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Your ref: Docket No. 52-006
Our ref: DCP/NRC2189

July 1, 2008

Subject: AP1000 Response to Request for Additional Information (SRP3.8.4)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 3.8.4. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in the response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

A response is provided for RAI-SRP3.8.4-SEB1-01, as sent in an email from Mike Miernicki to Sam Adams dated March 19, 2008. This response completes all requests received to date for SRP Section 3.8.4.

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
Licensing and Customer Interface
Regulatory Affairs and Standardization

/Enclosure

1. Response to Request for Additional Information on SRP Section 3.8.4

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NRO

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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 3.8.4

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.8.4-SEB1-01
Revision: 0

Question:

The shield building in AP1000 Rev.15 was a 100% reinforced concrete structure. The shield building has been revised in Rev.16. The revision involves a portion of the shield building cylinder wall and the shield building roof. The excerpts from the Rev. 16 are provided below:

3H.5.1.5 Shield Building Cylinder at Elevation 180'-0"

[*The thickness of the cylindrical portion of the shield building wall is 3 feet. Above the roof level, the wall consists of high strength concrete contained within ½-inch think steel liner plates on both*
faces. The liner plates, tied to concrete with shear connectors, behave as reinforcement bars. Vertical angle stiffeners are provided to support the wet concrete load.

The wall is designed for the applicable loads described in subsection 3H.3-3. A finite element analysis is performed to determine the design forces.

The design of the shield building roof is described in 3H.5.6.]*

3H.5.6 Shield Building Roof

[*The shield building roof is a reinforced concrete shell supporting the passive containment cooling system tank and air diffuser. The structural configuration is shown on sheets 7, 8, and 9 of Figure 3.7.2-12. Air intakes are located at the top of the cylindrical portion of the shield building. The conical roof supports the passive containment cooling system tank. The conical roof*
is constructed as a structural steel module and lifted into place during construction. Steel beams provide permanent structural support for steel liner and concrete. The concrete is cast in place. Connection between concrete and steel liner are made using shear studs.]*

Section 2.2.2.1.5 of Technical Report (TR) 57 states that the shield building cylinder in the air inlet region is 4.5' thick, and the cylinder thickness above and below the air inlet region is 3'-0".

The staff requests the following information:

1. Provide the geometries, typical cross-sections, and dimensions of the revised portion of the shield building wall and the boundary lines, in the horizontal (circumferential) and vertical (meridional) directions, between the revised portion and the non-revised portion of the shield building.
2. Provide anchorage details, in the horizontal (circumferential) and vertical (meridional) directions, between the revised portion and the non-revised portion of the shield building.

Provide calculations to demonstrate that the anchorage details have sufficient capacity to transfer all types of loads, such as bending moment, shear force and axial force. Describe the method that was used for the calculations, and state whether the method was derived from, or substantiated by, test data. If yes, provide the test data. If not, provide the basis for using the method.

3. Provide the size (diameter), length, and spacing of shear connectors, and state whether they are welded to the entire plate or not. If not, specify the regions of the plate that contain shear connectors.
4. Section 3H.5.1.5 states that "*A finite element analysis is performed to determine the design forces*", but fails to state the method that was used to design the concrete-filled steel cylinder to resist *the design forces*. Therefore, identify the critical regions (elements) of the revised portion of the shield building that are subjected to the largest load combination effects of *the design forces* (bending moment, axial force, and shear force) from your finite element analysis. Describe your design method and state whether the method was derived from, or verified by, test data. If yes, provide the test data. If not, provide the basis for using the design method. Is your design method influenced by the size, length, and spacing of shear connectors? If yes, state the influence of each item. If not, state the reason for no influence. Provide numerical examples, with at least one involves positive bending moment and the other negative bending moment, to illustrate your design method and demonstrate that the critical regions of the revised portion of the shield building can resist *the design forces*.
5. Based on the description of the last two sentences in Section 3H.5.6, Shield Building Roof, the staff assumes that steel plates (liners) with studs are welded to the top of the steel beams and concrete is then poured over the steel plates as exteriors of the roof. Provide drawings that indicate the thickness of the steel and the type, size, length, and spacing of welds that are used to attach the steel plates to steel beams and the size, length, and spacing of the studs. Identify the location of the most critical section (the largest load combination effect of bending moment, shear force, and axial force) in the shield building roof and provide numerical examples, with at least one involves positive bending moment and the other negative bending moment, to illustrate how the sections are designed to resist those forces.
6. Voids or honeycombs in reinforced concrete structures have been observed, after the removal of forms, and then repaired. Some structural members were found so deficient, after the removal of forms, that they were demolished and re-poured. Since the steel forms of the revised portion of the shield building walls are not to be removed, provide the method that you would use to inspect or detect concrete voids/honeycombs and other major defects.
7. In concrete construction, after the removal of forms, water in the concrete migrates continuously toward the faces of a concrete member and evaporates into the air, and the concrete dries out. With the steel forms remained in place, water will accumulate at the inside face of the steel forms and cannot escape. This water accumulation problem may cause the long-term steel plate corrosion problem. Therefore, provide your solution to this potential corrosion problem.

Westinghouse Response:

1. The 'Enhanced Shield Building Design' is developed to withstand beyond design basis loads also. Some of the design features are security related.

Typical details related to the geometries, cross-sections, and dimensions of the shield building wall, and the roof, are shown in Figure 2.2-18 (7 sheets) of Technical Report 57, APP-GW-GLR-045, Rev 2. The additional details and calculations are available for NRC audit.

2. As stated above, typical details related to the geometries, cross-sections, and dimensions of the shield building wall, and the roof, are shown in Figure 2.2-18 (7 sheets) of Technical Report 57, APP-GW-GLR-045, Rev 2.

The design calculations and the drawings are available for NRC audit.

3. Typical shear connectors design information is shown in Technical Report 57, APP-GW-GLR-045, Rev 2 figure 2.2-18 Sheets 2, 3 and 4.

The detail design calculations and the drawings are available for audit.

4. Detailed analyses and design calculations are available for the NRC audit. Answers to specific questions are provided below.

- Finite Element Analysis Method: Detailed analyses were performed using a 3-dimensional ANSYS finite element analysis model.

- Critical Regions: A list of the Auxiliary Building 'Critical Sections' is contained in the DCD Chapter 3 Appendix 3H (also in TR57 section 2.2.1).

- Two 'Critical Sections' were established, by the NRC, associated with the shield building conical roof and cylinder air inlet region. These critical sections are as follows:

(i) Shield building roof / PCCS Tank interface

(ii) Shield building roof / Shield building cylinder interface

These regions were modeled in great detail in the ANSYS 3-D finite element analysis model. The design details are summarized in Technical Report 57, APP-GW-GLR-045, Rev 2, Table 2.2-13 (3 sheets).

- Documents containing the analyses and design calculations are available for NRC audit.

5. - The conical roof structure includes the liner plate, with studs, welded to the top of the steel beams. Concrete slab, with reinforcement, poured on the steel liner plate forms the exterior surface of the roof.

- Sketches showing the typical design features are included in Technical Report 57, APP-GW-GLR-045, Rev 2, Figure 2.2-18 (sheets 1 thru 5). Detailed drawings, showing the information requested in the RAI, are available for NRC audit.

- 'Critical Sections': (Please see response to RAI question 4).

6. Concrete module construction technology has been in use for a long time. 'Self Consolidating Concrete', that precludes the possibility of voids or honeycombs, will be used for the modules.

7. The concrete mix is designed to control the heat of hydration, using appropriate water/cement ratio, specified type of cement, and a percentage of fly-ash. The moisture will not accumulate at steel plates. In a sealed environment there is no reason for moisture migration to a free surface. Even if some moisture accumulates at the steel plates, the lack of oxygen condition will prevent the plate corrosion.

As stated above, the concrete module construction technology has been in use for a long time; potential corrosion can be precluded by a proper concrete mix design.

Design Control Document (DCD) Revision:

See Revision 2 of Technical Report 57, APP-GW-GLR-045, for the changes already incorporated in DCD Rev 16; and the changes to be made in DCD Rev 16.

PRA Revision:

None

Technical Report (TR) Revision:

See Revision 2 of Technical Report 57, APP-GW-GLR-045.