AP1000 DESIGN CERTIFICATION REVIEW

Response to Request For Additional Information

RAI Number: 220.006

Question:

AP1000 DCD Subsection 3.8.3.1, "Description of the Containment Internal Structures," states that "The steel surface plates of the structural modules provide reinforcement in the concrete and anchor the structural modules to the base concrete." According to Figure 3.8.3-8 and the AP600 design, the structural modules also require anchoring to the concrete with mechanical connectors/rebars. Westinghouse is requested to clarify the statement in Subsection 3.8.3.1, specifically explaining whether the steel surface plates are sufficient to provide anchorage to the concrete or if additional mechanical connectors/rebars are also required. If additional mechanical connectors/rebars are required, identify where the details are described in the AP1000 DCD or provide the details as part of the response.

Westinghouse Response (Revision 1):

Structural modules are anchored to the base concrete to resist the reactions obtained from the design analyses. The anchorage design is developed in accordance with ACI 349 and typical details are shown in Figure 3.8.3-8. Reinforcement is provided to resist tension. ~~The connection between t~~The steel plate module **is anchored to** ~~and~~ the reinforced concrete basemat ~~is a combination of~~**by** mechanical connections welded to the steel plate ~~and~~ **or by** lap splices where the reinforcement overlaps shear studs on the steel plate.

See also the response to RAI Number 220.011.

Design Control Document (DCD) Revision:

Revise fourth paragraph of subsection 3.8.3.1 as follows:

Walls and floors are concrete filled steel plate structural modules. The walls are supported on the mass concrete containment internal structures basemat with the steel surface plate extending down to the concrete floor on each side of the wall. The steel surface plates of the structural modules provide reinforcement in the concrete. ~~and anchor t~~The structural modules are **anchored** to the base concrete **by mechanical connections welded to the steel plate or by lap splices where the reinforcement overlaps shear studs on the steel plate as shown in Figure 3.8.3-8.** Figure 3.8.3-1 shows the location of the structural modules. Figures 3.8.3-2 and 3.8.3-15 show the typical structural configuration of the wall modules. A typical floor module is shown in Figure 3.8.3-3 and also in Figure 3.8.3-16 combined with the liner module. These structural modules are structural elements built up with welded steel structural shapes and plates. Concrete is used where required for shielding, but reinforcing steel is not normally used.

Revise last paragraph of subsection 3.8.3.5.3

Figure 3.8.3-8 shows the typical design details of the structural modules, typical configuration of the wall modules, typical anchorages of the wall modules to the reinforced base concrete, and connections between adjacent modules. Concrete-filled structural wall modules are designed as reinforced concrete structures in accordance with the requirements of ACI-349, as supplemented in the following paragraphs. The faceplates are considered as the reinforcing steel, bonded to the concrete by headed studs. The application of ACI-349 and the supplemental requirements are supported by the behavior studies described in subsection 3.8.3.4.1. **The steel plate module is anchored to the reinforced concrete basemat by mechanical connections welded to the steel plate or by lap splices where the reinforcement overlaps shear studs on the steel plate.** The design of critical sections is described in subsection 3.8.3.5.8.

PRA Revision:

None

AP1000 DESIGN CERTIFICATION REVIEW

Response to Request For Additional Information

RAI Number: 220.011

Question:

AP1000 DCD Figure 3.8.3-1 (sheets 1 through 7) refers to three types of wall modules: CA Structure Wall Module, Left-in-Place Form, and CA Structure Module With Single Surface Plate. Please provide the following information:

A. A description, design approach, and analytical methods are provided for the first two types of modules; however, no descriptive information has been identified for the CA Structure Module With Single Surface Plate. A description for the CA type module similar to the information provided for the other two modules should be provided.

B. On this figure, sheets 1, 2, 4, 6, and 7, there are solid heavy lines (without tick marks) for a structural module. However, this marking is not identified on the "Key." Please explain what is meant by the solid heavy line marking.

Westinghouse Response (Revision 1):

A. The CA Structure Module With Single Surface Plate is an extension of the CA type wall module with two plates. Plates on each face of the wall module extend down to the elevation of the adjacent floor. Since the floors in the rooms each side of the wall module are at different elevations one of the plates extends further than the other. This portion is designated on the figures as "Structure Module With Single Surface Plate". A typical configuration is shown in Figure 3.8.3-8. The module functions as a wall above the upper floor level (elevation 103' 0" in Figure 3.8.3-8). The single plate below this elevation is designed to transfer the reactions at the base of the wall into the base mat. This plate also acts as face reinforcement for the basemat. Basemat reinforcement dowels are provided at the bottom of the single plate as shown in Figure 3.8.3-8.

B. On DCD Figure 3.8.3-1, sheets 1, 2, 4, 6, and 7, the solid heavy lines (without tick marks) are the two faces of the CA structural wall module. The heavy lines are joined by a representation of the trusses and are identified on the "Key." This representation is missing on some sheets and is being added.

Design Control Document (DCD) Revision:

Revise second paragraph of subsection 3.8.3.1.3:

Structural wall modules consist of steel faceplates connected by steel trusses. The primary purpose of the trusses is to stiffen and hold together the faceplates during handling, erection, and concrete placement. The nominal thickness of the steel faceplates is 0.5 inch. The nominal spacing of the trusses is 30 inches. Shear studs are welded to the inside faces of the steel faceplates. Face plates are welded to adjacent plates with full penetration welds so that the weld is at least as strong as the plate. **Plates on each face of the wall module extend down to the elevation of the adjacent floor. Since the floors in the rooms each side of the wall module are at different elevations one of the plates extends further than the other. This portion is designated on Figure 3.8.3-1 as "CA Structure Module With Single Surface Plate". A typical configuration is shown in Figure 3.8.3-8. The module functions as a wall above the upper floor level (elevation 103' 0" in Figure 3.8.3-8). The single plate below this elevation is designed to transfer the reactions at the base of the wall into the base mat. This plate also acts as face reinforcement for the basemat. Basemat reinforcement dowels are provided at the bottom of the single plate as shown in Figure 3.8.3-8.** The structural wall modules are anchored to the concrete base by reinforcing steel dowels or other types of connections embedded in the reinforced concrete below. After erection, concrete is placed between the faceplates. Typical details of the structural modules are shown in Figures 3.8.3-2, 3.8.3-8 and 3.8.3-17.

Revise Figure 3.8.3-1 as shown in attached figures.

PRA Revision:

None

AP1000 DESIGN CERTIFICATION REVIEW

Response to Request For Additional Information

RAI Number: 220.019

Question:

Subsection 3.8.5.5, "Structural Criteria," provides Tier 2* information applicable to the design of shear reinforcement for the basemat below the auxiliary building. The criteria for AP1000 appear to be a significant departure from the comparable Tier 2* criteria presented in the AP600 DCD and previously accepted by the staff. Therefore, Westinghouse is requested to provide (1) a detailed explanation of the differences between the new AP1000 criteria and the accepted AP600 criteria; and (2) the technical justification that a comparable level of safety will be achieved.

Westinghouse Response (Revision 1):

The criteria for the design of shear reinforcement for the basemat below the auxiliary building of the AP600 required minimum shear reinforcement even if the factored shear forces were very small. For the AP600 on a wide range of soil and rock sites, the design shear forces were of such magnitude that shear reinforcement was appropriate in all locations. For the AP1000 design for a hard rock site, bearing reactions are transmitted primarily below the walls of the auxiliary building and design shear forces in the 6 foot thick basemat are much lower. For such cases Westinghouse proposes to apply paragraph 11.5.5.1 of ACI 349 which does not require minimum shear reinforcement when the factored shear force is less than one half the shear strength provided by concrete, φV_c.

Design Control Document (DCD) Revision:

Revise the second paragraph of subsection 3.8.5.5 as follows:

[*The basemat below the auxiliary building is designed for shear in accordance with the provisions for continuous deep flexural members in paragraph 11.8.3 of ACI 349-01.* ~~*, except that*~~ ***As permitted by paragraph 11.5.5.1 of ACI 349-01,*** *shear reinforcement is not provided when the factored shear* ~~*strength*~~***force,*** V_u, *is less than one half of the shear strength provided by the concrete,* φV_c.]*

PRA Revision:

None