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Your ref: Docket No. 52-006
Our ref: DCP/NRC1588

May 13, 2003

SUBJECT: Transmittal of Westinghouse Responses to US NRC Requests for Additional Information on the AP1000 Application for Design Certification

This letter transmits the Westinghouse responses to NRC Requests for Additional Information (RAI) regarding our application for Design Certification of the AP1000 Standard Plant. A list of the RAI responses that are transmitted with this letter is provided in Attachment 1. Attachment 2 provides the RAI responses.

Please contact me if you have questions regarding this submittal.

Very truly yours,

M. M. Corletti

M. M. Corletti
Passive Plant Projects & Development
AP600 & AP1000 Projects

/Attachments

1. Table 1, "List of Westinghouse's Responses to RAIs Transmitted in DCP/NRC1588"

2. Westinghouse Non-Proprietary Response to US Nuclear Regulatory Commission Requests for Additional Information dated May 2003

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D063

DCP/NRC1588

May 13, 2003

Attachment 1

"List of Westinghouse's Responses to RAIs Transmitted in DCP/NRC1588"

Attachment 1

Table 1 **"List of Westinghouse's Responses to RAIs Transmitted in DCP/NRC1588"**
230.018, Rev. 3 230.020, Rev. 0 230.023, Rev. 0 260.006, Rev. 0 260.007. Rev. 0 260.008, Rev. 0 261.016, Rev. 0 261.017, Rev. 0

DCP/NRC1588

May 13, 2003

Attachment 2

Westinghouse Non-Proprietary Response to US Nuclear Regulatory Commission
Requests for Additional Information dated May 2003

AP1000 DESIGN CERTIFICATION REVIEW

Response to Request For Additional Information

RAI Number: 230.018 (Response Revision 3)

Question:

It is the staff's understanding that the layouts of the coupled shield and auxiliary buildings for AP1000 and AP600 are the same and only the height of the shield building and the size of the passive containment cooling water storage tank were increased. As a result of these design changes, the dominating frequency (6.065 hz) of the AP1000 in the vertical direction is lower than that of the AP600 (6.77 hz). From Figure 3.7.1-2, "Vertical Design Response Spectra - Safe Shutdown Earthquake," one can find that the vertical responses (accelerations) of the coupled shield and auxiliary buildings for the AP1000 should be higher than those of the AP600. However, the comparison of the two designs summarized in Table 3.7.2-5 and Figure 3.7.2-4 shows an opposite conclusion. The staff's review identified the following areas for clarification:

A. Westinghouse used a detailed model between Elevation 306'-3" (the top of the tank roof) and Elevation 241'-0" (the bottom of the air vent columns) for AP600, while it used a less detailed model for AP1000. Please provide an explanation for the change in models and reason for using the less detailed model for the AP1000.

B. As summarized in Table 3.7.2-5 of DCD, Revision 0, the comparison of the vertical seismic responses (maximum absolute nodal accelerations) of the two designs indicates that the dynamic amplification in the vertical direction is higher for the AP600 than for the AP1000. Based on our engineering judgement, it is the staff's expectation that the results should be reversed, because there is no change to the building wall thickness for both designs and the shield building complex of the AP1000 is more massive than that of the AP600. Westinghouse is requested to provide an explanation to address the staff's observation.

The staff's observation regarding the dynamic amplification discussed in (a) and (b) above are also applicable for the steel containment vessel.

Westinghouse Response (Revision 1):

A. The AP1000 shield building roof is represented in the stick model by masses at the top of the roof and at the elevation of the intersection of the exterior wall of the PCS tank with the conical roof. The AP600 model also had a mass at the mid height of the tank. The roof response is primarily influenced by the conical roof and the additional mass at mid height of the tank was not necessary. Both the AP600 and AP1000 models were developed to match the dynamic properties of a detailed axi-symmetric model of the roof.

B. The maximum vertical absolute acceleration of the roof is 0.90g for the AP600 and 0.89g for the AP1000. In the most recent AP1000 analyses in the proposed revision to the DCD Section 3.7 transmitted by letter number DCP/NRC1526, the frequency is 5.81 hertz and the maximum acceleration is 0.96g. These differences in response are partly due to changes in modal properties but are also affected by the time history which envelopes the ground input spectrum of Figure 3.7.1-2 as shown in Figure 3.7.1-8.

The maximum vertical absolute acceleration of the steel containment vessel is 1.49g for the AP600 and 1.40g for the AP1000. In the most recent AP1000 analyses in the proposed revision to DCD Section 3.7 transmitted by letter DCP/NRC1526, the maximum acceleration is 1.13g. The reduction in vertical response is associated with better definition of the AP1000 polar crane and the use of a multi-mass model of the polar crane instead of the single mass used in the AP600 analyses and the initial AP1000 analyses. The description of the polar crane model is included in the proposed revision to the DCD. Table 3.7.2-2 in the proposed revision to DCD Section 3.7 transmitted by letter DCP/NRC1526 shows the modal properties of the containment vessel. A second sheet will be added to this table showing the modal properties of the containment vessel combined with the polar crane. The first frequency of the combined model in the vertical direction is 6.415 Hertz compared to 5.843 Hertz in the previous analyses.

Design Control Document (DCD) Revision: *these changes are included in Revision 3*

Revise fourth paragraph of subsection 3.7.2.3.2

The polar crane is supported on a ring girder which is an integral part of the steel containment vessel at elevation 228'-0" **as shown in Figure 3.8.2-1**. It is modelled as a ~~single~~ **multi**-degree of freedom system attached to the steel containment shell **at elevation 224' (mid point of ring girder)** as shown in Figure 3.7.2-5. **The polar crane is modeled as shown in Figure 3.7.2-8 with five masses at the mid height of the bridge at elevation 233'-6" and one mass for the trolley.** The polar crane model includes the flexibility of the crane bridge girders and truck assembly, and the containment shell's local flexibility. **When fixed at the center of containment, the model shows fundamental frequencies of 3.7 hertz transverse to the bridge, 6.4 hertz vertically, and 8.5 hertz along the bridge.**

Add sheet 2 to Table 3.7.2-2 showing modal properties of steel containment vessel combined with polar crane

Revise Figure 3.7.2-5 as shown in the proposed revision to DCD Section 3.7 transmitted by letter number DCP/NRC1526.

Add Figure 3.7.2-8 as shown on page 230.018 (R1) -5

PRA Revision: None

Table 3.7.2-2 (Sheet 1 of 2)

STEEL CONTAINMENT
VESSEL LUMPED-MASS STICK MODEL (WITHOUT POLAR CRANE)
MODAL PROPERTIES

		Effective Mass		
Mode	Frequency	X Direction	Y Direction	Z Direction
1	6.309	2.380	159.153	0.005
2	6.311	159.290	2.382	0.000
3	12.942	0.018	0.000	0.000
4	16.970	0.000	0.006	171.030
5	18.960	0.102	40.263	0.002
6	18.970	40.161	0.102	0.000
7	28.201	0.000	0.000	28.073
8	31.898	0.054	2.636	0.000
9	31.999	2.789	0.057	0.000
10	37.990	0.909	0.007	0.000
11	38.634	0.022	4.846	0.009
12	38.877	3.758	0.014	0.000
13	47.387	0.000	0.000	5.066
14	54.039	4.649	0.633	0.000
15	54.065	0.624	4.693	0.002
16	60.628	0.002	0.042	3.389
17	62.734	0.147	0.001	0.018
18	63.180	0.000	0.050	7.069
19	63.613	0.002	0.001	0.003
20	65.994	0.022	0.659	0.041
Sum of Effective Masses		214.929	215.545	214.706

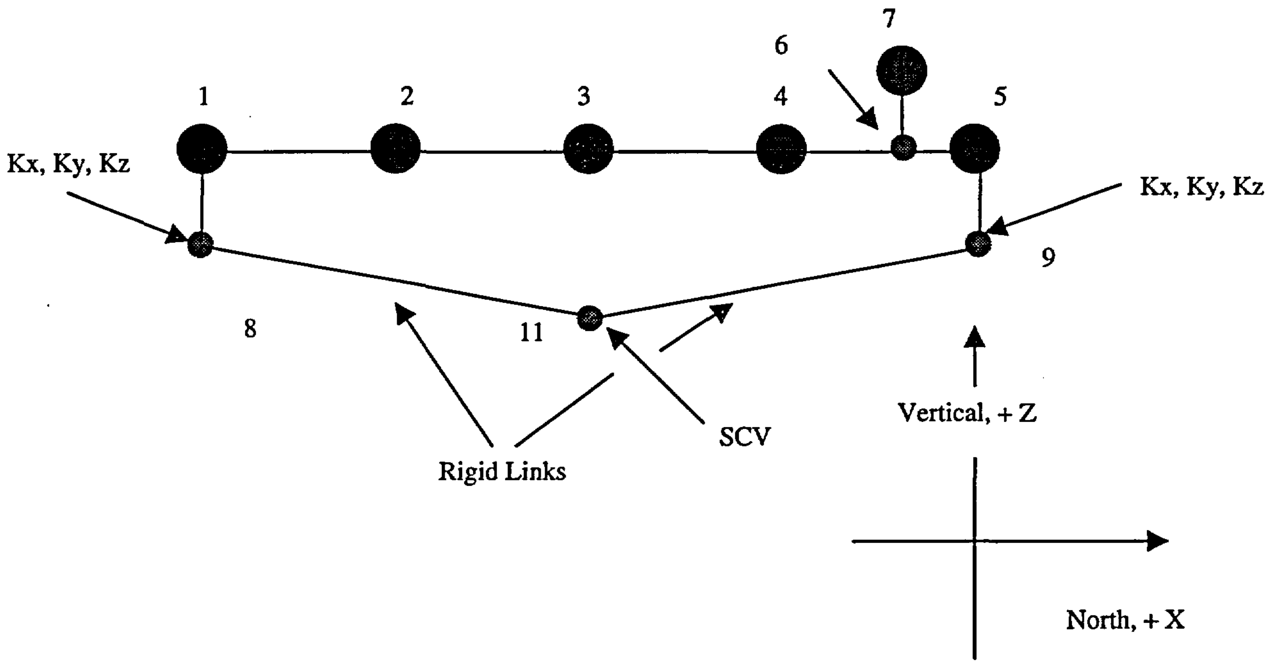
Note:
1. Fixed at Elevation 100'.
2. The total mass of the containment vessel is 225.697 kip-sec^2/ft.

Table 3.7.2-2 (Sheet 2 of 2)

STEEL CONTAINMENT
VESSEL LUMPED-MASS STICK MODEL (WITH POLAR CRANE)
MODAL PROPERTIES

Mode	Frequency	Effective Mass X Direction	Effective Mass Y Direction	Effective Mass Z Direction
1	3.619	0.000	41.959	0.000
2	5.387	175.274	0.000	0.175
3	6.192	0.000	148.385	0.005
4	6.415	3.321	0.000	24.074
5	9.422	0.002	1.017	0.000
6	9.674	10.510	0.000	0.532
7	12.811	0.015	0.001	0.000
8	15.757	0.004	0.320	0.010
9	16.367	3.103	0.003	159.153
10	17.495	28.537	0.001	19.546
11	18.944	0.000	40.053	0.001
12	21.043	10.724	0.000	0.426
13	22.102	0.000	0.005	0.000
14	27.340	0.054	0.000	18.661
15	30.387	2.978	0.001	1.559
16	31.577	0.002	3.526	0.004
17	35.033	0.194	0.006	3.895
18	35.535	0.211	0.027	0.399
19	35.646	0.000	1.451	0.019
20	37.599	0.325	0.426	0.007
Sum of Effective Masses		235.254	237.181	228.465

Note:
1. Fixed at Elevation 100′.
2. The total mass of the containment vessel with the polar crane is 255.85 kip-sec^2/ft.



Local SCV Stiffness are Kx, Ky, Kz

Dynamic Degrees of Freedom

- Masses at nodes 1, 2, 3, 4, 5, and 7
- All Mass nodes have DOFs in X, Y, and Z directions

Comments:

1. Cross Beams between girders are represented by rotation spring constants Kxx and Kzz
2. Cross Beam rotational spring constant Kyy is negligible compared to girder stiffness

Figure 3.7.2-8

Polar Crane Model

Extract from NRC Notes on meeting November 12-16

The staff also requested a similar clarification for the vertical dynamic amplification for the steel containment vessel. In its response, Westinghouse indicated that the vertical acceleration response of the steel containment vessel, 1.49g for AP600 and 1.40g for the AP1000 and the comparison is similar to that for the vertical response of the shield building roof. However, in the most recent AP1000 analyses in the proposed revision to DCD Section 3.7, the maximum vertical acceleration response is significantly reduced to 1.13g. Westinghouse attributed such reduction in the vertical response to the use of a multi-mass model for the polar crane instead of the single-mass model used in both the AP600 and the initial AP1000 analyses. To incorporate the change from the single-mass to multi-mass model of the polar crane, Westinghouse proposed the following revisions to the AP1000 DCD:

- Revise the fourth paragraph in Subsection 3.7.2.3.2 to describe the multi-mass polar crane model
- Add new Figure 3.7.2-8 to show the polar crane model
- Revise Figure 3.7.2-5 to reference Figure 3.7.2-8 for the polar crane model

The proposed DCD revisions sufficiently described the multi-mass polar crane model, but did not provide a sufficient basis for the significantly reduced vertical acceleration of 1.13g for the steel containment vessel. Westinghouse agreed to provide additional justification regarding the reduction of the vertical acceleration by using the new polar crane model.

Westinghouse Response (Revision 2):

In revision 1 to this response Westinghouse included Table 3.7.2-2 (sheet 2) in the DCD showing modal properties of the steel containment vessel combined with the polar crane.

Table 230.18-1 shows the significant modes from these tables contributing to the vertical response as well as the corresponding data for the containment vessel with a one mass model of the polar crane used in the previous AP1000 analyses documented in DCD Rev 1. The table includes results for a concentric stick model of the nuclear island, which includes a one mass model of the polar crane with the same local shell flexibility as that in the multi mass model. The table also shows the maximum vertical acceleration of the containment vessel at the top of the dome and at the crane girder from analyses of the combined nuclear island stick models. The single mass polar crane models show larger vertical accelerations than the multi mass model. The polar crane multi mass model introduces a mode (at 17.495 Hz) with coupling between the vertical and horizontal responses. The shape of this mode is shown in Figure 230.18-1. It is a rotational mode of the polar crane and containment vessel with coupling between the horizontal and vertical directions. This additional mode accounts for the reduction in vertical response.

Table 230.18-1
Significant Modes for Vertical Response

	SCV only DCD Rev 3		**SCV + 5 mass PC DCD Rev 3**		**SCV + 1 mass PC DCD Rev 1**		**SCV + 1 mass PC Concentric**	
Description	Freq	Mass (Z)	Freq	Mass (Z)	Freq	Mass (Z)	Freq	Mass (Z)
Polar crane vertical mode			6.415	24.07	5.84	29.92	6.37	23.31
SCV fundamental vertical mode	16.97	171.03	16.37	159.15	16.84	168.34	16.58	180.80
Polar crane second vertical mode with SCV rotation			17.50	28.54(X) 19.55(Z)				
SCV second vertical mode	28.20	28.07	27.34	18.66	28.36	26.93	27.75	24.26
Maximum vertical acceleration (g)								
At top of dome				1.13		1.40		1.44
At crane girder				0.56		0.74		0.76

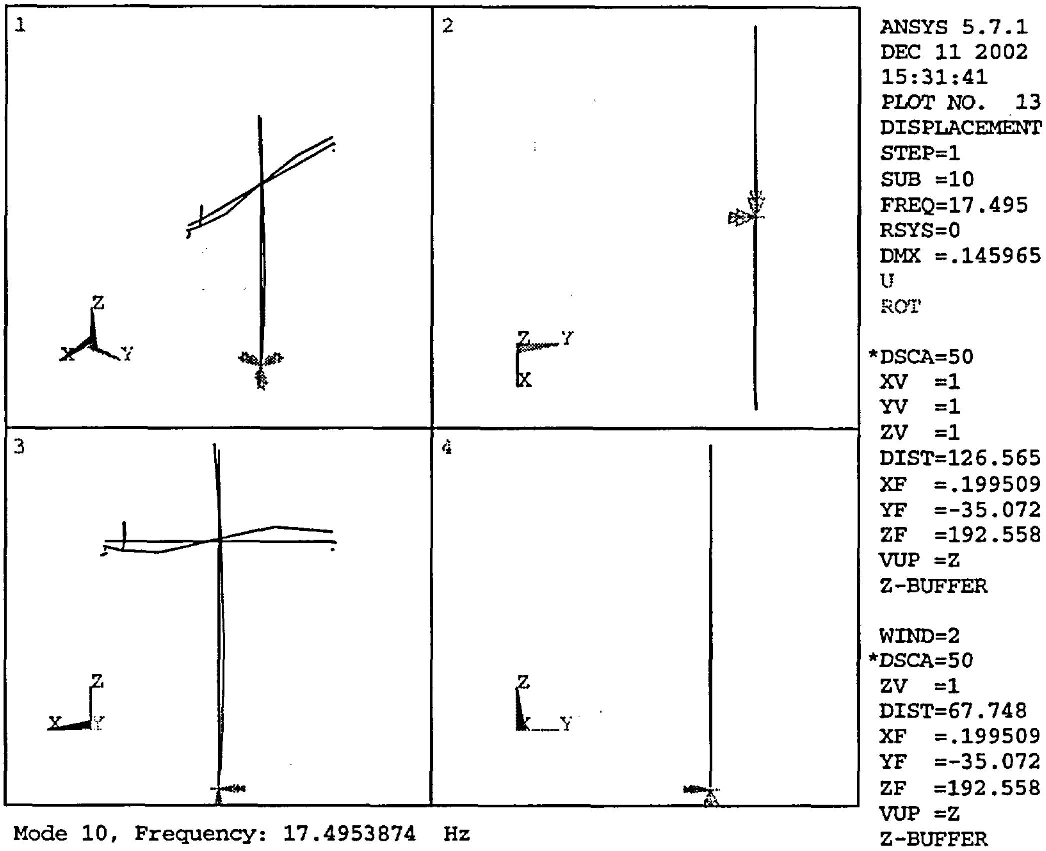


Figure 230.018-1

Westinghouse Response (Revision 3):

In revision 1 to this response Westinghouse included Table 3.7.2-2 (sheet 2) in the DCD showing modal properties of the steel containment vessel combined with the polar crane.

In revision 2 to this response Westinghouse included Table 230.18-1 and Figure 230.18-1 showing the additional rotational mode of the multi mass polar crane and containment.

Additional time history analyses have been performed to investigate the reduction of the vertical acceleration by using the multi-mass polar crane model. Figures 230.018-2 and 230.018-3 show a comparison of floor response spectra on the containment vessel at the polar crane and top elevation for the following two models:

- Steel Containment Vessel stick fixed at elevation 100' (i.e. not coupled to the rest of the nuclear island) with a multi mass polar crane model. These are the models of the containment vessel and polar crane described in the Revision 3 of the Design Control Document. (Multimass model "mm")
- Steel Containment Vessel stick fixed at elevation 100' with a single mass polar crane model. (Single mass model "1m")

These figures demonstrate that the additional polar crane modes with the multi mass model reduce the vertical response. Furthermore, the floor response spectra at the top of the Steel Containment Vessel (Figure 230.018-3) shows the first peak corresponding to the SCV fundamental vertical mode at about 17 Hz and a second peak corresponding to the SCV second vertical mode at about 27-28 Hz. A comparison with results for the nuclear island combined stick shown in DCD Figure 3.7.2-16 (sheet 6) shows that the second peak is much lower when there is no interaction with the nuclear island structure (this case is shown as "scvasb" on Figure 230.018-5).

The interaction between the steel containment vessel and the rest of the nuclear island was investigated. As shown in Table 230.18-1 the steel vessel and polar crane have significant frequencies at 16.37 Hz and 27.34 Hz. The nuclear island stick model has significant vertical frequencies at about 16 Hz (see DCD Table 3.7.2-4) and between 25 and 30 Hz. The vertical modes of the auxiliary and shield building in the nuclear island stick analyses were found to be reducing the response of the containment vessel at the polar crane elevation and amplifying the response of the top of the containment vessel. The containment vessel stick model is attached by a rigid link to the auxiliary and shield building stick at elevation 99' as shown in DCD Figure 3.7.2-18. At this elevation the centroid of the auxiliary and shield building cross section is far from the center of the containment vessel and rotation of the auxiliary and shield building stick affects the containment vessel vertical response. The structural configuration is shown in DCD Figure 3.7.2-12, sheet 9. Due to flexibility of the slab in the annulus at elevation 100', it was also recognized that the vertical displacement of the containment vessel would be controlled primarily by the containment internal structures and the cradle rather than by the shield building.

The nuclear island stick model was revised to connect the containment vessel stick to the CIS stick at elevation 99' rather than to the ASB stick. Floor response spectra on the containment vessel are compared in Figures 230.018-4 and 230.018-5 for this revised model against those for the model included in DCD Revision 3. The peak at 16 Hz increases by about 30% while the response at other frequencies is unchanged.

Floor response spectra shown in the DCD have been generated using the ANSYS post – processor that is conservative in the higher frequencies. Figures 230.018-6 and 7 show comparisons of the ANSYS post-processor against results obtained from another more accurate post-processor (macro) for the nuclear island model with the steel containment vessel attached to the containment internal structure. These figures explain why the spectra shown in the DCD calculated using ANSYS do not appear to converge to the zero period acceleration.

Based on the results described above, Westinghouse will include the following revisions in the new seismic analyses that are being performed with a reduced concrete stiffness as described in the response to RAI 230.020.

- Revise the connection at the base of the steel containment vessel stick in the nuclear island analyses. The base of the stick will be connected to the containment internal structure node at elevation 98' instead of to the auxiliary and shield building stick.

- Revise the truss elements at the lower elevations of the auxiliary and shield building model. This reduces their eccentricity and slightly improves the matching of the stick model modal properties to those of the finite element shell model. This change is conservative since it increases the vertical response of the auxiliary and shield building above that predicted in the dynamic analyses of the shell model.

- Develop floor response spectra using the more accurate post-processor instead of the standard ANSYS post-processor.

Design Control Document (DCD) Revision:

Revise Figure 3.7.2-18.

PRA Revision: None

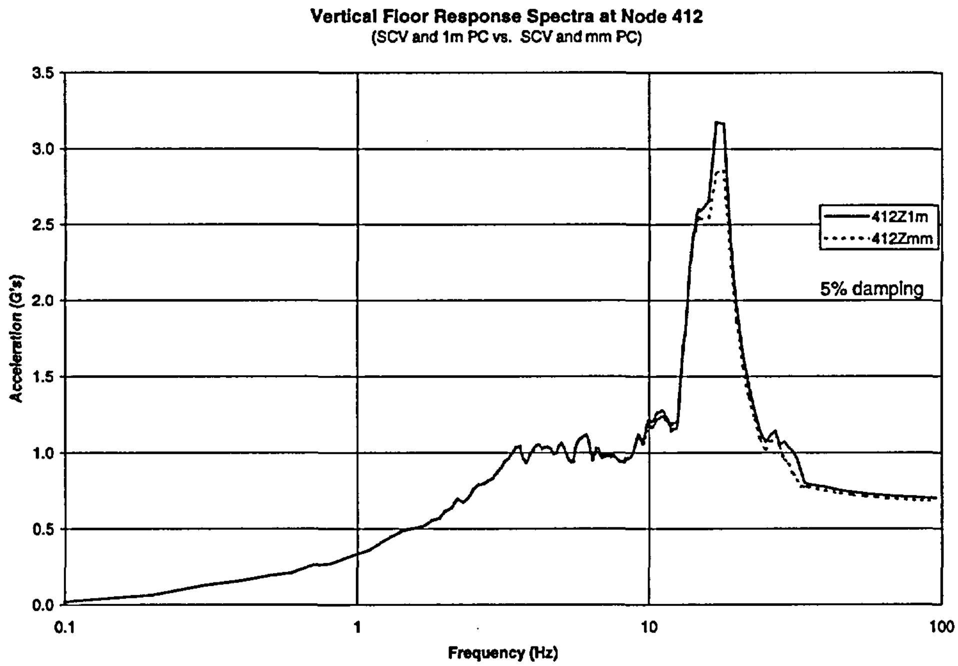


Figure 230.018-2 Comparison of Polar Crane Models - Vertical FRS at Polar Crane Elevation

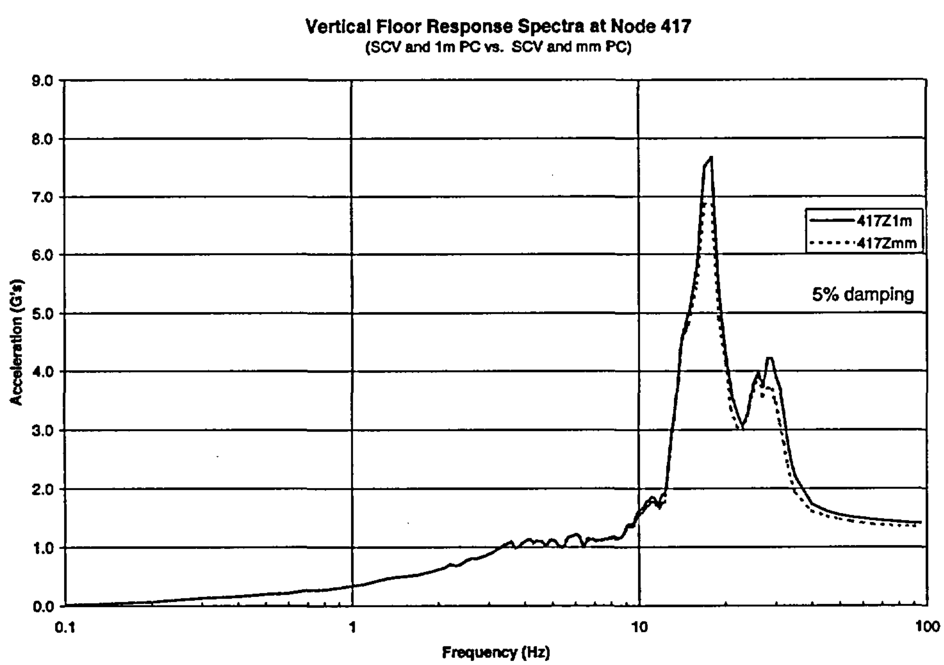


Figure 230.018-3 Comparison of Polar Crane Models - Vertical FRS at Top of Containment Vessel

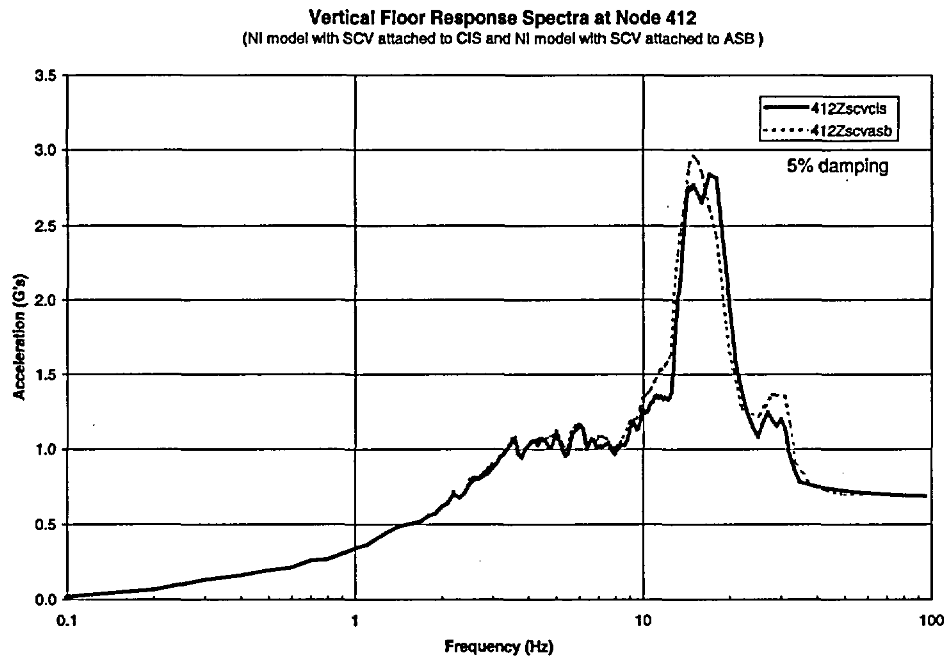


Figure 230.018-4 Comparison of Nuclear Island Models - Vertical FRS at Polar Crane Elevation

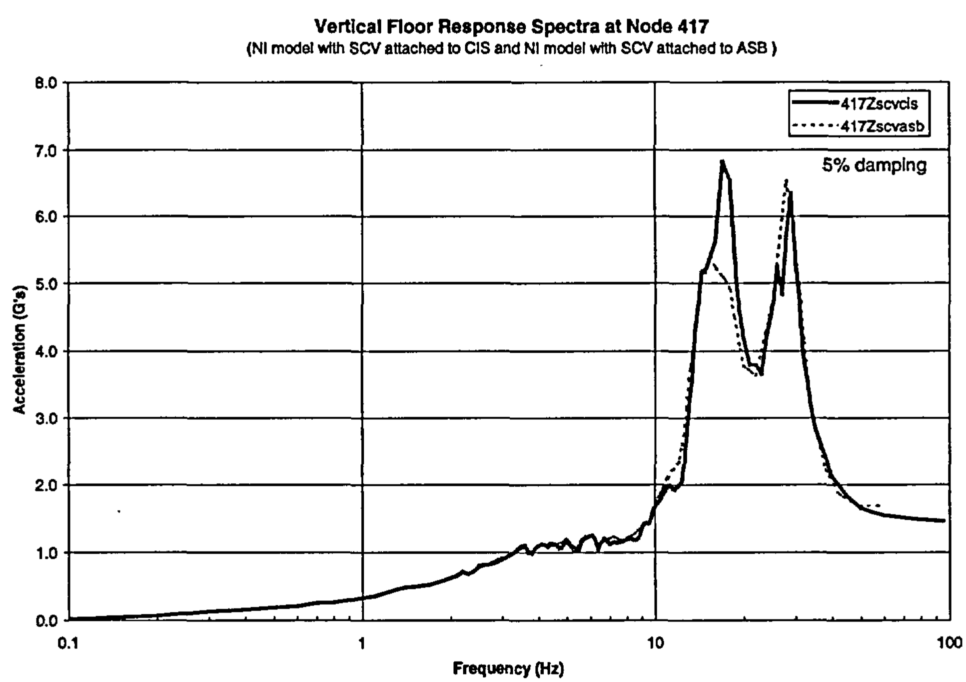


Figure 230.018-5 Comparison of Nuclear Island Models - Vertical FRS at Top of Containment Vessel

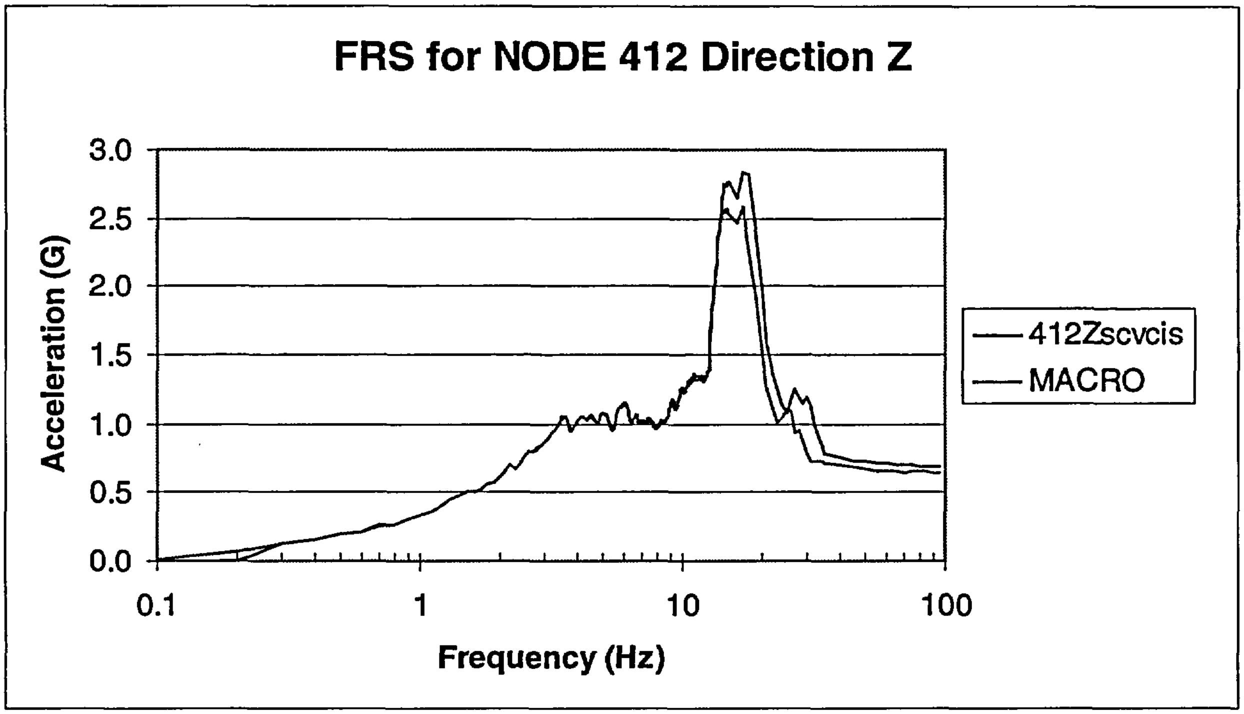


Figure 230.018-6 Comparison of FRS Methods - Vertical FRS at Polar Crane Elevation

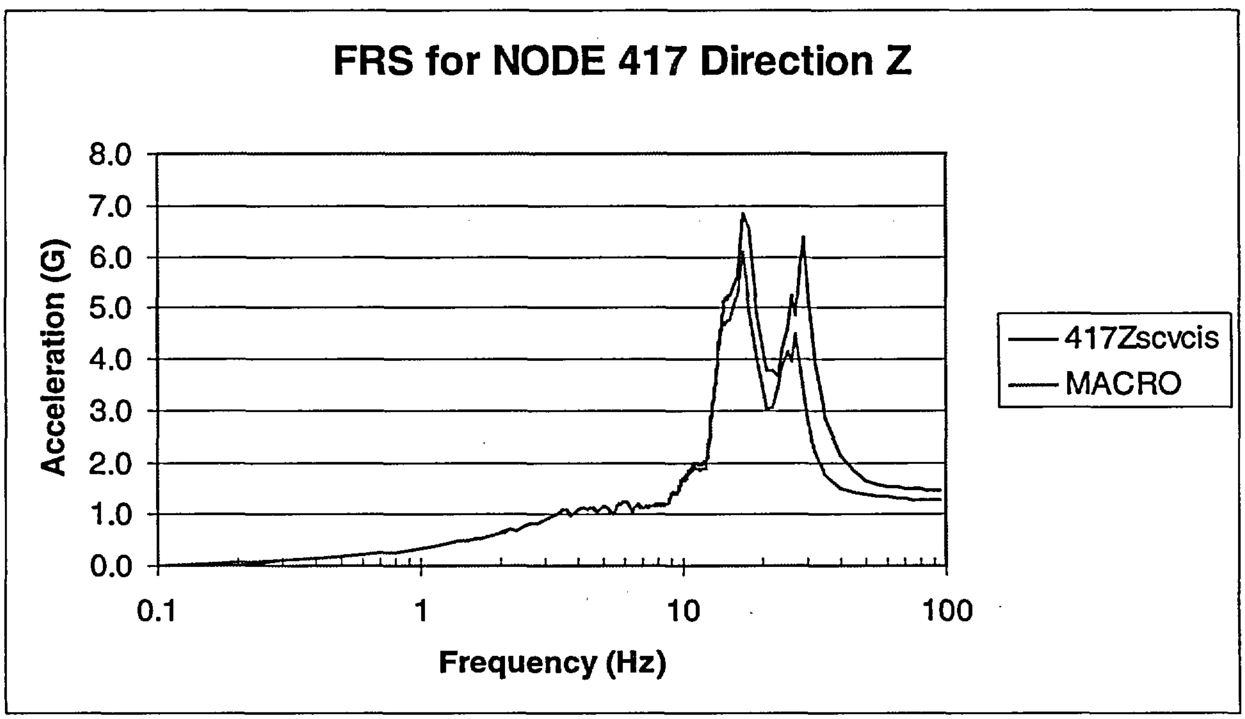


Figure 230.018-7 Comparison of FRS Methods - Vertical FRS at Top of Containment Vessel

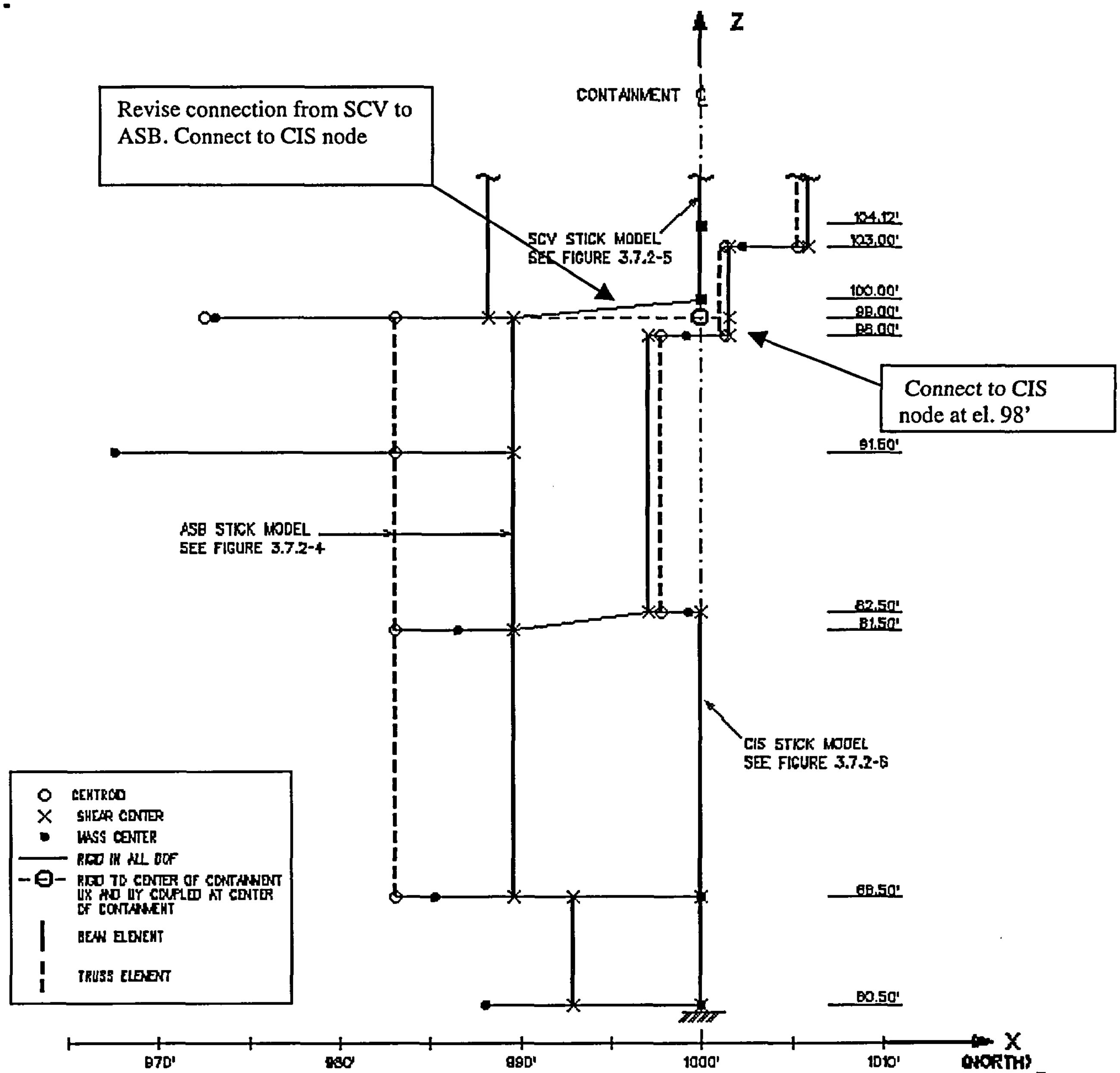


Figure 3.7.2-18

Connection Between Lumped Mass Stick Model – Fixed Base Analysis

AP1000 DESIGN CERTIFICATION REVIEW

Response to Request For Additional Information

RAI Number: 230.020

Question:

Section 3.7.2.3 - Procedure Used for Modeling:

In discussions with Westinghouse regarding the development of the Nuclear Island (NI) dynamic model, the NRC Staff identified instances in which this complex finite element model, which was developed by multiple organizations in different countries, has not produced acceptable results. The NRC staff is concerned as to the process used by Westinghouse to ensure the adequacy of the structural model. Specific examples where the model did not produce acceptable results include:

1. During a public meeting in November 2002, the NRC staff requested that Westinghouse select a simple shear wall section from its model to compare the lateral deflection of the selected wall predicted by the computer analysis against the result of hand calculation. The model results were not consistent with the hand calculation.

2. The seismic analysis result of the Auxiliary and Shield Building shows net tension in the shield building wall. This suggests that during seismic excitation parts of the basemat will lift up from the rock surface resulting in changes in the basemat stresses.

During a conference call on January 21, 2003, Westinghouse agreed to inform the NRC staff of its intentions regarding how Westinghouse plans to address the issues of (1) peer review of its AP1000 design models and (2) stiffness reduction of shear wall models. In a submittal dated March 13, 2003, Westinghouse provided its response. The response was not adequate for the following reasons:

1. Westinghouse has indicated its intention to conduct the peer review by a single expert who is already involved in the AP1000 design process. Although a peer review is not a requirement per the regulations, a review of the model to determine its adequacy by an individual who is associated with the development of the model does not appear to provide an independent review of the model.

2. Westinghouse stated that it has incorporated quality in its modeling and analysis of the nuclear island in all of its activities conducted so far; however, the NRC identified that the seismic analysis result of the Auxiliary and Shield Building shows net tension in the shield building wall. This suggests that during seismic excitation parts of the basemat will lift up from the rock surface resulting in changes in the basemat stresses. This result does not suggest that the model is of sufficient quality.

3. Westinghouse has accepted the recommendation to adopt the criteria in Federal Emergency Management Agency (FEMA) documents for the stiffness of reinforced concrete shear wall structures. However, Westinghouse would only use it when performing new analysis.

It claims that this effect will be covered by a peak broadening of +10% and -20%. The reduction in stiffness of shear walls has two effects: one, on the design of the structure itself, and two, on the structures, systems, and components (SSCs) supported by the structure. On the design of the structure, Westinghouse asserts that a reduction in frequency of about 7% will occur, based on some Japanese tests cited in NUREG/CR-6241. The NRC notes that the FEMA recommendations are most current, and based on a scrutiny of a broad base of test results. Using the FEMA recommendation, the reduction in natural frequency can be as much as 60% of those calculated without the stiffness reduction. The respective order and the fundamental natural frequency change can lead to significant changes in the seismic load, hence the member forces. On the response of supported SSCs, the ordering of respective dominant frequencies and higher significant modes of response can result in unpredictable shapes of response spectra. Therefore, it is essential that the response spectra at several critical locations be developed and compared against those obtained from the original analysis using higher stiffness properties.

In light of the inadequacies cited above, Westinghouse should provide further information as to how the NI dynamic model and related calculations used for design certification satisfy the requirements of 10 CFR 50, Appendix A.

Westinghouse Response:

Westinghouse does not agree that the Nuclear Island (NI) dynamic model has not produced acceptable results. The specific examples cited by the NRC Staff as not producing acceptable results do not relate to the adequacy of the finite element model for the static and dynamic analyses presented in the DCD.

1. During a public meeting in November 2002, the NRC staff requested that Westinghouse select a simple shear wall section from its model to compare the lateral deflection of the selected wall predicted by the computer analysis against the result of hand calculation. Westinghouse attempted to respond during the meeting with an "ad-hoc" hand calculation that subsequently was found to contain an error. A revised hand calculation and comparison against the ANSYS results was discussed with the NRC during the January 21 teleconference and is documented as attachment 4 of the NRC Teleconference Call Summary dated February 6, 2003. The finite element model results are consistent with the corrected hand calculation.

2. The seismic analysis result of the Auxiliary and Shield Building shows net tension in the shield building wall. This suggests that during seismic excitation parts of the basemat will lift up from the rock surface resulting in changes in the basemat stresses. Westinghouse presented results of non-linear analyses to assess the effect of cracking of the shield building wall during the meeting with NRC staff in November, 2002. Westinghouse presented additional results of non-linear horizontal analyses to assess the effect of lift-off of the shield building wall during the meeting with NRC staff in April, 2003. Both sets of analyses justified the assumptions made in the original analyses. The effect of coupled horizontal and vertical interaction on the lift-off will be evaluated further in response to RAI # 230.021.

The development and analyses of the NI dynamic model are documented as engineering calculations in accordance with Westinghouse quality assurance procedures. This includes verification by an independent person. Typical results are compared during this documentation process against those previously reviewed for the AP600. In addition to the formal quality assurance procedures followed by Westinghouse's partners, Westinghouse interacts with the partner during the work and reviews the final documentation. This review is extensive in the early stages of work with a partner and is reduced as Westinghouse establishes confidence in their capability.

A second level of model review occurs as the member forces from the detailed analyses are used in the design of the critical structural elements. The designer of the critical section is responsible for reviewing the results of the global analysis in his assigned area and for determining that the results are appropriate for his use. Where the review shows areas in which the model could be improved, the results are evaluated by the designer and Westinghouse together to confirm that the models are appropriate for use and the results are adjusted if necessary in the design calculation for the individual wall or floor. Such cases are documented and will be considered for incorporation in a revised model if it is necessary to rerun any of the analyses. Westinghouse considers this process to provide an appropriate level of design assurance and therefore do not propose to implement a peer review at this time.

Westinghouse will adopt criteria from the FEMA and draft ASCE documents for the stiffness of reinforced concrete shear wall structures. The stiffness will be reduced in a revised time history analysis of the nuclear island stick model by reducing the elastic modulus of the concrete to $0.8E_c$. This will be applied to the reinforced concrete elements and to concrete filled steel plate module elements. The reduction in natural frequency is expected to be substantially less than the reduction of "as much as 60% of those calculated without the stiffness reduction" quoted in the RAI. Results of the new analyses will be included in the DCD.

Design Control Document (DCD) Revision:

DCD Section 3.7 will be revised to show the results using the reduced elastic modulus to $0.8E_c$

PRA Revision:

None

AP1000 DESIGN CERTIFICATION REVIEW

Response to Request For Additional Information

RAI Number: 230.023

Question:

DCD Tier 2, Section 3.8.5.1 states that the foundation is built on a mud mat for ease of construction. The mud mat is lean, nonstructural concrete and rests on the load-bearing soil. Waterproofing requirements are described in DCD Tier 2, Section 3.4.1.1.1. The DCD does not contain adequate information to conclude that the nonstructural concrete mud mat can withstand the very high toe pressure predicted in the Westinghouse liftoff analysis. This would potentially affect the safety of the NI foundation mat under design basis combination of loads. Please discuss and propose revisions to the DCD to address this issue.

Westinghouse Response:

The mud mat is a thin layer of lean, nonstructural concrete sandwiched between the rock and the underside of the basemat. Lean concrete in this confined condition will be capable of withstanding the high toe pressures conservatively predicted in the Westinghouse liftoff analysis. The DCD is being revised as shown below so that the Combined License applicant submits information demonstrating that the design of the mudmat will withstand the structural loads.

Design Control Document (DCD) Revision:

Revise paragraph 2.5.4.6.3 as revised by the response to RAI 240.005

2.5.4.6.3 Excavation and Backfill – Information concerning the extent (horizontal and vertical) of seismic Category I excavations, fills, and slopes, if any, will be addressed. The sources, quantities, and static and dynamic engineering properties of borrow materials will be described in the site-specific application. The compaction requirements, results of field compaction tests, and fill material properties (such as moisture content, density, permeability, compressibility, and gradation) will also be provided. Information will be provided concerning the specific soil retention system, for example, the soil nailing system, including the length and size of the soil nails, which is based on actual soil conditions and applied construction surcharge loads. If backfill is to be placed adjacent to the exterior walls of the nuclear island, information will be provided concerning compaction of the backfill and any additional loads on the exterior walls of the nuclear island. Information will also be provided on the waterproofing system along the vertical face and the mudmat. **Information will be provided on the mudmat to demonstrate its ability to resist the structural bearing and shear loads.**

PRA Revision: None

AP1000 DESIGN CERTIFICATION REVIEW

Response to Request For Additional Information

RAI Number: 260.006

Question:

The NRC staff reviewed DCD Section 1, Appendix 1A, "Conformance with Regulatory Guides," and finds that Westinghouse has taken exceptions to certain quality assurance (QA) implementation guidance in the following Regulatory Guides (RGs). Specifically, RG 1.37, "Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water Cooled Nuclear Power Plants;" RG 1.38, "Quality Assurance Requirements for Packaging, Shipping, Receiving, Storage and Handling of Items for Water-Cooled Nuclear Power Plants;" and RG 1.39, "Housekeeping Requirements for Water-Cooled Nuclear Power Plants."

The RGs reference use of American National Standards Institute (ANSI) standards N45.2-1, N45.2-2, and N45.2-3. The ANSI standards are now updated and incorporated into American Society of Mechanical Engineers (ASME) NQA-1 and NQA-2. The updates in ASME NQA-1 and NQA-2 are compatible to the ANSI standards with some new implementation guidance; therefore, the NRC staff finds that these exceptions to the RGs are acceptable. However, similar to RG 1.39, Westinghouse should add the following statement in DCD Appendix 1A to the exception taken in RG 1.37 and 1.38: "See Section 17.5 for Combined License information items."

Westinghouse Response:

Westinghouse agrees and advises that the requested statements were recently added to Appendix 1A of the AP1000 DCD in Revision 4.

Design Control Document (DCD) Revision:

None.

PRA Revision:

None.

AP1000 DESIGN CERTIFICATION REVIEW

Response to Request For Additional Information

RAI Number: 260.007

Question:

In DCD Section 1, Appendix 1A, Westinghouse took exception to RG 1.28. Westinghouse states, in part, that "Section 2, Quality records requires programmatic nonpermanent records to be retained for 3 years. An additional requirement states that programmatic records shall be retained at least until the date of issuance of the full power operating license of the unit. A definitive schedule for obtaining a full power operating license does not exist. Westinghouse will follow a records retention plan that is keyed to the Final Design Approval. Compliance will be accomplished by initiating a retention period of 3 years from programmatic records starting on the date that NRC issues a AP1000 FDA."

RG 1.28, Regulatory Position C.2, Quality Assurance Records, states, in part, that programmatic nonpermanent records should be retained for at least 3 years. For programmatic nonpermanent records, the retention period should be considered to begin upon completion of the activity. In addition, product and programmatic nonpermanent records should be retained at least until the date of issuance of the full power operating license of the unit.

Since RG 1.28 states, in part, that programmatic nonpermanent records should be retained at least until the date of issuance of the full power operating license of a unit, the NRC staff could not determine if compliance with RG 1.28 would be achieved since programmatic nonpermanent will only be retained for 3 years following a final design approval (FDA). 10 CFR Part 52.55, "Duration of Certification," states, in part, that a standard design is valid for 15 years from the date of issuance. RG 1.28, Table 1, includes design and procurement programmatic nonpermanent records that can be discarded before a COL purchases the AP1000 design. Westinghouse should provide a list of the specific record types they are proposing to discard after three years. Westinghouse should also provide additional justification for discarding each of these record types after FDA.

Westinghouse Response:

The programmatic nonpermanent records that Westinghouse is proposing to retain for a period of 3 years starting on the date that NRC issues a AP1000 FDA are limited to timesheets, invoices for design work and other accounting type information. These records have no effect on the procurement or design information associated with the development of an AP1000.

Design Control Document (DCD) Revision:

None

PRA Revision:

None.

AP1000 DESIGN CERTIFICATION REVIEW

Response to Request For Additional Information

RAI Number: 260.008

Question:

The NRC staff noted that in DCD Section 17.6, References, did not list some documents discussed in DCD Section 17.3:

- Westinghouse Electric Company Quality Management System (QMS), Revision 4, dated January 31, 2001.
- WCAP-15985, AP1000 Implementation of the Regulatory Treatment of Nonsafety-Related Systems Process, Revision 1, dated April 2003

Westinghouse should add these references to DCD Section 17.6. In addition, there is no reference to a project specific quality plan for the AP1000 design similar to Reference 4, WCAP-12600, Revision 4, "AP600 Advanced Light Water Reactor Design Quality Assurance Program Plan," January 1998. Also, since Reference 6 is "not used," Westinghouse should delete Reference 6.

Westinghouse Response:

Westinghouse will add the reference, "Westinghouse Electric Company Quality Management System (QMS)" to the "References" section.

A reference to WCAP-15985 is not necessary. Although DCD section 17.3 uses the term RTNSS, it is not meant to infer that it is referencing WCAP-15985. DCD section 17.3 directs the reader to section 16.3, which includes a reference to DCD section 17.4. DCD sections 16.3 and 17.4 include all the discussions necessary to identify the RTNSS systems and the criteria used in selecting them. This approach is consistent with Chapter 22 of the AP600 Final Safety Evaluation Report (FSER), NUREG-1512.

The specific quality plan for AP1000 is WCAP-12600. The present wording of the DCD (repeated below for convenience) states,

"A project-specific quality plan was issued to supplement the quality management system document and the topical reports for design activities affecting the quality of structures, systems, and components for the AP600 project (Reference 4). This plan addresses the NQA-1-1989 edition through NQA-1b-1991 addenda and is applicable to work performed for the AP1000 design."

Reference 4 is WCAP-12600, Revision 4, "AP600 Advanced Light Water Reactor Design Quality Assurance Program Plan," January 1998. As the DCD identifies: "The plan ...is applicable to work performed for the AP1000 design." Westinghouse considers that it has identified a project specific quality plan (i.e. WCAP-12600) for the AP1000 design.

The wording in of Reference 6 will be changed from "not used" to "Deleted." When a reference is deleted, Westinghouse does not physically remove it from the list and renumber the remaining references as doing so could induce errors.

Design Control Document (DCD) Revision:

DCD section 17.3 will be revised as follows.

The current Westinghouse quality plan for work being performed on the AP1000 is the Westinghouse Electric Company Quality Management System (QMS) ~~Revision 5, issued October 1, 2002~~ **(Reference 9).** The **referenced revision of the** QMS ~~Rev. 5~~ was accepted by the NRC as meeting the requirements of 10 CFR 50, Appendix B, on September 13, 2002.

Revise reference 6 and add the reference 9 to DCD section 17.6: (Changes are to Rev. 4 of the DCD)

6. ~~Not used.~~ **Deleted**

9. **Westinghouse Electric Company Quality Management System (QMS), Revision 5, dated October 1, 2002.**

PRA Revision:

None.

AP1000 DESIGN CERTIFICATION REVIEW

Response to Request For Additional Information

RAI Number: 261.016

Question:

In the response to RAI 261.007b, Item 2, Westinghouse stated that the pseudo rod ejection test is performed as part of the rod cluster control assembly out of bank measurements in DCD subsection 14.2.10.4.6. Westinghouse notes that this test is only performed on the first plant to validate the analysis.

The NRC staff determined that the pseudo rod or Rod Cluster Control Assembly (RCCA) ejection test is performed in test abstract 14.2.10.4.6; therefore, RAI 261.007b, item 2 is partially resolved. However, Westinghouse states that this test is performed on the first plant only. The NRC staff determined that Westinghouse should clarify whether this test should be performed for every AP1000 plant or justify that this test is a first-plant-only test as described in DCD Section 14.2.5. The NRC staff also notes that DCD section 14.4.6 requires the COL applicant or licensee to either perform the tests listed in DCD subsection 14.2.5 or provide justification that the results of the first-plant-only tests are applicable to subsequent plants.

Westinghouse Response:

Westinghouse will revise DCD subsection 14.2.5 to include a justification consistent with the response to RAI 231.007b, Items 2 and 3, stating why the rod cluster control assembly out of bank measurements test is performed on the first plant only.

Design Control Document (DCD) Revision:

Revise the third paragraph of DCD 14.2.5 as show:

First Plant Only Test	Section
IRWST Heatup Test	14.2.9.1.3 Item (h)
Pressurizer Surge Line Stratification Evaluation	14.2.9.1.7 Item (d)
Reactor Vessel Internals Vibration Testing	14.2.9.1.9 – Prototype Test
[*Natural Circulation Tests*]*	14.2.10.3.6, [*14.2.10.3.7*]*
Rod Cluster Control Assembly Out of Bank Measurements	**14.2.10.4.6**
Load Follow Demonstration	14.2.10.4.22

Insert a new paragraph below into DCD section 14.2.5 prior to the paragraph entitled, "**Load Follow Demonstration (14.2.10.4.22)**":

Rod Cluster Control Assembly Out of Bank Measurements (14.2.10.4.6)

Rod cluster control assembly out of bank measurements are performed during power ascension tests. The test is performed at the 30 percent to 50 percent power level so as not to cause the plant to exceed peaking factor limits. The test is only required to be performed for the first plant because its purpose is to validate calculation tools and instrument responses.

PRA Revision:

None.

AP1000 DESIGN CERTIFICATION REVIEW

Response to Request For Additional Information

RAI Number: 261.017

Question:

In the response to RAI 261.007b, Item 3, Westinghouse states that the rod cluster control assembly out-of-bank measurements test is not performed at full power as it would cause the plant to exceed peak power limits.

The NRC staff notes that in RG 1.68, Appendix A, Section 5, item (i) states, in part, demonstrate the capability and/or sensitivity, as appropriate for the facility design of incore and excore neutron flux instrumentation, to detect a control rod misalignment equal to or less than the technical specification (TS) limits (50 percent, 100 percent). Although the NRC staff agrees that this test should not be performed at a power level that could cause the plant to exceed thermal limits, the test should be performed at power levels consistent with RG 1.68. Westinghouse should either perform the test at a higher power level consistent with RG 1.68 or provide additional information to justify performing this test at a maximum of 50 percent power.

Westinghouse Response:

Westinghouse limits the test to the 30 to 50 percent power level in order to assure that plant peaking factor limits are not exceeded. Testing at this range of power levels is sufficient to validate the calculation tools and calibrate instrument responses such that the intent of RG 1.68 Appendix A, Section 5, item (i) is met.

Design Control Document (DCD) Revision:

The DCD revision associated with this response is included in the response to RAI 261.016.

PRA Revision:

None.