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Your ref: Project Number 740
Our ref: DCP/NRC1999

September 18, 2007

Subject: AP1000 COL Response to Requests for Additional Information (TR 85)

In support of Combined License application pre-application activities, Westinghouse is submitting responses to the NRC requests for additional information (RAIs) on AP1000 Standard Combined License Technical Report 85, APP-GW-GLR-044, Nuclear Island Basemat and Foundation. These RAI responses are submitted as part of the NuStart Bellefonte COL Project (NRC Project Number 740). The information included in the responses is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification.

Responses are provided for RAI-TR85-SEB1-03, RAI-TR85-SEB1-13, RAI-TR85-SEB1-27, and RAI-TR85-SEB1-38, transmitted in an email from Dave Jaffe to Sam Adams dated August 9, 2007 These are the first four responses of thirty-nine total requests received to date for Technical Report 85.

Pursuant to 10 CFR 50.30(b), the responses to the requests for additional information on Technical Report 85, are submitted as Enclosure 1 under the attached Oath of Affirmation.

Questions or requests for additional information related to the content and preparation of these responses 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,

D. A. Lindgren /FOR

A. Sterdis, Manager
Licensing and Customer Interface
Regulatory Affairs and Standardization

D079
D063

NRO

/Attachment

1. "Oath of Affirmation," dated September 18, 2007

/Enclosure

1. Responses to Requests for Additional Information on Technical Report No. 85

cc:	D. Jaffe	-	U.S. NRC	1E	1A
	E. McKenna	-	U.S. NRC	1E	1A
	G. Curtis	-	TVA	1E	1A
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	C. Ionescu	-	Progress Energy	1E	1A
	A. Monroe	-	SCANA	1E	1A
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	C. Pierce	-	Southern Company	1E	1A
	E. Schmiech	-	Westinghouse	1E	1A
	G. Zinke	-	NuStart/Entergy	1E	1A
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ATTACHMENT 1

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the Matter of:	)
NuStart Bellefonte COL Project	)
NRC Project Number 740	)

APPLICATION FOR REVIEW OF
"AP1000 GENERAL COMBINED LICENSE INFORMATION"
FOR COL APPLICATION PRE-APPLICATION REVIEW

W. E. Cummins, being duly sworn, states that he is Vice President, Regulatory Affairs & Standardization, for Westinghouse Electric Company; that he is authorized on the part of said company to sign and file with the Nuclear Regulatory Commission this document; that all statements made and matters set forth therein are true and correct to the best of his knowledge, information and belief.

W. E. Cummins
Vice President
Regulatory Affairs & Standardization

Subscribed and sworn to
before me this 18th day
of September 2007.

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Patricia S. Aston, Notary Public
Murrysville Boro, Westmoreland County
My Commission Expires July 11, 2011
Member, Pennsylvania Association of Notaries

Notary Public

ENCLOSURE 1

Responses to Requests for Additional Information on Technical Report No. 85

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR85-SEB1-03
Revision: 0

Question:

In Section 2.3.1, the fourth paragraph (Page 9 of 83) states that, for the AP1000 certified design for hard rock sites, the value of 120,000 pound per square foot was based on the maximum bearing reaction from the (3D FEM) equivalent static nonlinear NI basemat analyses described in Subsection 3.8.5. Provide an explanation for the following:

a. How were the equivalent static nonlinear analyses performed? Were the static forces increased incrementally in an iterative static analysis which released any springs in tension? The description of the analysis method should be described in the technical report and the DCD.

b. Is the same type of analysis performed for the 3D ANSYS equivalent static nonlinear analysis described in Section 2.6.1 of the Technical Report for soil sites?

Explain why the maximum dynamic bearing pressure due to the seismic load reduced from 120,000 psf for the hard rock case in the previous AP1000 certified design to 35,000 psf for the envelope of all rock and soil cases in the current analysis and design?

Westinghouse Response:

a. As described in the DCD, the non-linear static analyses were performed using the ANSYS computer code. ANSYS employs the "Newton-Raphson" approach to solve nonlinear problems. ANSYS iterates the analysis until the solution converges.

b. The 3D ANSYS equivalent static nonlinear analysis described in Section 2.6.1 of the Technical Report for soil sites is the same type of analysis as that performed for the hard rock site. The soil springs corresponded to a soil profile rather than to hard rock. There were minor differences to the building models as described and reviewed in Technical Report 03 (Reference 1). The equivalent static accelerations applied in the latest analyses were the envelope of hard rock and soil cases from the nuclear island analyses using shell models. The equivalent static accelerations applied in the hard rock analyses were from the nuclear island analyses using stick models as documented in DCD Rev 15.

The maximum dynamic bearing pressure due to the seismic load reduced from 120,000 psf for the hard rock case in the previous AP1000 certified design to 35,000 psf for the envelope of all rock and soil cases in the current analysis and design due to the use of results from additional non-linear dynamic analyses instead of the more conservative equivalent static analyses. The differences between the maximum dynamic bearing pressure due to the seismic load in the

previous AP1000 hard rock certified design and the envelope of all rock and soil cases in the current analysis and design is addressed in Section 2.4.3 which states:

> The AP1000 DCD for hard rock added a requirement of 120,000 lb/ft^2 for dynamic loads. This was based conservatively on the maximum bearing reaction from the equivalent static non-linear nuclear island basemat analyses described in section 2.3. This maximum bearing reaction occurs below the west edge of the thick concrete basemat below the shield building. This value was included in DCD Table 2-1 since it was expected that a hard rock site would be capable of satisfying this bearing demand. The dynamic non-linear analyses described in section 2.4.2 show much lower bearing reactions (27.8 ksf for hard rock) than those from the equivalent static design analyses for the basemat. The 2D ANSYS non-linear analyses show that the soft-to-medium soil case gives higher bearing pressures (34.5 ksf) than the hard rock case. This establishes the soil bearing interface of 35,000 lb/ft^2. The bearing pressures from the ANSYS analyses are conservative because the effect of the side soil is conservatively neglected.

References:

1. APP-GW-S2R-010, Revision 1, Extension of Nuclear Island Seismic Analyses to Soil Sites, September, 2007.

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-TR85-SEB1-13
Revision: 0

Question:
In Section 2.4.1, the fifth paragraph (Page 11 of 83) states that from review of the member forces in Table 2.4-1, the bearing reactions in Table 2.4-2 and the maximum bearing pressures in Figure 2.4-2, the soft-to-medium soil case is selected as the basis for the bearing demand. However, according to Tables 2.4-1 and 2.4-2, the upper bound of soft-to-medium soil case generally results in the highest member forces in the ASB and the reactions at the center line of containment, not the soft-to-medium soil case. Also, for certain loads (e.g., M_{xx} and M_{yy}), the soft rock and the firm rock are the controlling cases. Therefore provide the technical justification why the other soil cases were not considered.

Westinghouse Response:
In Section 2.4.1, the fifth paragraph (Page 11 of 83) describes the basis for selection of the soft-to-medium soil profile for the non-linear analyses of bearing using the 2D model. The 2D east west model is chosen for these analyses since the footprint is significantly shorter in this direction than in the north-south direction. For the east-west direction the ASB member force results are those in the right hand columns of Table 2.4-1 (F_Y , M_X). Bearing pressures are controlled by the overturning moment. Table 2.4-1 shows a moment of 7985 for the upper bound case and 7983 for the soft-to-medium case. Table 2.4-2 extrapolates these values to the underside of the foundation and shows a moment of 12,783 for the upper bound case and 12,509 for the soft-to-medium case. This extrapolation is conservative since the horizontal loads on the portion below grade are added absolutely to the sum of the member forces above grade. Figure 2.4-2 provides bearing pressures from SASSI dynamic analyses. This shows that the soft to medium case gives the largest bearing pressures.

Other soil cases give slightly higher overturning moments in the north-south direction. However, the bearing pressures are lower due to the much larger footprint in the north-south direction. In addition the location of maximum bearing pressure in the east-west model is below the west side of the shield building. This location is close to the center of the footprint in the north-south direction so the north-south earthquake has only a small contribution at this location. Thus, the other soil cases were not evaluated in the 2D non-linear ANSYS analyses.

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-TR85-SEB1-27
Revision: 0

Question:

Section 2.6.1.4 discusses liftoff analyses performed for 16 load cases of dead, live, and seismic loads. The results of the analyses are used for the basemat design. Explain what the 16 load cases correspond to and why weren't all possible load combinations utilized in accordance with the 100/40/40 rule.

Westinghouse Response:

The following 16 cases for the 1.0, 0.4, 0.4 method were used. Non-linear analyses were not performed for the cases with 1.0 applied in the vertical direction since the maximum bearing demand is due to overturning rather than vertical seismic.

Load Case 3-# = D+L+Es where Es takes the following forms for each #.

#=1:	Es= 1.0xSns	+0.4xSew	+0.4xSvt
#=2:	Es= 1.0xSns	+0.4xSew	-0.4xSvt
#=3:	Es= 1.0xSns	-0.4xSew	+0.4xSvt
#=4:	Es= 1.0xSns	-0.4xSew	-0.4xSvt
#=5:	Es= -1.0xSns	+0.4xSew	+0.4xSvt
#=6:	Es= -1.0xSns	+0.4xSew	-0.4xSvt
#=7:	Es= -1.0xSns	-0.4xSew	+0.4xSvt
#=8:	Es= -1.0xSns	-0.4xSew	-0.4xSvt
#=9:	Es= 0.4xSns	+1.0xSew	+0.4xSvt
#=10:	Es= 0.4xSns	+1.0xSew	-0.4xSvt
#=11	Es= 0.4xSns	-1.0xSew	+0.4xSvt
#=12	Es= 0.4xSns	-1.0xSew	-0.4xSvt
#=13:	Es= -0.4xSns	+1.0xSew	+0.4xSvt
#=14:	Es= -0.4xSns	+1.0xSew	-0.4xSvt
#=15:	Es= -0.4xSns	-1.0xSew	+0.4xSvt
#=16:	Es= -0.4xSns	-1.0xSew	-0.4xSvt

where,

Sns element forces due to SSE acceleration in X (NS)
Sew element forces due to SSE acceleration in Y (EW)
Svt element forces due to SSE acceleration in Z (VT)

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:

Revise section 2.6.1.4 as follows:

2.6.1.4 Normal plus seismic reactions

Liftoff analyses were performed for 16 load cases of dead, live and seismic loads for the soil site with subgrade modulus of 520 kcf. Seismic loads are applied with unit factor in one direction and with 0.4 factor in the other two directions. The 16 cases were those having the unit factor applied in the horizontal direction in order to maximize the overturning. Cases with unit factor in the vertical direction do not control. Maximum bearing reactions at the corners of the auxiliary building and at the west side of the shield building are shown in Table 2.6-3. Bearing pressure contours are shown in Figures 2.6-4 to 2.6-8 for the five load cases resulting in these maximum bearing reactions. The seismic load combination is shown for each figure. Note that the bearing pressures reduce rapidly away from the corners. These figures show lift off for equivalent static loads which are higher than the maximum time history loads as discussed in section 2.4.2. This is particularly the case for load combinations with unit seismic load in the Y direction (East-West) where the footprint dimension is smaller. The results of the equivalent static analyses are used for basemat design. The maximum bearing capacity reactions for defining minimum dynamic soil bearing capacity are based on time history analyses as discussed in Section 2.4.2.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR85-SEB1-38
Revision: 0

Question:

In Section 5.1, entitled "Proposed Revisions to DCD Section 2.5," the DCD mark up of Section 2.5.4.5.3.1 identifies the use of a rigid basemat evaluation method and a flexible basemat evaluation method to evaluate sites that do not satisfy the site soil parameters directly. It is not evident that following these methods would ensure the design adequacy of the foundation. Provide an explanation for the following items:

a. Section 2.5.4.5.3.1, second paragraph, states that "As described in subsection 3.8.5 the nuclear island foundation is designed specifically for bearing pressures of 120 percent of those of the uniform soil properties case." This does not appear to be consistent with the description in Section 3.8.5 of the DCD, which indicates that "Additional reinforcement is provided in the design of the 6' mat for soil sites such that the basemat can resist loads 20 percent greater than the demand calculated by the equivalent static acceleration analyses on uniform soil springs. This increase accommodates potential site specific lateral variability of the soil investigated separately in a series of paramedic studies." The apparent inconsistency arises because the basemat was not designed specifically for bearing pressures that are 20 percent higher. Instead a nonlinear 3D ANSYS analysis was performed as the base case for design and the loads for the basemat design came from this nonlinear (uplift) analysis, not from 120 percent increase of bearing pressures. With uplift occurring over a significant portion of the basemat, making this a nonlinear analysis, provide the technical justification for the criteria presented in Section 2.5.4.5.3.1.

b. Section 2.5.4.5.3.1, first paragraph, last sentence refers to "non-uniform soil conditions that may also require evaluation of the AP1000 seismic response as described in subsection 2.5.2.2." That subsection does not describe the evaluation of the AP1000 seismic response. Clarify what was meant.

Westinghouse Response:

a. The basemat was designed specifically for bearing pressures that are 20 percent higher than the results from the non-linear analyses. This increase is based on the AP600 precedent. The required reinforcement calculated for axial-flexure forces was increased by 20%. For out-of-plane shear, where the design shear strength is dependent on the concrete strength as well as the reinforcement strength, the member force from the non-linear analyses was increased by 20% for sizing of the shear reinforcement.

b. The reference should be to DCD subsection 2.5.2.3 instead of 2.5.2.2.

Design Control Document (DCD) Revision:

Revise DCD, Rev 16 Section 2.5.4.5.3.1, first paragraph, as follows

Many sites that do not meet the above criteria for a uniform site are acceptable for the AP1000. The key attribute for acceptability of the site for an AP1000 is the bearing pressure on the underside of the basemat. A site having local soft or hard spots within a layer or layers does not meet the criteria for a uniform site. Non-uniform soil conditions may also require evaluation of the AP1000 seismic response as described in subsection 2.5.2.~~2~~3.

PRA Revision:

None

Technical Report (TR) Revision:

Revise Section, DCD mark up, Section 2.5.4.5.3.1, first paragraph, as follows:

Many sites that do not meet the above criteria for a uniform site are acceptable for the AP1000. The key attribute for acceptability of the site for an AP1000 is the bearing pressure on the underside of the basemat. A site having local soft or hard spots within a layer or layers does not meet the criteria for a uniform site. Non-uniform soil conditions may also require evaluation of the AP1000 seismic response as described in subsection 2.5.2.~~2~~3.