

ENCLOSURE 4

APP-GW-GLR-603

“AP1000 Shield Building Design Details for Select Wall and RC/SC Connections”

Revision 1

(Non-Proprietary)

June 2011

AP1000 License Report

AP1000 Shield Building Design Details for Select Wall and RC/SC Connections

**Note: Except as noted, the information in this document is
considered to be Tier 2*.**

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Record of Revisions

Item	Section	Change	Reason for Change
1	Cover	Added note about Tier 2*	NRC request
2	List of Tables	Deleted Table 2	Table 2 deleted
3	List of Figures	Added Figure 7	Figure 7 added
4	1	Added explanation of Tier 2*	Previous revision designated but did not explain Tier 2*
5	Table 1	Change "liner plate" to "faceplate"	Consistency with DCD and Shield building report.
6	Table 1	Added Connection Dowels	Additional item for material information
7	Table 1	Added Shear Lug	Additional items for material
8	2	Updated Shield Building Report Reference	Shield Building Report revised.
9	2	Added note about Tier 2*	Clarification
10	3	Added reference to subsections in Section 3.8	Section 3.8 revised to refer to GLR-603
11	3	Added explanation of Tier 2*	Clarification
12	4	Added reference to subsections in Section 3.8	Section 3.8 revised to refer to GLR-603
13	4	Added note about implementation of Tier 2*	Consistency with DCD approach for Tier 2* info.
14	4	Change "liner plate" to "faceplate"	Consistency with DCD and Shield building report.
15	4	Added phrase to steel specification to permit steel with equal or better material properties	Resolution of NRC comment.

Item	Section	Change	Reason for Change
16	4	Changed italic font to regular font for reinforcement info.	Since this report is a Tier 2* report additional designation is not needed.
17	4	Revise description of faceplate welds	Clarification
18	4	Added information on connection between the RC Auxiliary Building Roof and steel concrete composite (SC) Shield Building	NRC request
19	Table 2	Deleted Table 2	Information is not proprietary and is moved to DCD Table 3H.5-15
20	Figure 1	Added reference to Tier 2* information in Section 1	Refer to information added about Tier 2*
21	Figure 2	Added reference to Tier 2* information in Section 1	Refer to information added about Tier 2*
22	Figure 3	Added reference to Tier 2* information in Section 1	Refer to information added about Tier 2*
23	Figure 3	Added information on size of gusset and support plates	NRC request
24	Figure 4	Added reference to Tier 2* information in Section 1	Refer to information added about Tier 2*
25	Figure 5	Added reference to Tier 2* information in Section 1	Refer to information added about Tier 2*
26	Figure 5	Moved arrows identifying parts	Previous revision did not point to correct locations
27	Figure 6	Added reference to Tier 2* information in Section 1	Refer to information added about Tier 2*
28	Figure 7	Figure added to show connection between the RC Auxiliary Building Roof and Steel Concrete Composite (SC) Shield Building	NRC request

TABLE OF CONTENTS

1	INTRODUCTION.....	6
2	REFERENCES.....	7
3	REGULATORY IMPACT.....	7
4	TECHNICAL BACKGROUND.....	8

LIST OF TABLES

Table 1	List of Components and Material Properties used in the Shield Building.....	6
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LIST OF FIGURES

Figure 1:	RC/SC Connection Zone Showing Nominal Connection to SC Panel and Reinforcing Bars..	10
Figure 2:	Plan View of RC/SC Connection of [] ^{a,c} from Elevation 100 Feet to Elevation 103 Feet, 6 Inches.....	11
Figure 3:	Plan View of RC/SC Connection of [] ^{a,c} above Elevation 103 Feet, 6 Inches.	12
Figure 4:	Typical Interface Between Vertical Bar [] ^{a,c} and Hoop Bar [] ^{a,c} at grade	13
Figure 5:	Nominal SC Panel Details	15
Figure 6:	Rollout View Detailing Nominal Spacing of Tie Bars (Viewed from SB Interior)	15
Figure 7:	Typical Auxiliary building RC roof connection to the shield building SC wall	16

1 INTRODUCTION

This report documents proprietary design detail information, including Tier 2* information, for the AP1000 Shield Building cylinder and connections to the auxiliary building and basemat as described in design basis documents. *Tier 2** means the portion of the Tier 2 information, designated as such in the AP1000 design control document, which is subject to the change process in Section VIII of the AP1000 design certification rule. An applicant who references the AP1000 design certification rule may not depart from Tier 2* information, without NRC approval. See Section 3.5 of the introduction to the AP1000 Design Control Document (APP-GW-GLR-700) for a discussion of Tier 2* information. This information is consistent with the information previously provided in the Shield Building Report (Reference 1). Except as noted the information in this document is considered to be Tier 2*. A Tier 2* designation for a figure means that the design implemented in fabrication and construction drawings and instructions will have the design shown, an equal design, or a better design for the key structural elements.

The NRC staff, in its review of information in reports and responses to Requests for Additional Information (RAIs) provided by Westinghouse to support the AP1000 Design Certification amendment, identified information that should be incorporated into the Design Control Document (DCD). Some of this information provided to explain, define, and support the Shield Building design has been determined to be information proprietary to the Westinghouse Electric Company LLC. In conformance with the requirements of 10 CFR Section 2.390 Sensitive Unclassified Non-Safeguards Information, including proprietary information submitted to the NRC, may be withheld from public disclosure.

The AP1000 uses the innovative application of steel-concrete composite construction in the design of the shield building. Design information and criteria to demonstrate the strength of the shield building and the response to seismic and other loads is based on []^{a,c}. This design information is not publicly available and is proprietary. The NRC staff has determine that some of this detailed design information, in particular key design information for the design and construction of the shield building, is of sufficient importance that it should be incorporated into the DCD. This report considers the design details that are contained within selected portions of the shield building that are incorporated into DCD Section 3H by reference to this document.

The list of components with the material properties used in the enhanced shield building is identified in the following table.

<u>Component</u>	<u>Material</u>
Stiffener Plate	ASTM A572 Gr50 ¹
Faceplate	
Gussets	
Support Plate	
End Plate	
[] ^{a,c} Tie Bar in RC/SC Connection	ASTM A706 ¹

[] ^{a,c} Tie Bar	ASTM A496 ¹
[] ^{a,c} Stud	ASTM A108 ¹
[] ^{a,c}	ASTM A615 Gr60 ¹
[] ^{a,c}	
[] ^{a,c}	
[] ^{a,c}	
Dowels at connection of Auxiliary Building roof and Shield Building.	
Shear Lug (Connection with Auxiliary Building Roof)	ASTM A572 Gr50 ¹

¹Steel with equal or better material properties may be used in place of the listed material.

2 REFERENCES

1. APP-1200-S3R-003; Design Report for the Enhanced Shield Building, Revision 4, June 2011 (Westinghouse Proprietary)

Note: This reference is not designated as Tier 2*. The information included in the Shield Building report is not considered to be Tier 2* information.

3 REGULATORY IMPACT

This document documents and summarizes key structural design details of the AP1000 shield building. The technical information contained within this report is derived from the information contained in the Shield Building report for selected shield building components. The information included in the Shield Building report was subject to extensive review by the NRC as part of their review of the Shield Building design. The Shield Building report (Reference 1) was docketed during the review.

The information included in the text, table, and figures of this report (APP-GW-GLR-603) is incorporated by reference as part of the DCD in Subsections 3.8.4.1, 3.8.4.5.4, 3.8.4.5.5, 3.8.4.6.1.3, and Appendix 3H.5.7 and is considered to have the same level of importance as information as the reference itself. The generation and revision of this report is subject to the same process and review as DCD information. Tier 2* information in this report is subject to the same requirements for NRC approval as Tier 2* information in the DCD.

The information included in this report was identified by the NRC as important to their conclusions documented in the Safety Evaluation Report supplement for the AP1000 Design Certification amendment. The information required to be included in this report was discussed with the NRC during meetings and phone call in January, February and March 2011.

4 TECHNICAL BACKGROUND

This report identifies selected proprietary design detail information for the AP1000 Shield Building cylinder and connections to the auxiliary building and basemat as described in design basis documents. It is intended to be consistent with the information which was provided in the Shield Building Report (Reference 1) and Appendix 3H5.7 of the DCD.

This report provides the requisite design details that are contained within selected portions of the auxiliary and shield building critical sections that are part of DCD Subsections 3.8.4.1, 3.8.4.5.4, 3.8.4.5.5, 3.8.4.6.1.3, and Appendix 3H. In compliance with the Tier 2 * designation of the information in this report, the design implemented in fabrication and construction drawings and instructions will have the design described, an equal design or a better design for the key structural elements.

Steel Concrete Composite (SC) Shield Building RC/SC Connection Zone Details (3H.5.7.2)

Figure 1 shows the representative details for the vertical RC/SC connection zone which are based on Figure 4.1-2 of the enhanced SB design report (Reference 1). The faceplate, support plate, and gusset plates are American Society of Testing Materials (ASTM) A572 Grade 50 or steel with equal or better material properties. The steel faceplate is thickened in this region to 1.0 inch thick. The connection design methodology is similar for each of the RC/SC connections, vertical connections at elevation 100', 146'-10" and the hoop bar connection at Azimuths 340 degrees and 177 degrees. A view of the hoop bar []^{a,c} is shown in Figure 3. An end plate on the []^{a,c} is used to allow for welding of the hoop bars that are within the height of the []^{a,c}. The end plate and []^{a,c} to the plate are shown in Figure 2. []^{a,c}

The []^{a,c} that are welded to the steel faceplates are ASTM A706 or steel with equal or better material properties. The []^{a,c} are made of ASTM A496 or steel with equal or better material properties.

DCD Table 3H.5-14 (Sheet 3 of 3) shows the plate thickness provided and plate thickness required for mechanical load cases. This location, on the west side at grade, is one of the most stressed locations in the shield building under SSE loading due to overturning of the cylinder. The shear reinforcement required is also calculated. []^{a,c} The out of plane shear capacity is calculated using beam action equations in ACI-349 Section 11, including the reduction in concrete shear strength when the section is under significant tension.

The welds that anchor the faceplates to the RC/SC connection are complete joint penetration (CJP) welds, as defined by AWS A3.0M/A3.0:2010. The welds that connect the faceplate to faceplate are also CJP welds.

Steel Concrete Composite (SC) Shield Building Wall Panel (3H.5.7.1)

Figure 5 shows the representative details for a standard (Type 2 module) shield building wall panel which are based on Figure 3.1-2 of the enhanced SB design report (Reference 1). []

]^{a,c} fabricated of ASTM A572 or steel with equal or better material properties steel faceplates on each face. The[]^{a,c} are made of ASTM A496 or steel with equal or better material properties. The studs are []^{a,c} made of ASTM A108 material or steel with equal or better material properties.

Type 1 module are fabricated in the same manner except []^{a,c} Type 1 modules are used in regions with higher out of plane shear.

The studs and tie bars are provided to ensure composite action. []^{a,c}

DCD Table 3H.5-14 (Sheet 2 of 3) provides details about the loading and plate required and provided for an element with maximum out of plane demand for a Type 2 module outside of []^{a,c} This element is located at elevation 175 ft near wall 7.3 above the auxiliary building roof line. The shear reinforcement required is also calculated. []

]^{a,c} The out of plane shear capacity is calculated using beam action equations in ACI-349 Section 11, including the reduction in concrete shear strength when the section is under significant tension.

DCD Table 3H.5-14 (Sheet 1 of 3) provides details about the loading and plate required and provided for an element with maximum out of plane demand for a Type 1 module inside of []^{a,c} This element is located at elevation 180 ft near fuel handling building roof line. The shear reinforcement required is also calculated. []^{a,c}

The out of plane shear capacity is calculated using beam action equations in ACI-349 Section 11, including the reduction in concrete shear strength when the section is under significant tension.

The tie bars are welded to the steel face plates using a weld detail that will develop 125% of the specified yield of the bar. The faceplates are connected to adjacent panels with a complete joint penetration weld.

Figure 6 shows the representative details for the rolled-out circumferential RC/SC connection zone which are based on Figure 4.1-1 of the enhanced SB design report (Reference 1). The SC Shield Building walls are anchored to the RC basemat and walls by []^{a,c}

Connection Between the RC Auxiliary Building Roof and Steel Concrete Composite (SC) Shield Building (3.8.4.1)

Figure 7 shows the representative details for the connection between the RC auxiliary building roof and the SC Shield building wall. The design and construction of the connection with in the reinforced concrete roof is governed by ACI-349.



Figure 1: RC/SC Connection Zone Showing Nominal Connection to SC Panel and Reinforcing Bars

Note: See Section 1, INTRODUCTION for information on Tier 2* requirements.



**Figure 2: Plan View of RC/SC Connection of []^{a,c} from Elevation
100 Feet to Elevation 103 Foot, 6 Inches**

Note: See Section 1, INTRODUCTION for information on Tier 2* requirements.



Figure 3: Plan View of RC/SC Connection of []^{a,c} above Elevation 103 Feet, 6 Inches

Note: See Section 1, INTRODUCTION for information on Tier 2* requirements.



Figure 4: Typical Interface Between Vertical Bar []^{a,c} and Hoop Bar []^{a,c} at grade

Note: See Section 1, INTRODUCTION for information on Tier 2* requirements.



Figure 5: Nominal SC Panel Details

Note: See Section 1, INTRODUCTION for information on Tier 2* requirements.



Figure 6: Rollout View Detailing Nominal Spacing of Tie Bars (Viewed from SB Interior)

Note: See Section 1, INTRODUCTION for information on Tier 2* requirements.



1. The connection inside the shield building wall is provided by a range of reinforcement, []^{a,c} Spacing is determined along the shield building wall.
2. This connection is typical of connections in sections of the roof away from discontinuities such as walls or openings.
3. See Table 1 for material information for connection reinforcement bars and shear lug.
4. Figure not to scale.
5. []^{a,c}
6. See Section 1, INTRODUCTION for information on Tier 2* requirements.

Figure 7 Typical Auxiliary building RC roof connection to the shield building SC wall