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# **Design Requirements for the U.S. EPR Aircraft Hazard Protection Structures**

ANP-10317  
Revision 1

## **Technical Report**

April, 2013

AREVA NP Inc.

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**Nature of Changes**

Item	Section(s) or Page(s)	Description and Justification
000	All	Initial Issue
001	All	Page numbering and format updates, included acronyms after first use of words.
001	Section 2.2	Updated Item 1 description to remain consistent with source document, corrected Item 7 text from "Safeguards Building 2/3" to "Fuel Building", Added Design Requirements Items 11 - 16 to provide more information, changed units for last five items of Table 2-1 to remain consistent with source document, for items 5-7 "20g" update to "27g" to be consistent with Reference 2, added fire barrier protection to Item 7 to be consistent with source document. Updated Item 13 text to address RAI 565 Question 358 (in part), including reviewer comment re; the concrete sliding door.
001	Section 2.2	Figure 2-8 information was incorporated into new Figures 2-8 through 2-11 for clarity and updated barrier parameters information to remain consistent with source document.
001	Section 2.2	Added new Figures 2-12 through 2-14 to provide more information.
001	Section 2.2	Figure 2-9 was updated to Figure 2-15 and figure updated to remain consistent with source document.
001	Section 3.0	In response to RAI 565, Question 1-357, updated reference methodology from Revision 7 to Revision 8 of NEI 07-13.

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## Nomenclature

**Acronym****Definition**

NEI	Nuclear Energy Institute
FSAR	Final Safety Analysis Report
EF	Each Face
EW	Each Way
NI	Nuclear Island
RSB	Reactor Shield Building
FBSW	Fuel Building Front and Side Shield Walls
FBSR	Fuel Building Shield Roof
MLSW	Material Lock Front and Side Shield Walls
SGSW	Safeguard Building 2&3 Front and Side Shield Walls
SGSR	Safeguard Building 2&3 Shield Roof
SGW	Safeguard Buildings 1 and 4 Front and Side Structural Walls
AISW	Air-Intake Front Structural Walls
FBWB	Fuel Building Wall Buttress
FBRB	Fuel Building Roof Buttress
SGFWB	Safeguard Building 2&3 Front Wall Buttresses
SGSWB	Safeguard Building 2&3 Side Wall Buttresses
SGRB	Safeguard Building 2&3 Roof Buttresses

## **1.0 PURPOSE**

This report, in combination with the U.S. EPR™ FSAR, documents the design requirements for the U.S. EPR standard plant design Aircraft Hazard Protection Structures in accordance with the regulatory requirements stated in the final rule amending 10 CFR Parts 50 and 52 (Reference 1) for a large commercial aircraft impact. The design requirements specified in this report conform to the guidance of the Nuclear Energy Institute (NEI) (Reference 2) for performing the evaluation of a large commercial aircraft impact as a beyond-design-basis event. Design requirements for the U.S. EPR aircraft hazard protection structures prevent perforation of the exterior of the Nuclear Island (NI) Common Basemat exterior structures and prevent or control areas where fuel can enter the buildings.



## **2.0 DESIGN REQUIREMENTS FOR THE NI STRUCTURES**

The design requirements specified in this report include aircraft hazard protection design requirements for the NI structures based on Reference 2. Fire barriers with a [ ] in accordance with Reference 2 are specified in the U.S. EPR FSAR Tier 2, Appendix 9A figures.

### **2.1 NI Common Basemat Exterior Shield Structures**

The NI Common Basemat exterior shield structures and identifiers for specific structures and structural elements are shown in Figure 2-1 and Figure 2-2. The corresponding minimum design requirements for the indicated structures and structural elements are shown in Table 2-1. Figure 2-3 through Figure 2-7 provide minimum reinforcing requirements for the exterior shield structure buttresses.

The construction (placement) of reinforcement for the specified shield structures will satisfy the following requirements:

- Flexural reinforcement layers will be tied together at each bar's intersection point.
- Shear ties or stirrups will provide confinement for the flexural reinforcement layers in the section.
- Coupling bar connectors will be used for the bar extension.

### **2.2 Additional Design Requirements**

The following are additional design requirements:

1. Shield blocks are designed to prevent perforation by the component specified in the AIA. Refer to Figures 2-8 through 2-15 for placement and additional specifications for shield blocks.

2. Design requirements for specific structural elements of the Nuclear Auxiliary Building (NAB), Radioactive Waste Processing Building (RWPB), Emergency Power Generating Buildings (EPGB), and Essential Service Water Buildings (ESWB) are available for inspection. The figures related to design requirements for these areas have been determined to contain Safeguards Information, therefore, they will be made available for inspection but will not be included in this report.
3. The main steam relief train silencers will incorporate breakaway features above the Safeguard Building penetration seal that limit forces imposed on the main steam system in the Safeguard Building such that the safety-related main steam valves remain functional and the pressure boundary of the system is not compromised.
4. The main steam and main feedwater piping exterior to the Safeguard Buildings will be routed so that loads resulting from aircraft impact will provide sufficient stress in the pipe exterior to the building such that this pipe undergoes plastic deformation, before damaging the penetration support at the Safeguard Building [ ] .
5. A six inch clearance gap will be maintained between the inside face of the Reactor Shield Building and any components in the annulus. However, this clearance gap is not required if an evaluation has been performed to demonstrate that the shock induced on the containment structure or other safety-related components from a large commercial aircraft impact is less [ ] (Reference 2).
6. The U.S. EPR is designed so that following an aircraft impact, the gap will not be closed between the inside face of the Safeguard Building 2/3 shield walls, and any components attached to the adjacent Safeguard Building 2/3 inner wall or that the shock induced on the component or Safeguard Building 2/3 inner walls from a large commercial aircraft impact is less [ ] (Reference 2).

7. The U.S. EPR is designed so that following an aircraft impact, the gap will not be closed between the inside face of the Fuel Building shield walls, and any components attached to the adjacent Fuel Building inner wall or that the shock induced on the component or Fuel Building inner walls from a large commercial aircraft impact is less [ ] (Reference 2).

8. [ ] .

9. Exterior doors at Elevation 0 feet for the Fuel and Safeguard Buildings that open to the outside will be recessed into the exterior wall so that there are no protrusions beyond the outside face of the wall (including hinges and door handles). An evaluation will be performed for doors located directly behind concrete barriers to verify that there is a sufficient gap for deflections of the barrier without impacting the door after aircraft impact and that any fire rating or pressure rating applied to the door is maintained after aircraft impact.

10. [ ]

11. EPGB Removable Missile Shields:

The removable missile shields in the EPGBs, see Figure 2-12, are constructed to the same standards as the walls containing the opening for which they are providing protection and will overlap the protected opening by a minimum of 24" on all sides (e.g., 24 inch 5000 psi concrete, #8 GR 60 rebar every 8 inches, etc).

## 12. Minimum Concrete Wall Characteristics for Non-NI Buildings:

All concrete walls within the NAB, EPGB, and ESWB with thicknesses greater than or equal to 17 inches and less than 23 inches will utilize, as a minimum, 5000 psi concrete with #7 GR 60 rebar on a 12 inch spacing.

All concrete walls within the NAB, EPGB, and ESWB with thicknesses greater than or equal to 23 inches and less than 35 inches will utilize, as a minimum, 5000 psi concrete with #8 GR 60 rebar on a 12 inch spacing.

All concrete walls within the NAB, EPGB, and ESWB with thicknesses greater than or equal to 35 inches will utilize, as a minimum, 5000 psi concrete with two layers of #8 GR 60 rebar on a 12 inch spacing.

The concrete walls within the RWPB shown in Figure 2-15 will have a thickness greater than or equal to 24 inches and will utilize, as a minimum, 5000 psi concrete with #8 GR 60 rebar on a 12 inch spacing.

## 13. Radioactive Waste Processing Building Protection:

The Radioactive Waste Processing Building includes a sliding concrete door as shown in Figure 2-15. The concrete sliding door is maintained closed during operations and shutdown conditions but is periodically opened to the size of a typical personnel door for normal personnel access. The normal position of the concrete sliding door may be maintained as partially open (not to exceed the size of a typical personnel door) at the discretion of the licensee. The concrete sliding door is infrequently opened in excess of the size of the typical personnel door for equipment transit but may not be maintained open in excess of the size of a typical personnel door. The opening and closing of the concrete sliding door is controlled by site administrative procedures.

Due to the weight of the concrete sliding door, electric power, hydraulic controls, or other controls or devices are required to open and close the concrete sliding door.

#### 14. Horizontal Roof Openings:

Horizontal roof openings are protected by raised concrete curbs to prevent unburned aviation fuel from draining into the opening following impact.

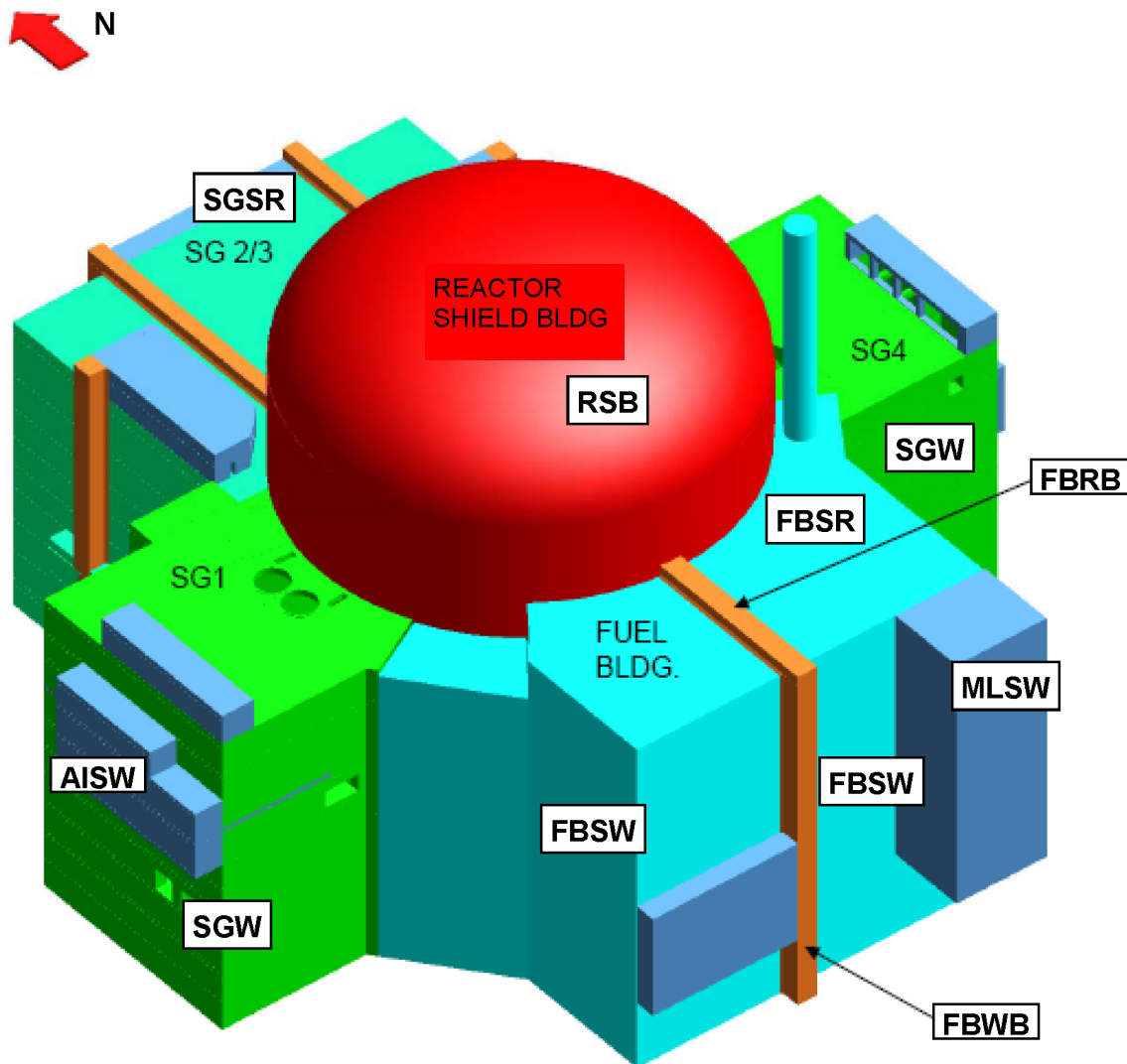
#### 15. Exterior Buried Conduit:

Exterior buried conduit is protected by seepage-resistant manways under concrete covers on the exterior manholes to prevent unburned aviation fuel from draining into the opening following impact.

Case No.	Case Name	Case Type	Case Status	Case Date	Case Location	Case Description	Case Details	Case Notes	Case Comments	Case Actions
1	John Doe	Case 1	Open	2023-01-01	New York	Case 1 Description	Case 1 Details	Case 1 Notes	Case 1 Comments	Case 1 Actions
2	Jane Smith	Case 2	Closed	2023-01-02	California	Case 2 Description	Case 2 Details	Case 2 Notes	Case 2 Comments	Case 2 Actions
3	Bob Johnson	Case 3	Pending	2023-01-03	Texas	Case 3 Description	Case 3 Details	Case 3 Notes	Case 3 Comments	Case 3 Actions
4	Alice Brown	Case 4	Open	2023-01-04	Florida	Case 4 Description	Case 4 Details	Case 4 Notes	Case 4 Comments	Case 4 Actions
5	Charlie Davis	Case 5	Closed	2023-01-05	Illinois	Case 5 Description	Case 5 Details	Case 5 Notes	Case 5 Comments	Case 5 Actions
6	Diana Prince	Case 6	Pending	2023-01-06	Ohio	Case 6 Description	Case 6 Details	Case 6 Notes	Case 6 Comments	Case 6 Actions
7	Frank Miller	Case 7	Open	2023-01-07	Georgia	Case 7 Description	Case 7 Details	Case 7 Notes	Case 7 Comments	Case 7 Actions
8	Grace Lee	Case 8	Closed	2023-01-08	Arizona	Case 8 Description	Case 8 Details	Case 8 Notes	Case 8 Comments	Case 8 Actions
9	Henry Wilson	Case 9	Pending	2023-01-09	Colorado	Case 9 Description	Case 9 Details	Case 9 Notes	Case 9 Comments	Case 9 Actions
10	Ivy White	Case 10	Open	2023-01-10	Connecticut	Case 10 Description	Case 10 Details	Case 10 Notes	Case 10 Comments	Case 10 Actions
11	Jack Black	Case 11	Closed	2023-01-11	Delaware	Case 11 Description	Case 11 Details	Case 11 Notes	Case 11 Comments	Case 11 Actions
12	Karen Green	Case 12	Pending	2023-01-12	Idaho	Case 12 Description	Case 12 Details	Case 12 Notes	Case 12 Comments	Case 12 Actions
13	Liam King	Case 13	Open	2023-01-13	Indiana	Case 13 Description	Case 13 Details	Case 13 Notes	Case 13 Comments	Case 13 Actions
14	Mia Queen	Case 14	Closed	2023-01-14	Iowa	Case 14 Description	Case 14 Details	Case 14 Notes	Case 14 Comments	Case 14 Actions
15	Noah Scott	Case 15	Pending	2023-01-15	Kansas	Case 15 Description	Case 15 Details	Case 15 Notes	Case 15 Comments	Case 15 Actions
16	Olivia Taylor	Case 16	Open	2023-01-16	Kentucky	Case 16 Description	Case 16 Details	Case 16 Notes	Case 16 Comments	Case 16 Actions
17	Peter Hall	Case 17	Closed	2023-01-17	Louisiana	Case 17 Description	Case 17 Details	Case 17 Notes	Case 17 Comments	Case 17 Actions
18	Quinn Adams	Case 18	Pending	2023-01-18	Maine	Case 18 Description	Case 18 Details	Case 18 Notes	Case 18 Comments	Case 18 Actions
19	Rachel Baker	Case 19	Open	2023-01-19	Maryland	Case 19 Description	Case 19 Details	Case 19 Notes	Case 19 Comments	Case 19 Actions
20	Samuel Clark	Case 20	Closed	2023-01-20	Massachusetts	Case 20 Description	Case 20 Details	Case 20 Notes	Case 20 Comments	Case 20 Actions
21	Tina Evans	Case 21	Pending	2023-01-21	Michigan	Case 21 Description	Case 21 Details	Case 21 Notes	Case 21 Comments	Case 21 Actions
22	Uma Frost	Case 22	Open	2023-01-22	Minnesota	Case 22 Description	Case 22 Details	Case 22 Notes	Case 22 Comments	Case 22 Actions
23	Victor Gray	Case 23	Closed	2023-01-23	Mississippi	Case 23 Description	Case 23 Details	Case 23 Notes	Case 23 Comments	Case 23 Actions
24	Wendy Harris	Case 24	Pending	2023-01-24	Missouri	Case 24 Description	Case 24 Details	Case 24 Notes	Case 24 Comments	Case 24 Actions
25	Xavier King	Case 25	Open	2023-01-25	Montana	Case 25 Description	Case 25 Details	Case 25 Notes	Case 25 Comments	Case 25 Actions
26	Yara Lee	Case 26	Closed	2023-01-26	Nebraska	Case 26 Description	Case 26 Details	Case 26 Notes	Case 26 Comments	Case 26 Actions
27	Zoe Miller	Case 27	Pending	2023-01-27	Nevada	Case 27 Description	Case 27 Details	Case 27 Notes	Case 27 Comments	Case 27 Actions
28	Adam White	Case 28	Open	2023-01-28	New Hampshire	Case 28 Description	Case 28 Details	Case 28 Notes	Case 28 Comments	Case 28 Actions
29	Bella Black	Case 29	Closed	2023-01-29	New Jersey	Case 29 Description	Case 29 Details	Case 29 Notes	Case 29 Comments	Case 29 Actions
30	Chris Green	Case 30	Pending	2023-01-30	New Mexico	Case 30 Description	Case 30 Details	Case 30 Notes	Case 30 Comments	Case 30 Actions
31	Diana King	Case 31	Open	2023-01-31	New York	Case 31 Description	Case 31 Details	Case 31 Notes	Case 31 Comments	Case 31 Actions
32	Ethan Lee	Case 32	Closed	2023-02-01	North Carolina	Case 32 Description	Case 32 Details	Case 32 Notes	Case 32 Comments	Case 32 Actions
33	Fiona Miller	Case 33	Pending	2023-02-02	North Dakota	Case 33 Description	Case 33 Details	Case 33 Notes	Case 33 Comments	Case 33 Actions
34	Gavin White	Case 34	Open	2023-02-03	Ohio	Case 34 Description	Case 34 Details	Case 34 Notes	Case 34 Comments	Case 34 Actions
35	Hannah Black	Case 35	Closed	2023-02-04	Oklahoma	Case 35 Description	Case 35 Details	Case 35 Notes	Case 35 Comments	Case 35 Actions
36	Ian Green	Case 36	Pending	2023-02-05	Oregon	Case 36 Description	Case 36 Details	Case 36 Notes	Case 36 Comments	Case 36 Actions
37	Jessica King	Case 37	Open	2023-02-06	Pennsylvania	Case 37 Description	Case 37 Details	Case 37 Notes	Case 37 Comments	Case 37 Actions
38	Kyle Lee	Case 38	Closed	2023-02-07	Rhode Island	Case 38 Description	Case 38 Details	Case 38 Notes	Case 38 Comments	Case 38 Actions
39	Laura Miller	Case 39	Pending	2023-02-08	South Carolina	Case 39 Description				

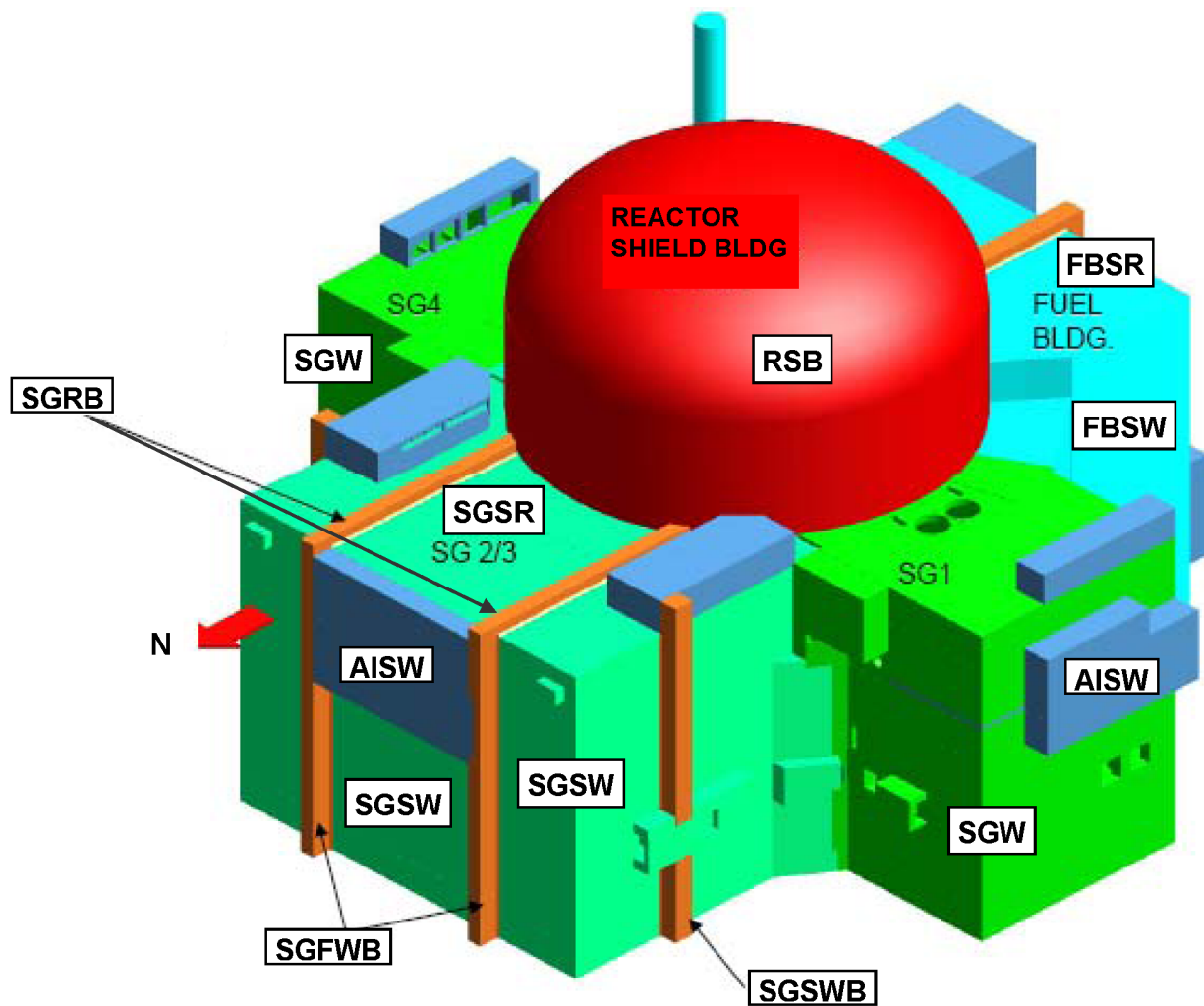
The image consists of a solid white rectangular area enclosed within a thin black border. The border is uniform in thickness and runs along all four edges of the page, creating a simple frame around the central white space.

**Figure 2-1: 3-Dimensional View of NI Common Basemat Structures  
Looking Northeast**

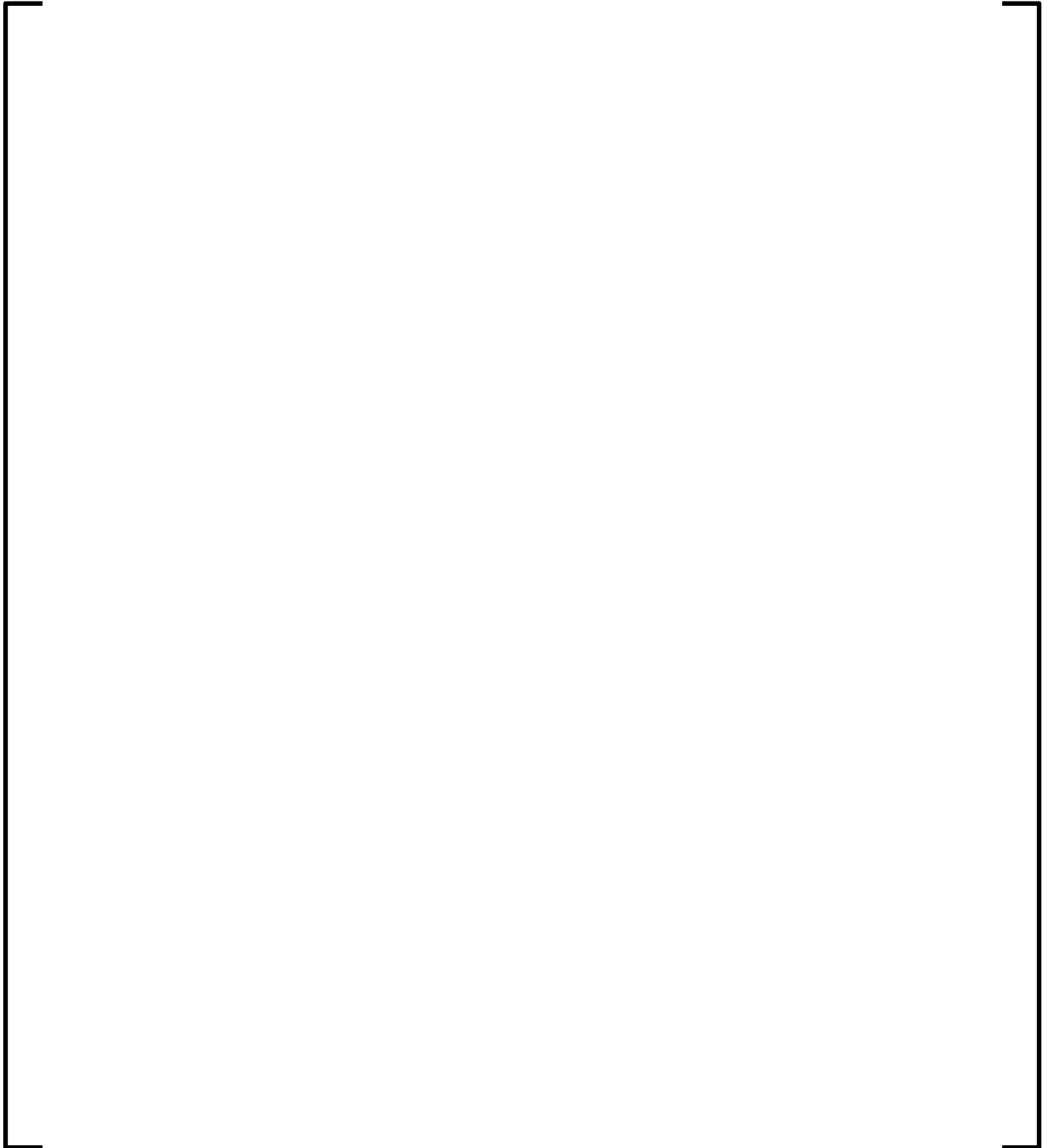




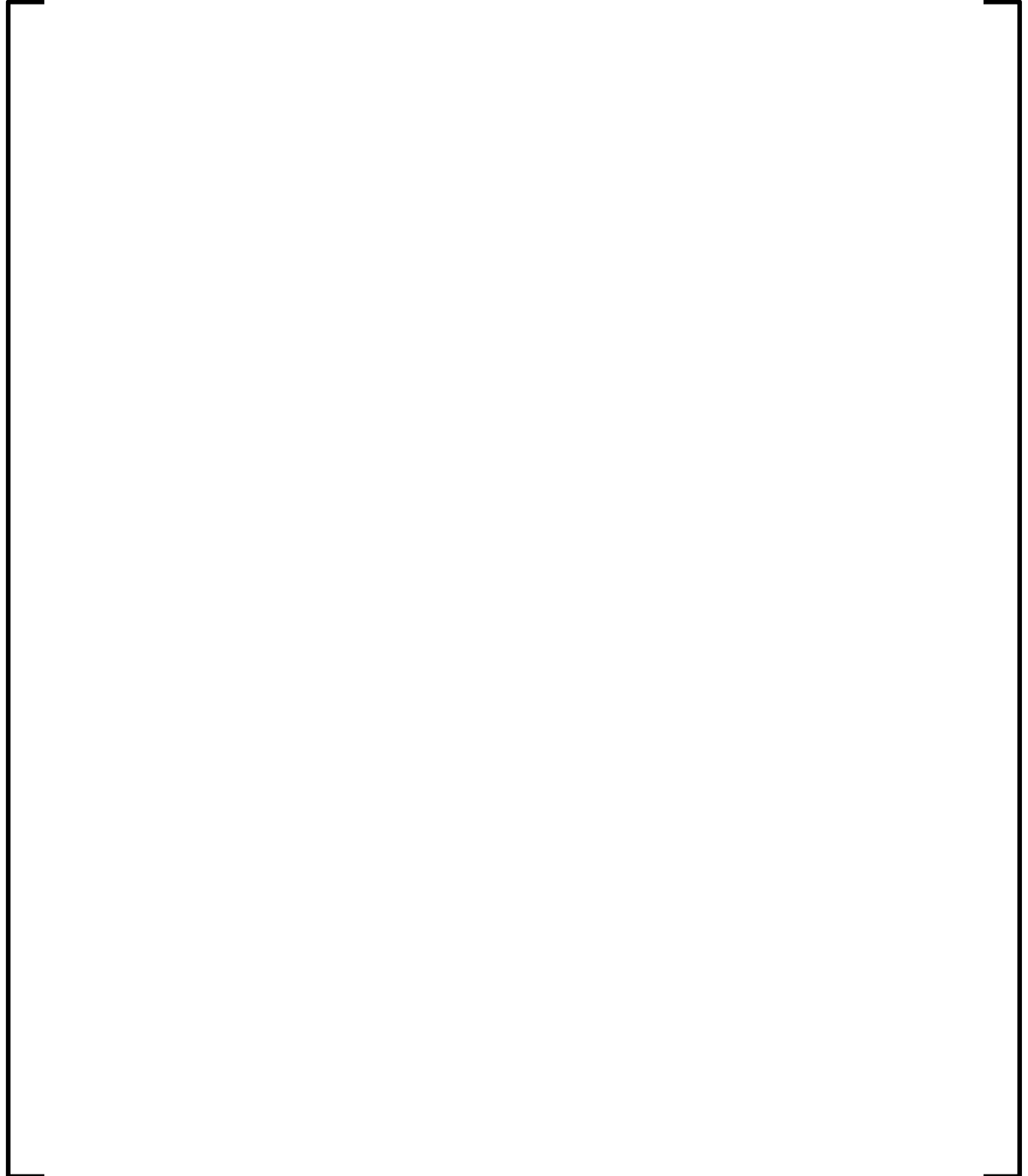
**Figure 2-2: 3-Dimensional View of NI Common Basemat Structures  
Looking Southeast**



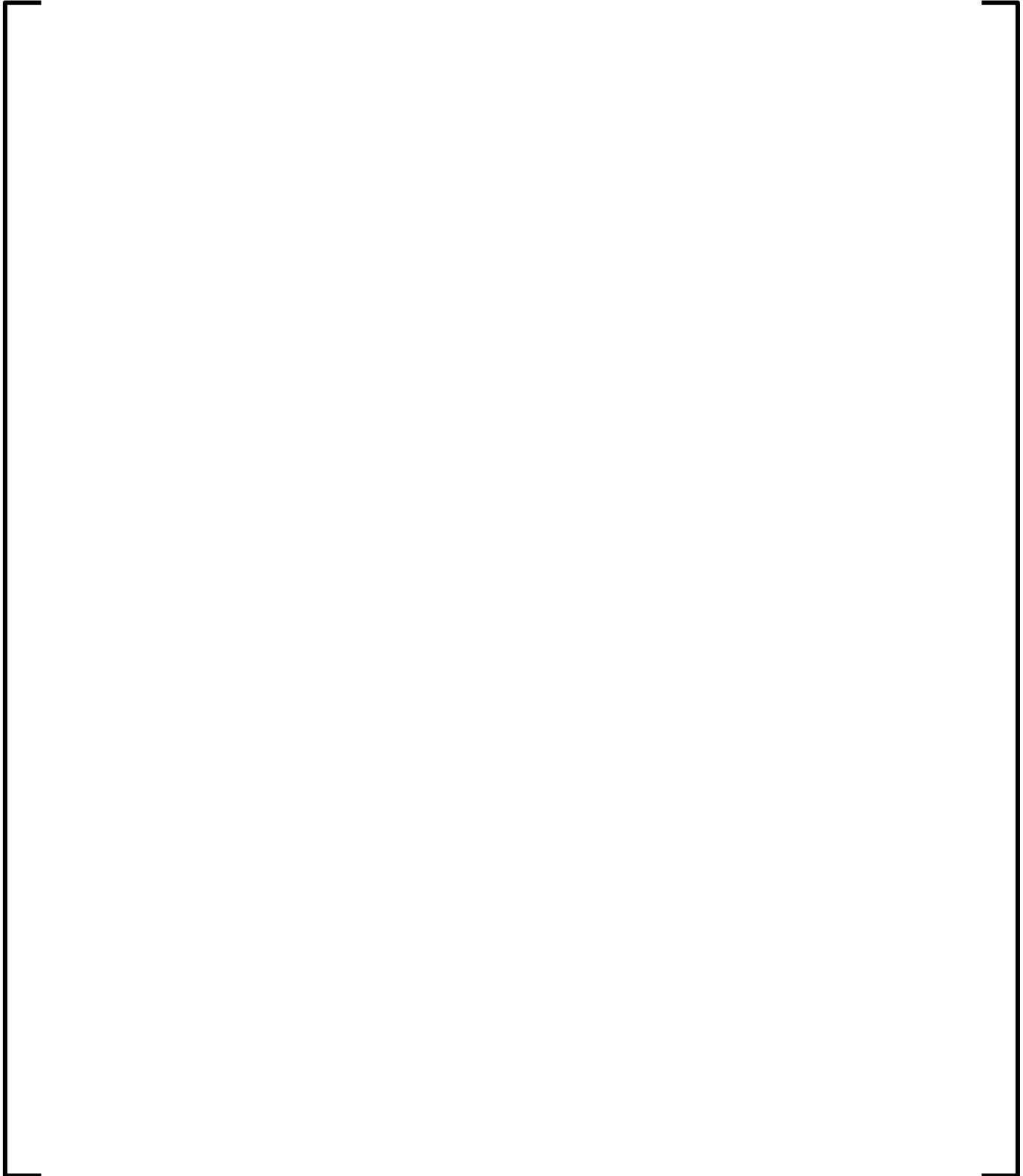
**Figure 2-3: Reinforcement Details in Fuel Building Wall Buttress**



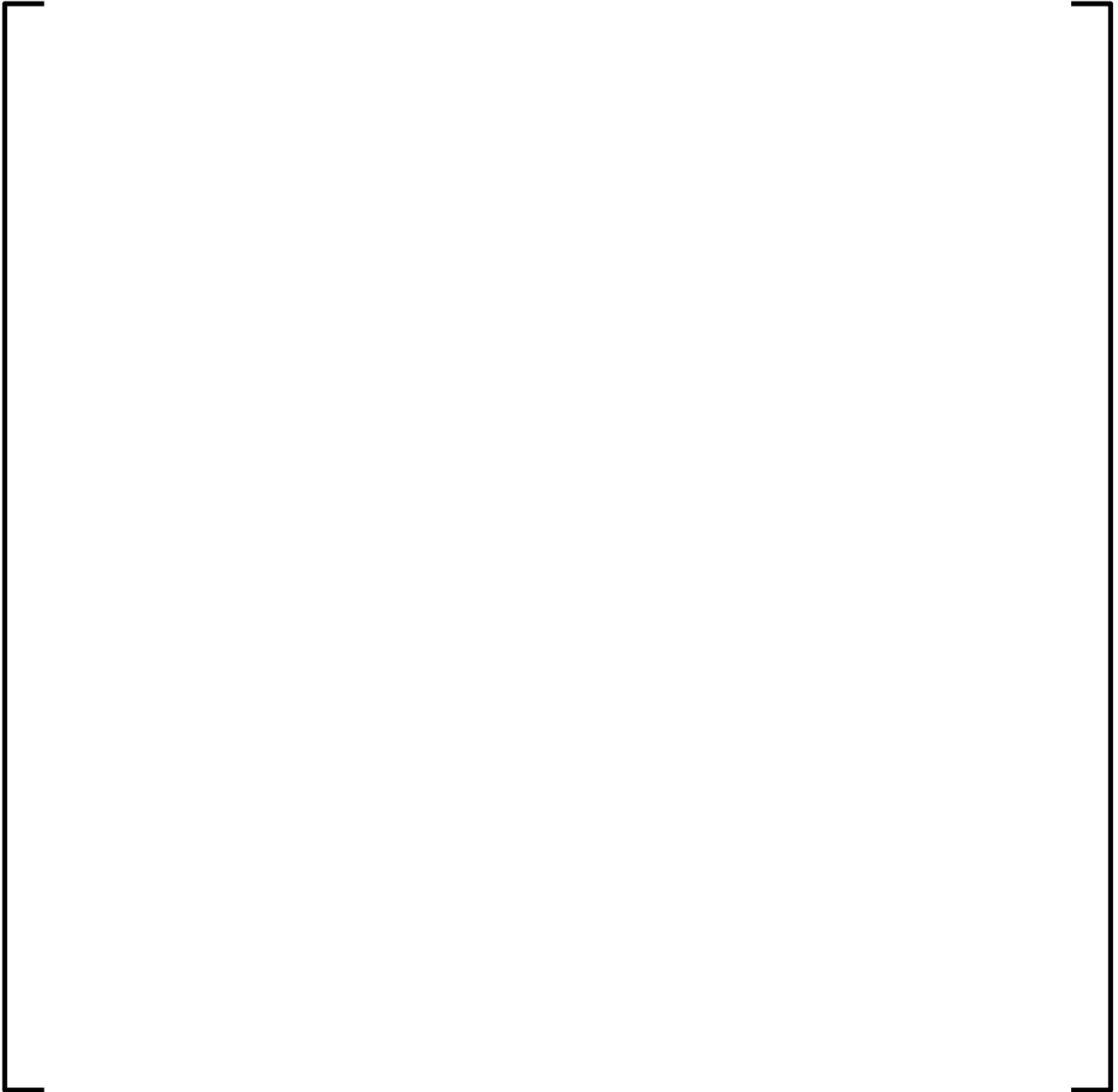
**Figure 2-4: Reinforcement Details in Safeguard Building 2&3 Front  
Wall Buttresses**



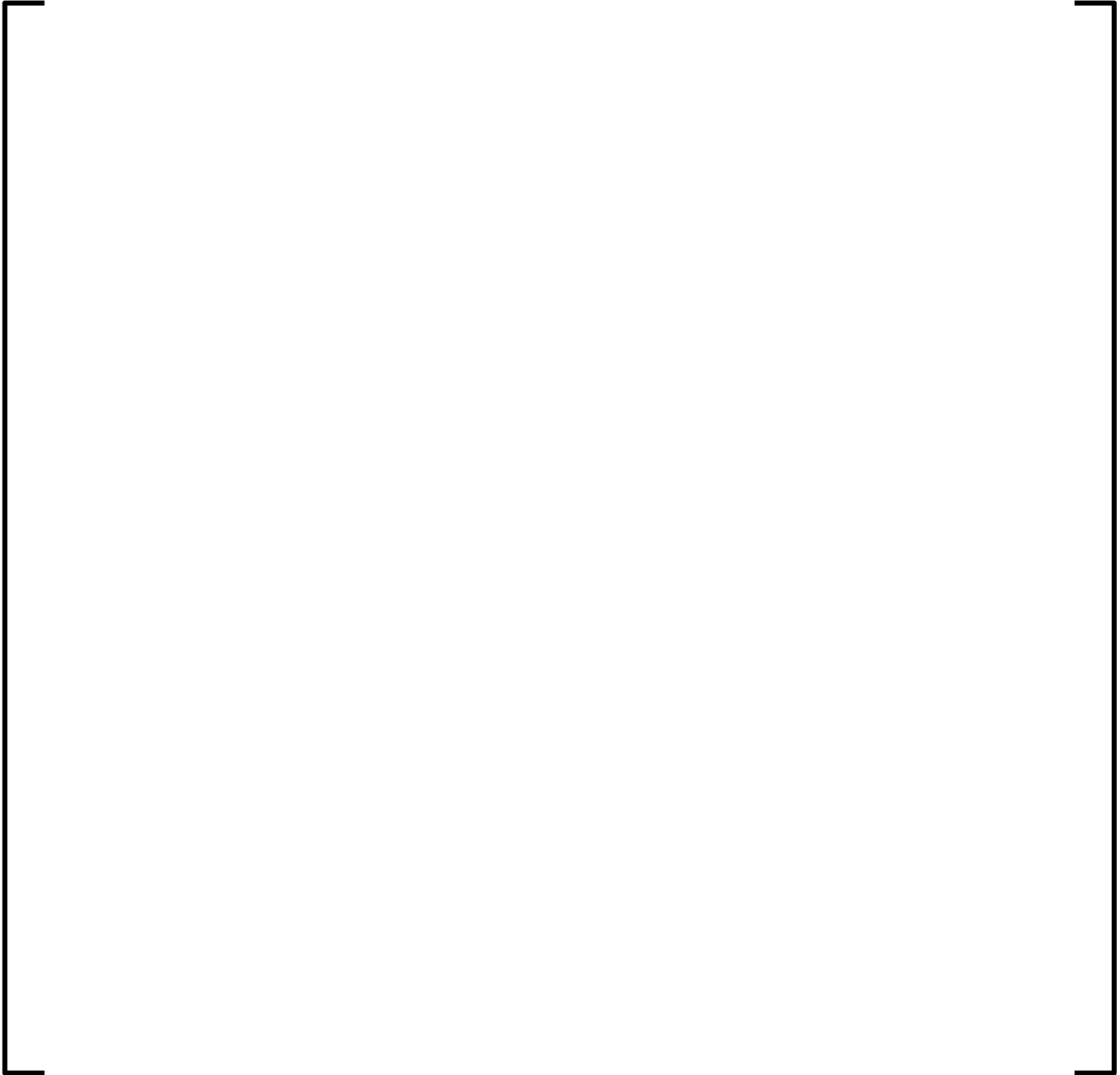
**Figure 2-5: Reinforcement Details in Safeguard Building 2&3 Side  
Wall Buttresses**



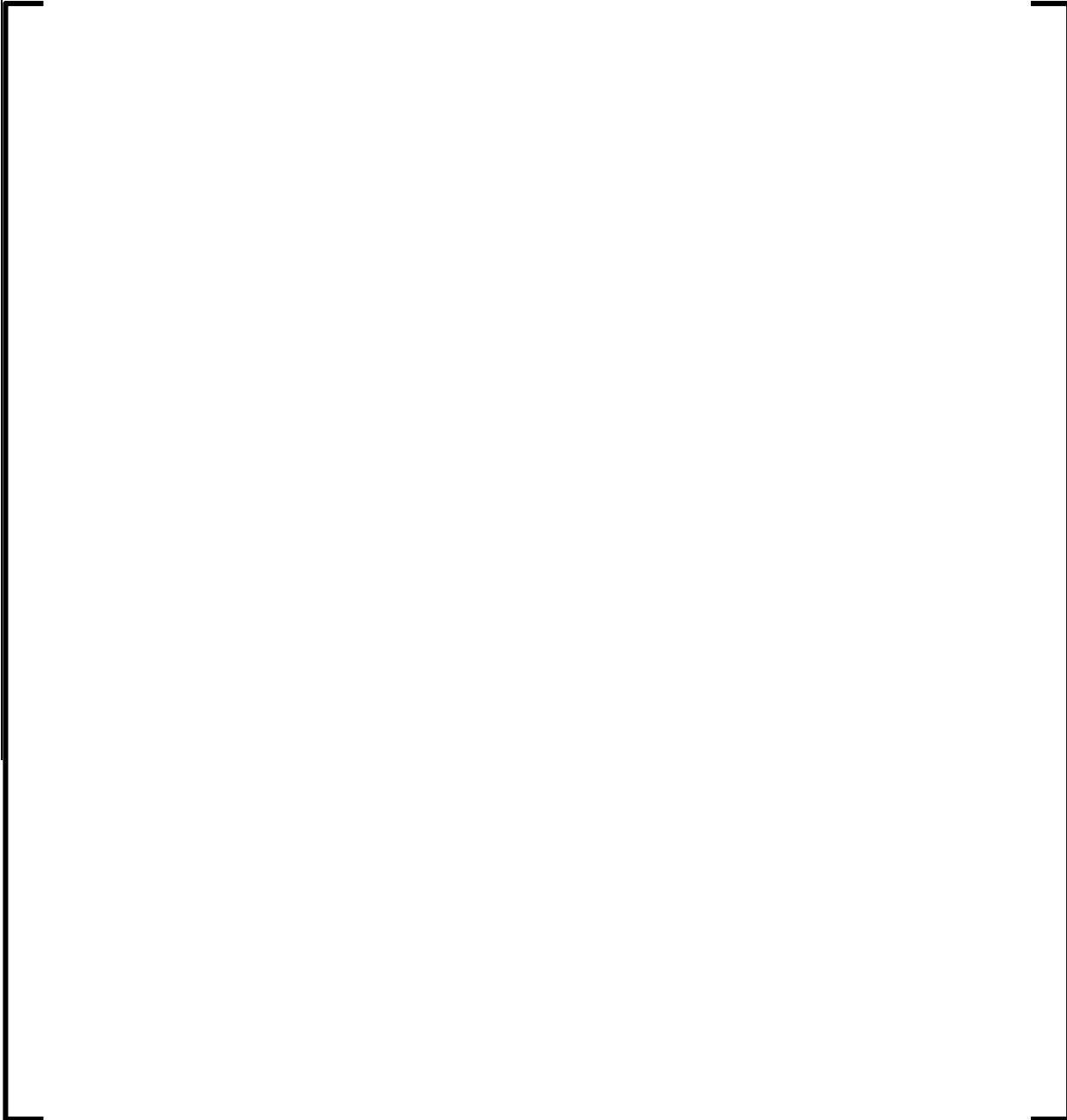
**Figure 2-6: Reinforcement Details in Fuel Building Roof Buttress**



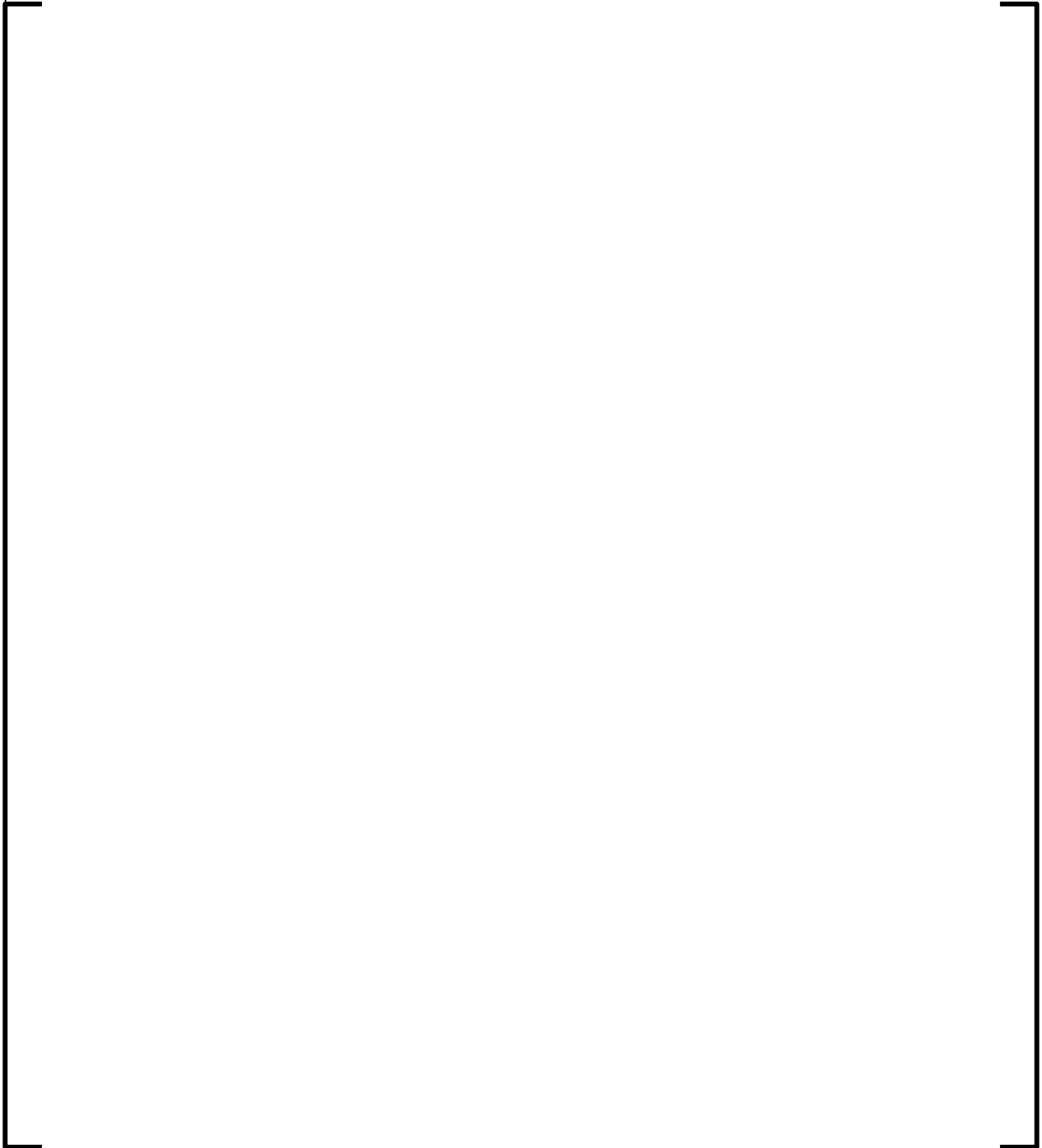
**Figure 2-7: Reinforcement Details in Safeguard Building 2&3 Roof  
Buttresses**



**Figure 2-8: SGB1 Removable Concrete Shield Blocks at Elevation  
0 Ft**



**Figure 2-9: SGB2 Removable Concrete Shield Block at Elevation 0 Ft**





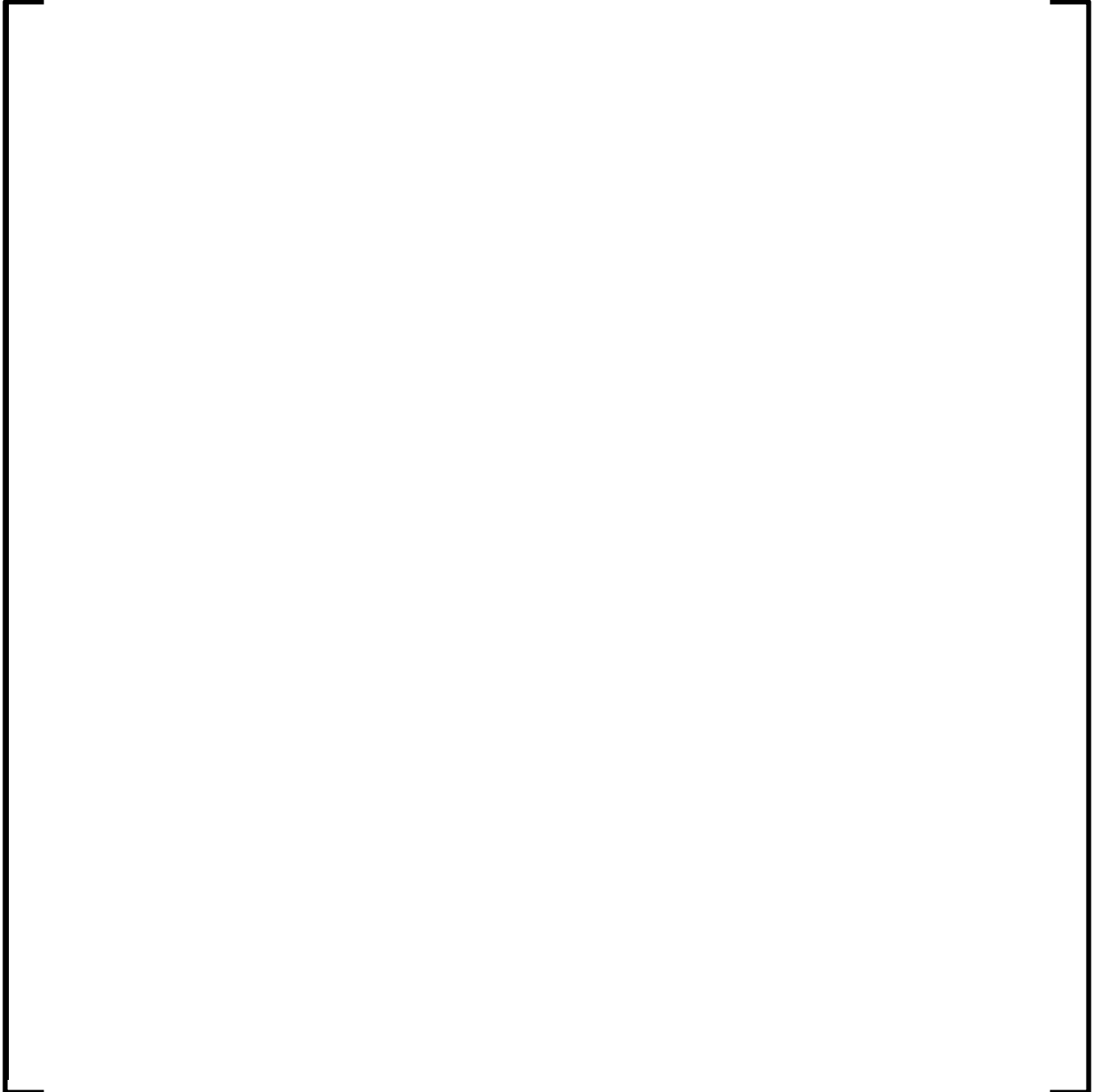
**Figure 2-10: SGB4 Removable Concrete Shield Block at Elevation  
0 Ft**



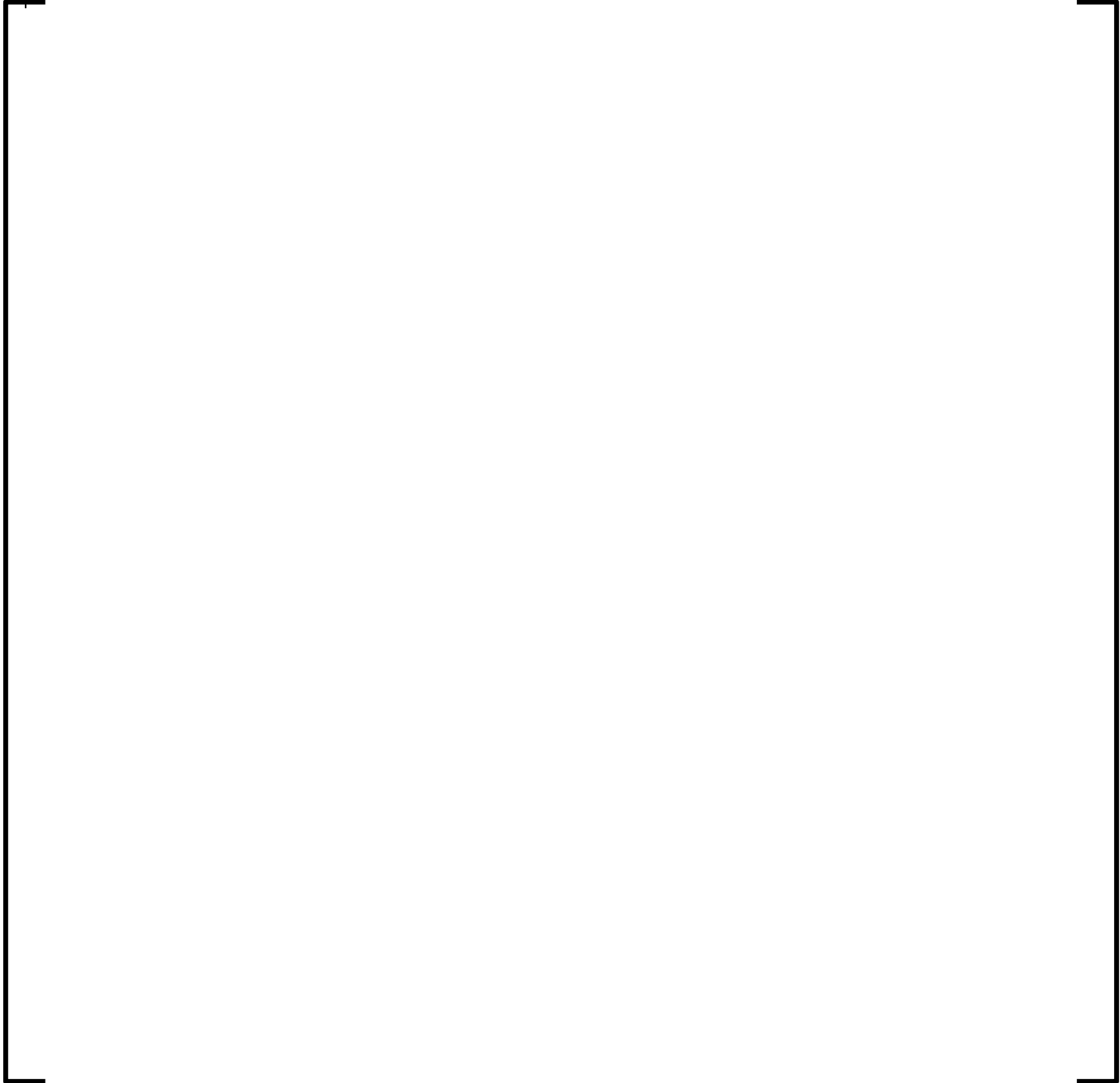
**Figure 2-11: Access Building Concrete Shield Blocks at Elevation  
0 Ft**



**Figure 2-12: EPGB Removable Concrete Shield Blocks at Elevation  
0 Ft**



**Figure 2-13: NAB Removable Concrete Shield Block at Elevation  
64 ft**



**Figure 2-14: NAB Removable Concrete Shield Block at Elevation  
81 ft**



**Figure 2-15: [**

**]**

### **3.0 REFERENCES**

1. 10 CFR Parts 50 and 52 Final Rule, "Consideration of Aircraft Impacts for New Nuclear Power Reactors," Federal Register, Vol. 74, No. 112, 74 FR 28146, June 12, 2009.
2. NEI 07-13, "Methodology for Performing Aircraft Impact Assessments for New Plant Designs," Revision 8, Nuclear Energy Institute, prepared by ERIN Engineering & Research, Walnut Creek, CA, April 2011.