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Our ref: DCP/NRC2370

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Subject: AP1000 Responses to Requests for Additional Information (SRP 3)

Westinghouse is submitting responses to the NRC request for additional information (RAI) on SRP Section 3. These RAI responses are submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in the responses is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

Enclosure 1 provides the response for the following RAIs:

RAI-SRP3.7.1-SEB1-16
RAI-SRP3.7.1-SEB1-17

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,

A handwritten signature in black ink, appearing to read "Robert Sisk".

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

/Enclosure

1. Response to Request for Additional Information on SRP Section 3

cc:	D. Jaffe	- U.S. NRC	1E
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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 3

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Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.7.1-SEB1-16
Revision: 0

Question:

The staff notes that seismic adequacy of systems and components supported by the NI structures needs to be demonstrated for in-structure seismic loads (FRS) derived from (1) the initial DCD Rev. 15 hard rock analysis; (2) the DCD Rev. 16 SASSI SSI analyses; and (3) the DCD Rev. 16 HRHF GMRS analysis.

In RG 1.61, Rev. 1 (March 2007), the structural material damping values listed in Table 1 are identified as applicable to stress states near code limits (i.e., high seismic demand resulting from SSE loading). However, in the case of the AP1000 HRHF-based analyses, where TR-115 demonstrates that stress states are much lower, it is not clear that Table 1 damping values are applicable. One option acceptable to the staff is to utilize the lower Table 2 damping values. The use of response-compatible damping values affects the magnitude of internal forces and moments in the structure and, more importantly for system and component analyses, the magnitude of the FRS. The staff needs to ensure that Westinghouse used appropriate structural material damping values in the HRHF GMRS seismic analyses.

The staff also notes that DCD Rev. 16 Table 3.7.1-1 and Figure 3.7.1-13 specify seismic damping values that are higher than those listed in RG 1.61, Revision 1 (March 2007), for (1) uniform support motion piping analysis; (2) electrical cabinet analysis; and (3) analysis of cable tray systems.

Therefore, the staff requests the applicant address the following:

- a. Identify the values of structural material damping that were used in the HRHF-based seismic analyses, and demonstrate consistency with RG 1.61 guidance on use of response-compatible damping values.
- b. In DCD Rev. 16, Section 3.7.1.3, Westinghouse states:
"The damping values for conduits, cable trays and their related supports are shown in Table 3.7.1-1 and Figure 3.7.1-13. The damping value of conduit, empty cable trays, and their related supports is similar to that of a bolted structure, namely 7 percent of critical. The damping value of filled cable trays and supports increases with increased cable fill and level of seismic excitation. For cable trays and supports demonstrated to be similar to those tested, damping values of Figure 3.7.1-13 may be used. These are based on test results (Reference 19)."

The staff notes that the damping values shown in DCD Figure 3.7.1-13 were developed from test conducted during the Systematic Evaluation Program (SEP) resolution. It is unclear to the staff whether the support types/configurations that produced 20% damping values will be implemented for new design applications. The staff requests that Westinghouse (1)

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specifically define the types of cable tray supports/configurations for which DCD Figure 3.7.1-13 is applicable; (2) identify whether any of these types of supports/configurations are permitted for AP1000; and (3) if not permitted, delete DCD Figure 3.7.1-13.

- c. The staff requests Westinghouse (1) identify whether it plans to implement the RG 1.61, Revision 1 damping values for electrical cabinets and cable trays; and (2) if not, provide the technical basis for concluding that the damping values Westinghouse plans to apply will provide sufficient conservatism. The response should reference recognized, readily available, and well documented test results that support the damping values Westinghouse plans to use, and should also address the uncertainty associated with scatter of the measured data.
- d. Westinghouse states in DCD Section 3.7.3.15, Revision 16:
"Piping systems analyzed by the uniform envelope response spectra method with rigid valves can be evaluated with 5 percent damping. Five percent damping is not used in piping systems that are susceptible to stress corrosion cracking."

The staff previously accepted this in the FSER for DCD Revision 15. The complete list of restrictions that the staff placed on the use of 5% piping damping is in FSER Section 3.12.

However, use of 5% damping for the uniform envelope response spectra method with rigid valves is not consistent with the latest staff guidance, as presented in RG 1.61, Revision 1 (March 2007). Based on a re-assessment of available piping damping data, RG 1.61, Revision 1, identifies either 4% damping without restrictions or former Code Case N-411 damping with restrictions, as being acceptable to the staff.

Although not specifically identified in DCD 3.7.3.15, the staff placed a restriction on the ground response spectra; the PGA frequency of the ground spectra cannot exceed 33 Hz. Therefore, 5% piping damping is NOT applicable to piping analyses for CEUS HRHF sites, for which the PGA frequency exceeds 33 Hz.

The staff requests Westinghouse (1) identify whether it plans to implement the RG 1.61, Revision 1 damping values for piping; and (2) if not, to provide the technical basis for concluding that the damping values Westinghouse plans to apply will provide sufficient conservatism. The response should reference recognized, readily available, and well documented test results that support the damping values Westinghouse plans to use, and should also address the uncertainty associated with scatter of the measured data.

- e. If any changes were made in DCD Rev. 17 that relates to these requests, provide the reference.

Westinghouse Response:

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- a. The damping values used in the HRHF-based seismic analyses are those listed in DCD, Revision 17, Table 3.7.1-1. No attempt was made to reduce damping levels based on stress levels since it was Westinghouse's intent to have a comparable basis for comparison (i.e., same damping values). It is recognized that the lower damping values will increase the load and stress levels, and the HRHF calculated values will approach or possibly even exceed the CSDRS (Certified Seismic Design Response Spectra) calculated values. If the HRHF comparison values with the lower damping are equal to or below the CSDRS values, then the CSDRS analyses control design. If the HRHF values exceed the CSDRS values, this does not imply that the HRHF calculated values will control design. This is because the stress levels have reached stress levels where the higher damping is applicable. Therefore, the conclusions reached from the HRHF evaluations that the CSDRS controls the AP1000 design remains unchanged.
- b. Westinghouse recognizes that the DCD Figure 3.7.1-13 is only applicable if the cable trays and supports are similar to those tested. For this reason note 1, applicable to cable trays and supports, was added to DCD Table 3.7.1-1 that states "Cable tray systems similar to those tested in Reference 19 may use the damping values given in Figure 3.7.1-13." Therefore, for cable trays and supports demonstrated to be similar to those tested, damping values up to 20% may be used. Otherwise, a maximum value of 10% shall be used.
- c. Westinghouse is using the damping ratios listed in DCD, Revision 17, Table 3.7.1-1. These damping values were approved by the NRC in their FSER document NUREG-1793, September 2004. In Section 3.7.1.3 it is stated: "The use of the damping ratios documented in DCD Tier 2, Table 3.7.1-1, meets the guidelines prescribed in RG 1.61 [Revision 0] and/or common industry practice. On this basis, the staff concludes that the damping ratios proposed by the applicant are acceptable." Westinghouse is not changing the damping values from those used to support the certified design documented in DCD Revision 15. The damping value criteria included in the regulatory guide is based on the type of construction of the structure and is not dependent on the spectra used for the seismic analysis. Therefore including six soil cases in the design ground response spectra does not subject the damping values to review as part of the design certification amendment review.

The AP1000 design uses the regulatory guidance effective six months prior to the submittal of the design certification application in March, 2002. Regulatory Guide 1.61, Revision 1 was published in March 2007. This is well after the application for AP1000 design certification. The application for the design certification amendment was submitted in May 2007. Even if the application did reset the regulatory guidance cut off, a regulatory guide published in March 2007 is effective less than six months prior to the amendment application and is not applicable to the design certification amendment.

- d. Westinghouse is not assessing the AP1000 design to Regulatory Guide 1.61 Revision 1. The AP1000 design uses the regulatory guidance effective six months prior to the submittal

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of the design certification application in March, 2002. Regulatory Guide 1.61, Revision 1 was published in March 2007. This is well after the application for AP1000 design certification. The AP1000 design was assessed for conformance with regulatory guidance in effect at the time that the application design certification was filed. The AP1000 is not required to assess conformance with guidance developed later.

The damping values used for piping are those that were included in DCD Revision 15 and approved as part of the Design Certification. Westinghouse has not altered the values of damping for piping analysis which remain the same in DCD Revision 17. This information is covered by the design finality of the Design Certification. The damping value criteria included in the regulatory guide for piping are not dependent on the spectra used for the seismic analysis. Therefore including six soil cases in the design ground response spectra does not subject the damping values to review as part of the design certification amendment review. See item c above.

- e. No changes were made in DCD Revision 17 that relates to these requests.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None

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RAI Response Number: RAI-SRP3.7.1-SEB1-17
Revision: 0

Question:

The staff notes that seismic re-analyses of the AP1000 nuclear island structures and foundation were conducted to demonstrate structural adequacy for a spectrum of soil sites (DCD Rev. 16 Appendix 3G) and for a representative CEUS HRHF GMRS (DCD Rev. 16 Appendix 3I), in addition to the original DCD Rev. 15 hard rock site. Subsequent to the staff's FSER on DCD Rev.15, the staff issued revised guidance for seismic design/analysis, that incorporates advances in the technology and the experience gained through implementation of previously accepted methods.

In its review of the AP1000 expanded seismic design basis presented in DCD Rev.16, the staff used the March 2007 revisions of SRP 3.7.1, 3.7.2, 3.7.3, and the revisions to RG 1.61 and RG 1.92 that are referenced therein, as the standard for acceptability. Deviations from this guidance are subject to more detailed review, to establish that an acceptable level of solution accuracy and/or conservatism has been achieved. Therefore, the staff requests the applicant to address the following:

- a. In DCD Revision 15, Westinghouse stated, "Seismic analyses of the nuclear island are performed in conformance with the criteria within SRP 3.7.2." The staff conducted its review accordingly, and accepted Westinghouse's commitments to SRP 3.7.2 (and supporting RGs) in existence at the time of the staff's review. Subsequent to the issuance of the staff's FSER on DCD Revision 15 in September 2004, the staff updated SRP Section 3.7.2 and supporting RG 1.92, Rev.2.

The staff notes that DCD Revision 16 has not been updated to reflect the latest staff guidance in SRP 3.7.2 on seismic analysis methods. Consequently, the statement, "Seismic analyses of the nuclear island are performed in conformance with the criteria within SRP 3.7.2." must be based on Westinghouse updating its seismic analysis methods accordingly.

The staff requests Westinghouse specifically describe its compliance to or deviations from the current SRP 3.7.2 and RG 1.92, Rev.2; and provide the technical basis for the adequacy of all seismic analysis methods that deviate from the current SRP and RG.

- b. Revision 2 to RG 1.92 (July 2006) and Revision 3 to SRP 3.7.2 (March 2007) updated the staff guidelines to improve the accuracy of results obtained when implementing the response spectrum analysis method for SC-I systems and subsystems. DCD Revision 16, Section 3.7.3.7 "Combination of Modal Responses", describes Westinghouse's procedures for response spectrum analysis. The staff requests Westinghouse (1) to identify whether it has implemented the RG 1.92, Revision 2 and SRP 3.7.2, Revision 3, guidelines for response spectrum analysis; and (2) if not, to provide the technical basis for concluding that

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the response spectrum analysis methods Westinghouse has applied provide comparable accuracy.

- c. In March 2007, the staff issued Revision 3 to SRP 3.7.2. The acceptance criteria formerly provided in SRP Section 3.7.2.II.3, to confirm the adequacy of the model refinement, has been deleted. It has been replaced by a new criterion based on review of modal responses up to the maximum frequency of interest. This is described in SRP Section 3.7.2.II.1.a.iv. The staff requests Westinghouse (1) identify whether it satisfies the latest SRP Section 3.7.2.II.1.a.iv acceptance criteria for confirming adequate model refinement; and (2) if not, to provide the technical basis for concluding that the method Westinghouse applied provides sufficient solution accuracy.
- d. An acceptable method to account for the modes corresponding to frequencies higher than the PGA frequency in a mode superposition time history analysis is described in RG 1.92, Revision 2, Regulatory Position C.1.4.1 (July 2006), and is referenced in the March 2007 revision to SRP 3.7.2.

The staff requests Westinghouse identify whether it implemented the RG 1.92, Revision 2 approach, and if not, provide the technical basis for concluding that the method Westinghouse applied provides a comparable level of solution accuracy.

- e. If any changes were made in DCD Rev. 17 that relates to these requests, provide the reference.

Westinghouse Response:

- a. The technical basis for the adequacy of seismic analysis methods is conformance with the regulatory guidance in effect six months prior to the submittal of the AP1000 Design Certification application in March, 2002. This is consistent with the requirements of 10 CFR 52.47(a)(9). The statement given in the DCD that the "Seismic analyses of the nuclear island are performed in conformance with the criteria within SRP 3.7.2," is consistent with the applicable guidance (e.g., SRP 3.7.2, Revision 2) applying to the AP1000 plant at the time of filing.

Westinghouse is not changing the seismic analysis methods from those used to support the certified design documented in Design Control Document (DCD) Revision 15. The seismic analysis methods are not dependent on the spectra used for the seismic analysis. Therefore including six soil cases in the design ground response spectra does not subject the seismic analysis methods to review as part of the design certification amendment review.

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Westinghouse is not assessing the AP1000 design to SRP 3.7.2, Revision 3. The AP1000 design uses the regulatory guidance effective six months prior to the submittal of the design certification application in March, 2002. In Westinghouse letter DCP/NRC1751, dated June 15, 2006, Westinghouse submitted APP-GW-SRP-010, "Extension of Nuclear Island Seismic Analysis to Soil Sites". This document provided information to support the expansion of the AP1000 design response spectra to include additional soil conditions. This submittal was well before the publishing of Revision 3 of SRP 3.7.2. The application for the design certification amendment which was supported by Revision 16 of the AP1000 Design Control Document was submitted in May 2007. Revision 16 of the DCD incorporated changes consistent with the information included in APP-GW-S2R-010. Even if the application did reset the regulatory guidance cut off, a Standard Review Plan Section published in March 2007 is effective less than six months prior to the amendment application and is not applicable to the design certification amendment.

See Item b below for discussion of RG 1.92.

- b. Westinghouse identifies both Revision 1 and 2 of RG 1.92, DCD Section 1.9, Revision 17, Table 1.9-1 (Sheet 8) for the AP1000 plant. RG 1.92, Revision 2, has been used for building structures as noted in DCD Appendix 3G, Section 3G.4.3.1, Revision 17. Both Revision 1 and 2 of RG 1.92 is acceptable for use in seismic analysis by Westinghouse since Revision 1 combination methods are more conservative as stated in RG 1.92, Revision 2 (Background). It is stated: "This guide (Revision 2) describes methods that the NRC staff considers acceptable in view of those improvements. The more conservative methods of combining modal responses (as described in Revision 1) remain acceptable." Westinghouse does address the residual rigid response of missing massing (see DCD Section 3.7.3.7, Revision 17).

As explained in item a. above Westinghouse is not assessing the AP1000 design to SRP 3.7.2, Revision 3. The AP1000 design uses the regulatory guidance effective six months prior to the submittal of the design certification application in March, 2002. SRP 3.7.2, Revision 3 was published in March 2007. This is well after the application for AP1000 design certification.

- c. Westinghouse follows SRP 3.7.2, Revision 2 for defining the solution accuracy of the methods used. As explained in item a. above Westinghouse is not assessing the AP1000 design to SRP 3.7.2, Revision 3.
- d. See item b above.
- e. No changes were made in DCD Revision 17 that relates to these requests.

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Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None