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Your ref: Docket No. 52-006
Our ref: DCP_NRC_002620

September 17, 2009

Subject: AP1000 Response to Request for Additional Information (SRP 3)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 3. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in this response 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 RAI(s):

RAI-SRP3.2.1-EMB2-06
RAI-SRP3.8.2-CIB1-01 R2

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

Very truly yours,

Robert Sisk, Manager
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/Enclosure

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

D063
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-SRP3.2.1-EMB2-06
Revision: 0

Question:

10 CFR Part 50, Appendix S, IV(a)(2)(I) states that SSCs necessary for continued operation without undue risk to the health and safety of the public must remain functional and within applicable stress, strain, and deformation limits when subject to the effects of the Operating Basis Earthquake Ground Motion. NUREG-0800, SRP 3.2.1 states that, if the applicant has set the OBE Ground Motion to the value one-third of the SSE Ground Motion, then the applicant should also provide a list of SSCs necessary for continued operation that must remain functional without undue risk of the health and safety of the public and within applicable stress, strain and deformation, during and following the OBE. AP1000 DCD Section 3.7 states that the OBE for shutdown is considered to be one-third of the SSE.

10 CFR Part 50, Appendix S, IV(a)(3) states that if vibratory ground motion exceeding that of the Operating Basis Earthquake Ground Motion or if significant plant damage occurs, the licensee must shut down the nuclear power plant, and that prior to resuming operations, the licensee must demonstrate to the Commission that no functional damage has occurred to those features necessary for continued operation without undue risk to the health and safety of the public and the licensing basis is maintained. Listing the SSCs in the DCD will allow the plant to address the requirements when the need exists.

Provide this list of SSCs necessary for continued operation or an alternative to address the requirements. If DCD Table 3.2-3 serves this purpose, clearly state in the DCD that the table contains the list of SSCs necessary for continued operation.

Westinghouse Response:

The structures, systems, and components (SSCs) necessary to protect the public health and safety are the safety related (AP1000 Equipment Class A, B, and C) SSCs identified in Section 3.2.2 of the AP1000 Design Control Document (DCD) and tabulated in DCD Table 3.2-3. These SSCs are those necessary to ensure: (1) the integrity of the reactor coolant pressure boundary; (2) the capability to shut down the reactor and maintain it in a safe shutdown condition; or (3) the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures. As noted in DCD Subsection 3.2.2.2 Equipment Class A, B, and C SSCs are seismic Category I. As noted in DCD Subsection 3.2.1.1.1, seismic Category I SSCs are designed, analyzed, and qualified to survive the safe shutdown earthquake (SSE). The safety-related SSCs are available following an operating basis earthquake (OBE) to shutdown the plant and maintain it in a safe condition.

As noted in DCD Section 3.7 the operating basis earthquake has been eliminated as a design requirement for the AP1000. Criteria for evaluating the need to shut down the plant following an

earthquake are established using the cumulative absolute velocity approach according to EPRI Report NP-5930 and EPRI Report TR-100082. As noted in DCD Section 3.7, for the purposes of the shutdown criteria in NP-5930, the operating basis earthquake for shutdown is considered to be one-third of the safe shutdown earthquake. Note: because the operating basis earthquake is one-third of the safe shutdown earthquake the criteria of 10 CFR Part 50, Appendix S, IV(a)(2)(i)(A) applies and the criteria of Part 50, Appendix S, IV(a)(2)(i)(B) and IV(a)(2)(i)(B)(I) do not apply

In the event of a seismic ground motion meeting criteria in 10 CFR Part 50, Appendix S the plant may need to be shut down. Prior to resuming operations, the licensee must demonstrate to the Commission that no functional damage has occurred to those features necessary for continued operation. DCD Table 3.2-3 tabulates the safety-related systems and components that must be considered in an inspection and evaluation performed to demonstrate that no functional damage has occurred. Information is added to DCD Subsection 3.2.1.1, as shown below, to specify that the systems and components tabulated in Table 3.2-3 as Equipment Class A, B, and C are the systems and components necessary for continued operation in conformance with the applicable criteria in 10 CFR Part 50, Appendix S

The capability of nonsafety-related SSCs to support power production following an OBE is an investment protection issue. Continued operation of the power production equipment is not required to protect the public health and safety. The systems and components important to reliable power production and which provide defense in depth functions are included in the D-RAP table in DCD Table 17.4-1.

Design Control Document (DCD) Revision:

Add the following to Subsection 3.2.1.1 ahead of the last paragraph.

> Seismic Category I systems, and components identified as safety-related systems and components in Table 3.2-3 are the systems, and components necessary for continued operation that must remain functional without undue risk of the health and safety of the public during and following an operating basis earthquake. Systems and components identified as Equipment Class A, B, and C in Table 3.2-3 are the systems and components that per the criteria of 10 CFR Part 50, Appendix S, must be demonstrated, prior to resuming operations, to have no functional damage following a seismic ground motion exceeding the operating basis earthquake ground motion. See Section 3.7 for information on the operating basis earthquake.

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.8.2-CIB1-01
Revision: 2

Question:

Tier 2, Section 3.8.2.6 of the AP1000 DCD, describes the materials used to fabricate the containment vessel. The material selected satisfies the lowest service metal temperature requirement, established by analysis for the portion of the vessel exposed to the environment when the ambient air temperature is -40 °F. Westinghouse Technical Report APP-GW-GLN-113 (TR-113), "AP1000 Containment Vessel Shell Material Specification," Revision 0, submitted by Westinghouse letter dated May 11, 2007, revised this section by replacing the material specification Supplementary Requirement S17 with Supplementary Requirement S1 concerning the material fabrication process. However, Revision 16 to AP1000, Section 3.8.2.6 was changed to specify the lowest service temperature of -18.5 degrees F instead of -15 °F which was previously stated in Revision 15 of the AP1000 DCD. TR-113 did not specify the change to the service temperature nor provided any justification for this change in service temperature as required by 10 CFR 52.63(a)(1). In NUREG-1793, Section 3.8.2.6, the NRC staff approved -15 °F as the lowest service temperature based on the staff review of Westinghouse calculation APP-PCS-M3C-002, Revision 1, "AP1000 Containment Shell Minimum Service Temperature." Therefore, provide the reason and justification for the change in minimum service temperature of the containment vessel in accordance with 10 CFR 52.63(a)(1), and the analysis that supports the new service temperature proposed in Revision 16 of the AP1000 DCD.

Additional Question (Revision 1)

In a letter dated July 22, 2008, Westinghouse stated that an additional scenario was postulated for the containment vessel shell analysis, which determined that the containment vessel will be subjected to a service metal temperature of -18.5 °F. This evaluation postulated that an SSE event occurred in conjunction with -40 °F outside temperature and inadvertent actuation of active containment cooling. Westinghouse Technical Report APP-GW-GLR-005 (TR-9) only describes the analysis, and inadvertently did not include the corresponding service metal temperature.

Since TR-9 does not include the analysis or the service metal temperature, the NRC staff cannot confirm that -18.5 °F is the lowest service metal temperature of the containment vessel shell, which is fabricated from SA-738 Grade B material. This material must meet the requirements of NE-2000 for fracture toughness (Charpy V-notch test) in the as-welded condition for thicknesses up to and including 1.75 inches, and in the post-weld heat treated condition for thicknesses greater than 1.75 inches. The minimum service temperature is used to determine the testing temperature for the Charpy V-notch tests required by ASME Code, Section III, Subsections NE-2300 and NE-4300. Previously, Westinghouse stated in its letter dated April 22, 2003, that the SA-738, Grade B plate material will be procured using the service metal temperature of -15 °F (i.e., -55 °F Charpy V-notch test temperature as required by ASME

Code, Section III, Subsections NE-4335.2(b)(2) and Tables NE-4622.7(b)-1, note (2)(b)(1) in order to account for degradation during welding of the heat affected zone in the base material). In addition, Westinghouse stated in a letter dated March 13, 2003, that the previous analysis added an 8 °F conservative factor to obtain a minimum service metal temperature of -15 °F.

Therefore, the NRC staff requires additional information to verify the minimum service metal temperature. This information includes the details of the analysis (e.g., calculation methodology, assumptions made, similarities/differences from previous analysis, etc.) to confirm that -18.5 °F is the lowest service metal temperature to ensure that the material will be tested to have adequate toughness for the design and environment the containment shell will experience. Also, clarification is needed of whether the conservative factors described in the Westinghouse letter dated March 13, 2003, were also used in this analysis. Otherwise, justification for not including these conservative factors should be included

Additional Question (Revision 2)

The response to RAI-SRP 3.8.2-CIB1-01 Rev. 1 was inadequate because it did not provide the information specifically requested in the last paragraph of the Rev. 1 Additional Question. This includes details of the analysis (e.g., calculation methodology, assumptions made, similarities/differences from previous analysis, etc.) and a discussion of the conservatisms.

Westinghouse Response: (Revision 0)

An evaluation of AP1000 containment vessel, in the vicinity of large penetrations, was performed by Westinghouse to meet the requirements of COL Information Item 3.8-1. During this evaluation an additional scenario was postulated for the containment vessel shell analysis. The AP1000 plant is designed for sites that can have cold weather conditions with a minimum atmospheric temperature of -40 °F. Therefore, an SSE event was postulated to occur in conjunction with extreme cold weather condition (-40 °F outside temperature) and inadvertent actuation of active containment cooling. The analyses results were documented in an AP1000 calculation. The analyses determined that during this event, the containment vessel will be subjected to an external pressure of 0.9 psid and a 'Service Metal Temperature' of -18.5 °F.

Westinghouse Technical Report APP-GW-GLR-005 submitted to the NRC described these analyses in subsection 2.4.1 of the report. Also, in Table 3.8.2-1 'Load Combinations', at the end of the report, a reference was added for this event. This Table showed the external pressure of 0.9 psid, but inadvertently did not include the corresponding 'Service Metal Temperature' of -18.5 °F.

This change will be incorporated in the next revision of the DCD.

Additional Response (Revision 1):

The Revision 0 change indicated was made in DCD Rev 17.

The additional information required to verify the minimum service metal temperature is provided in Westinghouse document APP-MV50-Z0C-020. Rev 0. This document is made available for review in the Twinbrook office, and provides support for the Lowest Service Metal Temperature of -18.5 °F, corresponding to -40 degree F outside temperature.

Additional Response (Revision 2)

The original calculation supporting a minimum shell temperature of -15 °F represented a simple radial heat balance. The model is shown below:

$$q'' = h\text{-}in * (T_{cont} - T_{wall\text{-}in}) \quad (1)$$

$$q'' = k/x * (T_{wall\text{-}in} - T_{wall\text{-}out}) \quad (2)$$

$$q'' = h\text{-}out * (T_{wall\text{-}out} - T_{amb}) \quad (3)$$

where	q''	is the average heat flux through the shell wall
	h-in	is the average heat transfer coefficient between the containment atmosphere and the inside wall of the shell
	Tcont	is the average containment atmosphere temperature
	Twall-in	is the average temperature of the shell inside surface
	Twall-out	is the average temperature of the shell outside surface
	k	is the steel shell thermal conductivity
	x	is the thickness of the steel shell
	h-out	is the average heat transfer coefficient between the outside surface of the containment shell and the air in the annulus
and	Tamb	is the average temperature of the air in the annulus

For this calculation, the following values were used:

h-in =	1.0 Btu/hr/ft^2/°F	based on free convection
Tcont =	50 °F	lower containment limit
k =	30 Btu/hr/ft/°F	carbon steel thermal conductivity
x =	1.75 in	containment average thickness
h-out =	2.6 Btu/hr/ft^2/°F	based on mixed forced/free convection (Ref. 1)

Solving equations 1-3 simultaneously,

Twall-in = -14.7 °F

Twall-out = -15.1 °F

This is the basis for the -15 °F shell temperature reported previously.

For the more detailed calculation, the WGOTHIC computer code was used. The correlations used to calculate the heat transfer coefficients on the shell surfaces were slightly different than those used in the simplified model. Essentially, the free/forced convection model used on the outside surface resulted in a slightly higher heat transfer coefficient which, in turn, resulted in a lower shell temperature. WGOTHIC calculates a heat transfer coefficient of

h-out = 3.18 Btu/hr/ft^2/F

The radial heat balance performed by WGOTHIC results in an average outside shell temperature of -18 °F

References:

1. Holman, J.P., *Heat Transfer*, 4th Ed, McGraw-Hill, 1976.

The conservatisms used for the WGOTHIC calculation are those inherent in the WGOTHIC code and not necessarily those in the March 13, 2003 letter. The conservative factors described in the Westinghouse letter dated March 13, 2003 apply to the manual calculation method and do not apply to the method using WGOTHIC.

Design Control Document (DCD) Revision: (Revision 0)

The following change will be incorporated in the next revision of the DCD:

- Note 6 will be added in DCD Table 3.8.2-1 as follows:

  The 'Lowest Service Metal Temperature' corresponding to -40 degree F outside temperature is -18.5 °F.

PRA Revision:
None

Technical Report (TR) Revision: (Revision 0)

Technical Report APP-GW-GLR-005 (TR 9) will be revised as follows:

Note 6 will be added in Table 3.8.2-1 and will read:

The 'Lowest Service Metal Temperature' corresponding to -40 degree F outside temperature is -18.5 degree F.