revision: 0

Question:

The first paragraph of DCD Section 2.5.2.3 states that if the site-specific spectra at foundation level exceed the response spectra in Figures 3.7.1-1 and 3.7.1-2 at any frequency, or if soil conditions are outside the range evaluated for AP1000 design certification, a site-specific evaluation can be performed. Please provide acceptance criteria (in terms of soil properties) in the DCD to guide the COL applicants regarding how to demonstrate the site-specific soil conditions are within the bound or outside the range.

Westinghouse Response:

In Section 3.7.1.4 of the DCD is provided tables and plots of soil profiles that were used for the design of the nuclear island. The applicant can plot the site soil profile using the appropriate distribution (e.g. parabolic) for the site, and from the comparison plots determine if the soil conditions are outside the range evaluated for AP1000 design certification (Figure 3.7.1-17, Strain-Iterated Shear Wave Velocity Profiles). It is not necessary to provide any more guidance in the DCD.

Table 3.7.1.4 is modified to reflect the strain compatible soil properties used in the SSI analyses and to be consistent with the plots shown in Figure 3.7.1-17 for Strain-Iterated Shear Wave Velocity Profiles.

Design Control Document (DCD) Revision:

Revise Table 3.7.1.4 as shown below.

Table 3.7.1-4 (Sheet 1 of 5)

STRAIN COMPATIBLE SOIL PROPERTIES

Depth to Bottom of Layer (ft)	Thickness of Layer (ft)	Layer Number	Total Unit Weight (kcf)	Initial G (ksf)	Initial Vs (fps)	Final G (ksf)	Final Vs (fps)	Damping
Firm Rock								
0.0	-	-	-	-	-	-	-	-
5.0	5.0	1	0.15	57422	3500	57032	3499	0.015
10.0	5.0	2	0.15	57422	3500	56600	3486	0.016
15.0	5.0	3	0.15	57422	3500	55943	3465	0.017
20.0	5.0	4	0.15	57422	3500	55511	3452	0.018
25.0	5.0	5	0.15	56442	3500	55933	3465	0.016
30.0	5.0	6	0.15	56442	3500	55436	3450	0.017
33.5	3.5	7	0.15	57422	3500	56076	3470	0.015
39.5	6.0	8	0.15	57422	3500	55898	3464	0.015
45.0	5.5	9	0.15	57422	3500	55716	3458	0.016
50.0	5.0	10	0.15	57422	3500	55575	3454	0.016
60.0	10.0	11	0.15	56442	3500	55400	3449	0.017
80.0	20.0	12	0.15	56442	3500	54695	3427	0.019
100.0	20.0	13	0.15	56442	3500	53358	3384	0.021
120.0	20.0	14	0.15	56442	3500	52295	3351	0.023
Bedrock	-	-	0.15	300000	8000	298137	8000	0.02

Table 3.7.1-4 (Sheet 2 of 5)

STRAIN COMPATIBLE SOIL PROPERTIES

Depth to Bottom of Layer (ft)	Thickness of Layer (ft)	Layer Number	Total Unit Weight (kcf)	Initial G (ksf)	Initial Vs (fps)	Final G (ksf)	Final Vs (fps)	Damping
Soft Rock								
0.0								
5.0	5.0	1	0.15	27660	2429	27425	2426	0.016
10.0	5.0	2	0.15	29180	2495	28318	2466	0.018
15.0	5.0	3	0.15	30262	2541	28819	2487	0.020
20.0	5.0	4	0.15	30620	2556	28589	2477	0.023
25.0	5.0	5	0.15	30920	2568	29290	2508	0.019
30.0	5.0	6	0.15	31384	2588	29481	2516	0.021
33.5	3.5	7	0.15	31932	2610	30768	2570	0.017
39.5	6.0	8	0.15	32464	2632	31144	2586	0.018
45.0	5.5	9	0.15	33042	2655	31314	2593	0.019
50.0	5.0	10	0.15	33668	2680	31598	2604	0.020
60.0	10.0	11	0.15	34341	2707	31826	2614	0.021
80.0	20.0	12	0.15	35021	2733	31738	2610	0.024
100.0	20.0	13	0.15	35708	2760	31585	2604	0.026
120.0	20.0	14	0.15	36401	2787	31585	2604	0.028
Bedrock			0.15	300000	8000	298137	8000	0.020

Table 3.7.1-4 (Sheet 3 of 5)

STRAIN COMPATIBLE SOIL PROPERTIES

Depth to Bottom of Layer (ft)	Thickness of Layer (ft)	Layer Number	Total Unit Weight (kcf)	Initial G (ksf)	Initial Vs (fps)	Final G (ksf)	Final Vs (fps)	Damping
Upper Bound Soft to Medium Soil								
0.0	-	-	-	-	-	-	-	-
5.0	5.0	1	0.11	6873	1414	6664	1397	0.018
10.0	5.0	2	0.11	9844	1692	9202	1641	0.023
15.0	5.0	3	0.11	13917	2012	12880	1942	0.024
20.0	5.0	4	0.11	14971	2087	13629	1997	0.027
25.0	5.0	5	0.11	15645	2133	14574	2065	0.022
30.0	5.0	6	0.11	16419	2186	15045	2099	0.024
33.5	3.5	7	0.11	17873	2280	16908	2225	0.019
39.5	6.0	8	0.11	19036	2353	17873	2287	0.020
45.0	5.5	9	0.11	20387	2435	18996	2358	0.021
50.0	5.0	10	0.11	21726	2514	20136	2428	0.021
60.0	10.0	11	0.11	23234	2600	21366	2501	0.022
80.0	20.0	12	0.11	24712	2681	22314	2556	0.024
100.0	20.0	13	0.11	26151	2758	23137	2602	0.026
120.0	20.0	14	0.11	27546	2831	24009	2651	0.027
Bedrock	-	-	0.15	300000	8000	298137	8000	0.020

Table 3.7.1-4 (Sheet 4 of 5)

STRAIN COMPATIBLE SOIL PROPERTIES

Depth to Bottom of Layer (ft)	Thickness of Layer (ft)	Layer Number	Total Unit Weight (kcf)	Initial G (ksf)	Initial Vs (fps)	Final G (ksf)	Final Vs (fps)	Damping
Soft to Medium Soil								
0.0	-	-	-	-	-	-	-	-
5.0	5.0	1	0.11	3438	1000	3222	971	0.023
10.0	5.0	2	0.11	4923	1197	4355	1129	0.031
15.0	5.0	3	0.11	6960	1423	5987	1324	0.035
20.0	5.0	4	0.11	7487	1476	6161	1343	0.040
25.0	5.0	5	0.11	7824	1509	6699	1400	0.031
30.0	5.0	6	0.11	8211	1546	6891	1420	0.033
33.5	3.5	7	0.11	8938	1613	7872	1518	0.026
39.5	6.0	8	0.11	9520	1664	8317	1560	0.027
45.0	5.5	9	0.11	10195	1722	8834	1608	0.028
50.0	5.0	10	0.11	10864	1778	9347	1654	0.029
60.0	10.0	11	0.11	11618	1838	9818	1695	0.031
80.0	20.0	12	0.11	12357	1896	10031	1714	0.036
100.0	20.0	13	0.11	13077	1950	10201	1728	0.040
120.0	20.0	14	0.11	13774	2002	10512	1754	0.043
Bedrock	-	-	0.15	300000	8000	298137	8000	0.020

Table 3.7.1-4 (Sheet 5of 5)

STRAIN COMPATIBLE SOIL PROPERTIES

Depth to Bottom of Layer (ft)	Thickness of Layer (ft)	Layer Number	Total Unit Weight (kcf)	Initial G (ksf)	Initial Vs (fps)	Final G (ksf)	Final Vs (fps)	Damping
Soft Soil								
0.0	-	-	-	-	-	-	-	-
5.0	5.0	1	0.11	3438	1000	3222	971	0.023
10.0	5.0	2	0.11	3633	1028	3042	944	0.038
15.0	5.0	3	0.11	3865	1060	2974	933	0.047
20.0	5.0	4	0.11	3921	1068	2752	898	0.059
25.0	5.0	5	0.11	3955	1073	2922	925	0.049
30.0	5.0	6	0.11	3994	1078	2762	899	0.056
33.5	3.5	7	0.11	4065	1088	3022	941	0.046
39.5	6.0	8	0.11	4121	1095	2958	931	0.049
45.0	5.5	9	0.11	4183	1103	2896	921	0.053
50.0	5.0	10	0.11	4244	1111	2851	914	0.056
60.0	10.0	11	0.11	4310	1120	2774	901	0.062
80.0	20.0	12	0.11	4374	1128	2668	884	0.068
100.0	20.0	13	0.11	4434	1136	2691	888	0.069
120.0	20.0	14	0.11	4492	1143	2718	892	0.069
Bedrock	-	-	0.15	300000	8000	298137	8000	0.020

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP2.5-RGS1-06
Revision: 0

Question:

The second sentence of the second paragraph of DCD Section 2.5.2.3 states that the site-specific soil structure interaction analyses use the site-specific soil conditions (including variation in soil properties in accordance with Standard Review Plan 3.7.2). A phrase, "... and site-specific soil degradation models," needs to be added after the words, "SRP Section 3.7.2."

Westinghouse Response:

Westinghouse will change the DCD as requested. This change is shown in the revision to DCD subsection 2.5.2.3 provided in the response to RAI-SRP 2.5-RGS1-04.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP2.5-RGS1-07
Revision: 0

Question:

In DCD Section 2.5.4.1, you state that excavation for the NI structures below grade may use either a sloping excavation or a vertical face ... Please add a statement, "if sloping excavations are to be used, the COL applicants must evaluate the 3D effects on the site response and site-specific SSI analyses as was done for the Vogtle site.

Westinghouse Response:

Westinghouse will modify DCD Section 2.5.4.1 incorporating the suggested statement. The 3D effects can be evaluated using either or a combination of 2D or 3D SASSI models representing the sloping excavations.

Design Control Document (DCD) Revision:

Revise DCD Section 2.5.4.1 as shown:

> Excavation for the nuclear island structures below grade may use either a sloping excavation or a vertical face as described in subsequent paragraphs. <u>If sloping excavations are to be used on a soil site, the COL applicants must evaluate the 3D effects on the site response and perform site-specific SSI analyses using either or a combination of 2D or 3D SASSI models that reflect the sloping excavations.</u> If backfill is to be placed adjacent to the exterior walls of the nuclear island, the Combined License applicant will provide information on the properties of backfill and its compaction requirements as described in subsection 2.5.4.6.3 and will evaluate its properties against those used in the seismic analyses described in subsection 3.7.2.

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP2.5-RGS1-08
Revision: 0

Question:

The last paragraph of DCD Section 2.5.4.1 states that for excavation in rock and for methods of soil retention other than soil nailing, four to six inches of shotcrete are blown onto the vertical surface. The second sentence states that the shotcrete for the exterior walls is placed against the shotcrete." This statement needs to be corrected. The paragraph further indicates that "the shotcrete contains a crystalline waterproofing material as described in DCD Section 3.4.1.1.1." Please clarify whether the use of precast concrete facing panels to retain the side soil (as proposed by one COL applicant) is intended to be included in the DCD. If so, please modify DCD Section 3.4.1.1.1.

Westinghouse Response:

DCD subsection 2.5.4.1 was substantially revised in the response to RAI-TR85-SEB1-040. The subsection now addresses the option to use Mechanically Stabilized Earth walls with pre-cast concrete facing panels to retain side soil.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP2.5-RGS1-09
Revision: 0

Question:

DCD Section 2.5.4.2 discusses the bearing capacity of soil foundations. In DCD Tier 1 Table 5.0-1 and Tier 2 Table 2.0-1 (Revision 16), you state that the maximum allowable dynamic bearing capacity for normal plus SSE is greater than or equal to 35 kips/ft^2 at the edge of the nuclear island at its excavation depth. The staff's review identified the following concerns:

a. Please explain how this "bearing capacity" was calculated. It is the staff's understanding that "bearing capacity" is highly site specific and can only be developed based on site specific test results. If the specified "bearing capacity" is calculated from seismic analyses, this calculated value should be bearing demand, not bearing capacity.

b. In Revision 15 of DCD Tier 1 Table 5.0-1 and Tier 2 Table 2.0-1, the maximum allowable dynamic bearing capacity (bearing demand) is greater than or equal to 120 kips/ft^2. Please justify how this "dynamic bearing demand" can be reduced from 120 kips/ft^2 for hard rock sites to 35 kips/ft^2 for a spectrum of site conditions (including hard rock sites)?

c. Please specify in the DCD that the ultimate site-specific "bearing capacity" for any sites must exceed the DCD specified "bearing demand" with a suitable "factor of safety" that depends on the combined loading condition used for the standard design. Please provide the acceptable "factor of safety" in the DCD.

Westinghouse Response:

(a) Westinghouse agrees that the term used in DCD Tier 1 Table 5.0-1 and Tier 2 Table 2.0-1 should be bearing demand and not bearing capacity. The change to the DCD is made as requested. Note that the average allowable static soil bearing capacity is changed from 8,600 psf to 8,900 psf to reflect the enhanced shield building design.

(b) This concern is discussed in RAI-TR85-SEB1-03.

(c) It is stated in DCD Section 2.5.4.2 that:

"... The evaluation of the allowable capacity of the soil is based on the properties of the underlying materials (see subsection 2.5.4.5.2), including appropriate laboratory

test data to evaluate strength, and considering local site effects, such as fracture spacing, variability in properties, and evidence of shear zones. The allowable bearing capacity should provide a factor of safety appropriate for the design load combination, including safe shutdown earthquake loads."

As stated in the DCD, as given above, the appropriate factor of safety is very much dependent on local site effects. It is not appropriate for Westinghouse to define what this factor of safety should be. This is a Combined License applicant responsibility to define the appropriate factor of safety for their site. It is stated in DCD Section 2.5.4.2 that "... The Combined License applicant will verify that the site-specific allowable soil bearing capacities for static and dynamic loads at the site will exceed this demand. ..."

Reference(s): None

Design Control Document (DCD) Revision:

Modifications are made to DCD Tier 1 Table 5.0-1 and Tier 2 Table 2.0-1 as shown below.

DCD Tier 1:

Table 5.0-1 (cont.) Site Parameters	
Soil	
Average Allowable Static Soil Bearing Capacity	The allowable bearing capacity, including a factor of safety appropriate for the design load combination, shall be g~~G~~reater than or equal to the average bearing demand of ~~8,600~~ 8,900 lb/ft^2 over the footprint of the nuclear island at its excavation depth
Maximum Allowable Dynamic Bearing Capacity for Normal Plus Safe Shutdown Earthquake (SSE)	The allowable bearing capacity, including a factor of safety appropriate for the design load combination, shall be g~~G~~reater than or equal to the maximum bearing demand of 35,000 lb/ft^2 at the edge of the nuclear island at its excavation depth

DCD Tier 2:

Table 2-1 (Sheet 1 of 3)	
SITE PARAMETERS	
Soil	
Average Allowable Static Bearing Capacity	The allowable bearing capacity, including a factor of safety appropriate for the design load combination, shall be g~~G~~reater than or equal to the average bearing demand of ~~8,600~~ 8,900 lb/ft^2 over the footprint of the nuclear island at its excavation depth
Maximum Allowable Dynamic Bearing Capacity for Normal Plus SSE	The allowable bearing capacity, including a factor of safety appropriate for the design load combination, shall be g~~G~~reater than or equal to the maximum bearing demand of 35,000 lb/ft^2 at the edge of the nuclear island at its excavation depth

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP2.5-RGS1-10
Revision: 0

Question:

In the last sentence of the first paragraph of DCD Section 2.5.4.3, you state that the settlement under the nuclear island footprint is represented in the distribution of subgrade stiffness. Please explain the meaning of this sentence and how can it be applied to the "settlement" evaluation?

Westinghouse Response:

The sentence in question will be removed from the DCD since it does not add to the paragraph.

Design Control Document (DCD) Revision:

Revise the last sentence of the first paragraph of DCD Section 2.5.4.3, Rev. 16 as shown:

The Combined License applicant will address short-term (elastic) and long-term (heave and consolidation) settlement for soil sites for the history of loads imposed on the foundation consistent with the construction sequence. The resulting time-history of settlements includes construction activities such as dewatering, excavation, bearing surface preparation, placement of the basemat, and construction of the superstructure. ~~The settlement under the nuclear island footprint is represented in the distribution of subgrade stiffness~~.

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP2.5-RGS1-11
Revision: 0

Question:

In DCD Tier 1 Table 5.0-1 and Tier 2 Table 2.0-1, You state that the liquefaction potential at the plant site is NONE. You also stated in Revision 16 of DCD Section 2.5.4.4 that the COL applicant will demonstrate that the potential for liquefaction is negligible. Please specify, in the DCD, that the COL applicant must demonstrate that the potential for liquefaction is negligible for both the soil underneath the NI foundation and the soil of the side embedment.

Westinghouse Response:

Westinghouse agrees and will add the requested words in Section 2.5.4.4 of the DCD.

Design Control Document (DCD) Revision:
Revise DCD Subsection 2.5.4.4 as follows:

2.5.4.4 Liquefaction

The Combined License applicant will demonstrate (for soil sites) that the potential for liquefaction is negligible for both the soil underneath the Nuclear Island foundation and the soil of the side embedment engaged in passive resistance adjacent to the Nuclear Island.

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP2.5-RGS1-12
Revision: 0

Question:

The last paragraph of Section 2.5.4.5 indicates that existing nuclear sites can only be described as "uniform" sites. Since the AP1000 is intended to be designed for locations at other general sites, the purpose of this paragraph is unclear. Please clarify the purpose of this statement.

Westinghouse Response:

The last paragraph of Section 2.5.4.5 of the DCD will be removed since it no longer applies.

Design Control Document (DCD) Revision:

Delete the last paragraph in Section 2.5.4.5.

~~A survey of 22 commercial nuclear power plant sites in the United States focused on site parameters that affect the seismic response such as the depth to bedrock, the type and characteristic of the soil layers, including the variation of shear wave velocities, the depth to the ground water level, and the embedment depth of the plant structures. Of the 22 sites, 11 are rock sites where competent rock exists at relatively shallow depths. At the other sites, the depth to bedrock varies from about 50 feet (Callaway) to well in excess of 4,000 feet (South Texas). A review of these 11 soil sites – all of which are marine, deltaic, or lacustrine deposits – did not reveal any significant variation of soil characteristics below the nuclear island footprint. There was one possible nonuniform site, Monticello, which is underlain by glacial deposits; the geologic description is such that there might be lateral variability in the foundation parameters within the plan dimension of the plant. The review of the 22 commercial nuclear power plant sites in the United States suggests that the majority of AP1000 sites exhibit "uniform" soil properties within the nuclear island footprint.~~

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP2.5-RGS1-13
Revision: 0

Question:

The site investigation criteria shown in Sections 2.5.4.5.1 and 2.5.4.5.2 only address the issues of potential settlements due to static loads and do not consider criteria needed to evaluate site response and dynamic SSI issues. Please expand the site investigation criteria for both uniform and nonuniform conditions to cover the evaluation of site response and dynamic SSI issues.

Westinghouse Response:

The site investigation criteria shown in Sections 2.5.4.5.1 and 2.5.4.5.2 is removed since it should not be part of the AP1000 DCD. This information, including static and dynamic SSI issues, is to be part of the Combined License applicant submittal as described in DCD Section 2.5.4.6.

Design Control Document (DCD) Revision:
Revise Sections 2.5.4.5.1 and 2.5.4.2 as follows:

2.5.4.5.1 (Deleted)
2.5.4.5.2 (Deleted)

~~**2.5.4.5.1Site Investigation for Uniform Sites**~~

~~For sites that are expected to be uniform, based on the geologic investigation outlined in subsections 2.5.1 and 2.5.4.6.2, Appendix C to Regulatory Guide 1.132 provides guidance on the spacing and depth of borings of the geotechnical investigation for safety-related structures. Specific language in the Regulatory Guide suggests a spacing of 100 feet supplemented with borings on the periphery and at the corners for favorable, uniform geologic conditions.~~
~~For foundation engineering purposes, a series of primary borings should be drilled on a grid pattern that encompasses the nuclear island footprint and 40 feet beyond the boundaries of the nuclear island footprint. The 40-foot extension for the grid of borings is established from a Boussinesq analysis of the zone of influence of the foundation mat which shows that the net change in the effective vertical overburden stress is less than 7 percent at a distance of 40 feet from the edge of the foundation mat. The grid need not be of equal spacing in the two orthogonal directions, but it should be oriented in accordance with the true dip and strike of the rock in the immediate area of the nuclear island footprint. If geologic conditions are such that true dip and strike are not obvious, or if the dip is practically flat, then the orientation of the grid can be consistent with the major orthogonal lines of the nuclear island. The depth of borings should be determined on the basis of the geologic conditions. Borings should be extended to a depth sufficient to define the site geology and to sample materials that may swell during excavation, may consolidate subsequent to construction, may be unstable under earthquake loading, or whose physical properties would affect foundation behavior or stability. At least one-fourth of the primary~~

~~borings should penetrate sound rock or, for a deep soil site, to a maximum depth of 250 feet below the foundation mat. At this depth of 250 feet, the change in the vertical stress during or after construction for the combined foundation loading is less than 10 percent of the in-situ effective overburden stress. Other primary borings may terminate at a depth of 160 feet below the foundation (equal to the width of the structure).~~

~~2.5.4.5.2Site Investigation for Non-uniform Sites~~

~~At sites that are determined to be non-uniform or potentially non-uniform during the course of the geological investigations outlined in subsections 2.5.1 and 2.5.4.6.2, the investigation effort is extended to determine if the site is acceptable for an AP1000.~~

~~As the AP1000 foundation/structural system is robust, the probability of being able to show compliance for all but the worst of sites is high, unless liquefaction or faulting is prevalent on the site. As stated in Regulatory Guide 1.132, where variable conditions are found, spacing of boreholes should be smaller, as needed, to obtain a clear picture of soil or rock properties and their variability. Where cavities or other discontinuities of engineering significance may occur, the normal exploratory work should be supplemented by secondary borings or soundings at a spacing small enough to detect such features. The depth of the secondary borings is 160 feet below the foundation mat. At this depth, the maximum change in vertical stress during or after construction is about 11 percent of the in-situ effective overburden stress. The depth of borings should be extended beyond 160 feet if the geologic investigation indicates the possible presence of karst conditions, under-consolidated clays, loose sands, intrusive dikes, or other forms of geologic impacts at depth greater than 160 feet.~~

Revise paragraph near the end of subsection 2.5.4.5.3 as follows (note that this section was revised from DCD Rev 16 in Technical Report 134 (APP-GW-GLR-134):

Subsurface conditions should be evaluated based on the geologic investigation ~~outlined in subsections 2.5.1 and 2.5.4.5.2~~in accordance with Appendix C to Regulatory Guide 1.132. Subsurface conditions may be considered uniform if the geologic and stratigraphic features at depths less than 120 feet below grade can be correlated from one boring or sounding location to the next with relatively smooth variations in thicknesses or properties of the geologic units. An occasional anomaly or a limited number of unexpected lateral variations may occur. If a site can be classified as uniform, it qualifies for the AP1000 based on analyses and evaluations performed to support design certification without additional site-specific analyses.

PRA Revision:
None

Technical Report (TR) Revision:
None