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Your ref: Docket No. 52-006
Our ref: DCP/NRC2375

February 6, 2009

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-SEB1-15 R1
RAI-SRP3.7.1-SEB1-16 R1
RAI-SRP3.7.1-SEB1-17 R1

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,

John DeBlasio/for

Robert Sisk, Manager
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/Enclosure

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

DO63
NRO

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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 3

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.7.1-SEB1-15
Revision: 1

Question (December 17, 2008):

(a) DCD Revision 16, Section 3.7.2.8.1, identifies that the portion of the Annex Building adjacent to the nuclear island is classified as SC-II, and describes the Annex Building seismic analysis models used for soil sites and for the hard rock site. There is no discussion of design allowables and acceptance criteria. The staff requests Westinghouse to confirm that SC-II structures are evaluated in accordance with the staff-accepted approach, as described in DCD Revision 16, Section 3.7.2.

DCD Revision 16, Section 3.7.2, states: "Seismic Category II building structures are designed for the safe shutdown earthquake using the same methods and design allowables as are used for Seismic Category I structures. The acceptance criteria are based on ACI 349 for concrete structures and on AISC N690 for steel structures including the supplemental requirements described in subsections 3.8.4.4.1 and 3.8.4.5."

(b) The staff requests Westinghouse to clarify the seismic classification of the remainder of the Annex Building, and also confirm that, for analysis purposes, the entire annex building has been treated as seismic Category II. If this is not the case, provide the technical basis for not treating it as such.

DCD Revision 15, Section 3.7.2.8.1, states "The annex building is classified as seismic Category II." DCD Revision 16, Section 3.7.2.8.1, states "The portion of the annex building adjacent to the nuclear island is classified as seismic Category II." It is silent about the seismic classification of the remainder of the Annex Building.

(c) Provide the technical basis for NOT classifying the turbine building as SC-II, considering its proximity to the nuclear island and the infeasibility of demonstrating the acceptability of a collapse.

DCD Revision 15, Section 3.7.2.8.3, states "...the major structure of the turbine building is separated from the nuclear island by approximately 18 feet." DCD Revision 16, Section 3.7.2.8.3, deleted this statement and additional descriptive information about the turbine building. Based on the information in DCD Revision 16, Section 3.7.2.8.3, the staff cannot determine whether the "non-seismic" classification is still valid.

Westinghouse Response:

(a) It is confirmed that the statement made in DCD Section 3.7.2 that "Seismic Category II building structures are designed for the safe shutdown earthquake using the same methods and design allowables as are used for seismic Category I structures. The acceptance criteria

are based on ACI 349 for concrete structures and on AISC N690 for steel structures including the supplemental requirements described in subsections 3.8.4.4.1 and 3.8.4.5," has been implemented.

(b) As stated in DCD Section 3.7.2.8.1, Annex Building, "The portion of the annex building adjacent to the nuclear island is classified as seismic Category II." As shown in DCD Table 3.2-2 the annex building area outlined by columns E-I.1 and 2-13 is classified as seismic Category II. The annex building area outlined by columns A-D and 8-13, as well as column A-G and 13-16 are classified as non-seismic. For design purposes, only the portion identified as seismic Category II are designed following the Seismic Category I structures acceptance criteria. This is acceptable since criteria listed in DCD Section 3.7.2.8 are satisfied. Specifically the portions of the annex building classified as nonseismic are not adjacent to the nuclear island, and their collapse will not cause the nonseismic structure to strike a seismic Category I structure, system or component, nor will their collapse impair the integrity of seismic Category I structures, systems or components. Further, the nonseismic portion of the annex building is only one story with roof elevations below 120'. If this portion of the annex building would fail it would not cause any failure to the seismic Category II portion that would impair the integrity of the seismic Category I structures.

(c) During the hard rock certification of the AP1000 the NRC reviewed the classification of the turbine building as a non-seismic structure. The NRC concluded from this review (AP1000 FSER) "that the method and criteria used for the design of the turbine building will prevent, during a SSE event, the turbine building to jeopardize the safety function of the NI structure, and are therefore acceptable." This conclusion was reached after Westinghouse agreed to modify the analysis and design requirements to:

- Upgrade the Uniform Building Code (UBC) seismic design from Zone 2A, importance Factor of 1.25, to Zone 3 with an Importance Factor of 1.0 in order to provide margin against collapse during the safe shutdown earthquake, and

- To use eccentrically braced steel frame structures meeting the requirements given in DCD Section 3.7.2.8.3.

The turbine building is designed as an eccentrically braced frame structure under the guidance of the UBC and is, by the principal of the code, therefore designed to deform during the design seismic event rather than collapse.

The methods and criteria that were agreed to with the NRC have not changed and are given in DCD Section 3.7.2.8.3, Revision 17.

Reference(s): None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

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-SRP3.7.1-SEB1-16
Revision: 1

Question (December 17, 2008):

(a) Identify the values of structural material damping that were used in the HRHF-based seismic analyses, and demonstrate consistency with the guidance in RG 1.61, Rev. 1, on the use of response-compatible damping values.

DCD Rev 15, Section 3.7.2, describes the design-basis seismic analyses performed for the SSE (i.e., modified RG 1.60 spectra at 0.3 g PGA) applied to a hard rock site. DCD Rev. 16 added Appendix 3G to describe the revised seismic design-basis, for the SSE applied to a range of layered soil sites, in addition to the original hard rock site. The description in Rev. 15, Section 3.7.2 was deleted. DCD Rev 16 also added Appendix 3I to describe the seismic analysis results for CEUS hard rock high frequency (HRHF) site spectra. The results for the HRHF site spectra, presented in Appendix 3I, indicate a lower seismic response of the structures than for the SSE. RG 1.61, Rev. 1, presents guidance on the use of response-compatible structural damping values. As the response level of a structure decreases, the effective damping also decreases.

(b) The staff requests Westinghouse: (1) specifically define the types of cable tray supports/configurations for which DCD Figure 3.7.1-13 is judged to be applicable; (2) identify whether any of these types of supports/configurations are candidates for use in AP1000; and (3) if not candidates, delete DCD Figure 3.7.1-13.

The staff notes that the damping values shown in DCD Figure 3.7.1-13 were developed from tests conducted in the 1980s during the Systematic Evaluation Program (SEP), to seismically qualify as-built cable tray systems that had not been seismically analyzed at the plant design stage. It is unclear to the staff whether the support types/configurations that produced 20% damping values will be implemented for new design applications.

DCD Revisions 15 and 16, Section 3.7.1.3, both state: "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)." In RG 1.61, Rev. 1, (March 2007), the staff currently accepts a maximum of 10% damping for cable tray systems, independent of the support type/configuration.

(c) The staff requests Westinghouse: (1) identify whether it plans to implement the RG 1.61, Rev. 1, damping values for electrical cabinets and cable trays; and (2) if damping values

different from RG 1.61, Rev. 1, are used, provide the technical basis for concluding that the selected damping values will provide sufficient conservatism, including reference to recognized, readily available, and well documented test results that support the use of the selected damping values, and also addresses the uncertainty associated with scatter of the measured data.

DCD Revisions 15 and 16, Section 3.7.1.3, Table 3.7.1-1, lists damping values for use in seismic analysis of seismic Category I structures, systems, and components. The staff notes that the listed damping values for electrical cabinets and cable trays are not consistent with the damping values currently acceptable to the staff, as identified in RG 1.61, Rev. 1, (March 2007).

(d) The staff requests Westinghouse: (1) identify whether it is implementing the RG 1.61, Revision 1 damping values for design-basis piping analyses; (2) identify the piping damping values used in the HRHF sample piping analyses; and (3) if damping values different from RG 1.61, Rev. 1, are used, provide the technical basis for concluding that the selected damping values will provide sufficient conservatism, including reference to recognized, readily available, and well documented test results that support the use of the selected damping values, and also addresses the uncertainty associated with scatter of the measured data.

Westinghouse states in DCD Section 3.7.3.15, Revision 15 and 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. Although not specifically identified in DCD Section 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.

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

Westinghouse Response:

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 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.

Reference(s): None

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-SRP3.7.1-SEB1-17
Revision: 1

Question (December 17, 2008):

(a) The staff requests that Westinghouse specifically describe its compliance with or deviations from SRP 3.7.2, Rev. 3, and RG 1.92, Rev.2; and provide the technical basis for the adequacy of all seismic analysis methods and acceptance criteria that deviate from the current staff guidance.

In DCD Revision 15, Section 3.7.2.1, Westinghouse stated "Seismic analyses of the nuclear island are performed in conformance with the criteria within SRP 3.7.2." The staff confirmed in its detailed review of DCD Revision 15, Section 3.7.2, that Westinghouse had committed to the provisions of SRP 3.7.2, Rev. 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 issued SRP Section 3.7.2, Rev. 3, in March 2007 and supporting RG 1.92, Rev. 2, in July 2006. The staff notes that DCD Revision 16 still states "Seismic analyses of the nuclear island are performed in conformance with the criteria within SRP 3.7.2." However, the staff's detailed review of Revision 16, Section 3.7.2, determined that Westinghouse has not committed to the latest staff guidance. The methods and acceptance criteria cited are the same as in Revision 15.

(b) The staff requests Westinghouse to (1) identify whether it is implementing the RG 1.92, Rev. 2 and SRP 3.7.2, Rev. 3, guidelines for conducting response spectrum analysis; and (2) if not, provide the technical basis for concluding that the response spectrum analysis methods Westinghouse has applied provide comparable accuracy.

RG 1.92, Rev. 2, (July 2006) and SRP 3.7.2, Rev. 3, (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. These are unchanged from DCD Revision 15, which pre-dates the latest staff guidance.

(c) 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.

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.

(d) The staff requests Westinghouse to identify whether it is implementing the RG 1.92, Revision 2 approach, and if not, to provide the technical basis for concluding that the method Westinghouse is applying provides a comparable level of solution accuracy.

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 SRP 3.7.2 (March 2007).

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.

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.

e. See item b above.

Reference(s): None

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None