Appendix 3H Auxiliary and Shield Building Critical Sections

3H.1 Introduction

[*This appendix summarizes the structural design and analysis of structures identified as "Critical Sections" in the auxiliary and shield buildings. The design summaries include the following information:*

- *Description of buildings*
- *Governing codes and regulations*
- *Structural loads and load combinations*
- *Global analyses*
- *Structural design of critical structural elements*

Subsections 3H.2 through 3H.5 include a general description of the auxiliary building and shield building, a summary of the design criteria and the global analyses. The 3H.5 figures referenced in the descriptions show the structural designs for critical sections which are identified in subsection 3H.5 and shown in Figure 3H.5-1 (3 sheets). The exact locations of the critical sections related to the shield building cylinder are shown in Figure 3H.5-16. Representative design details are provided for these structures in subsection 3H.5.]* RN-13-071 RN-13-027

3H.2 Description of Auxiliary and Shield Buildings

3H.2.1 Description of Auxiliary Building

[*The auxiliary building is a reinforced concrete structure. The auxiliary building is one of the three buildings that make up the nuclear island and shares a common basemat with the containment building and the shield building. The auxiliary building general layout is shown in Figure 3H.2-1. It is a C-shaped section of the nuclear island that wraps around approximately half of the circumference of the shield building. The building dimensions are shown on key structural dimension drawings, Figure 3.7.2-12.*

The auxiliary building is divided into six areas, which are identified in Figure 3H.2-1. It is a 5-story building; three stories are located above grade and two are located below grade. Areas 1 and 2 (Figure 3H.2-1) have five floors, including two floors below grade level. The lowest floor at elevation 66'-6" is used exclusively for housing battery racks. The next higher floor, at elevation 82'-6", also has battery racks and some electrical equipment. The floor at the grade level, elevation 100'-0", has electrical penetration areas, a remote shutdown workstation room, and some Division A and Division C equipment. The main control room is situated on the floor at elevation 117'-6", which also has rooms for the main steam and feedwater lines. The floor at elevation 135'-3" carries air filtration and air handling units, chiller pumps, and other mechanical and electrical equipment. The roof for areas 1 and 2 is at elevation 153'-0".

Areas 3 and 4 of the auxiliary building are the areas east of the containment shield building. Valve and piping areas, and some mechanical equipment, are located in the basement floor at elevation 66'-6". The floor at elevation 82'-6" has a piping penetration area, a radiation chemistry laboratory, makeup pumps, and other mechanical equipment. The floor at grade level elevation 100'-0" has an electrical penetration room, a staging area for the equipment hatch, and the access opening to the annex building. The electrical penetration area, trip switchgears, and motor control centers occupy most of the floor at elevation 117'-6". The floor at elevation 135'-3" is used for the

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storage of main control room air cylinders and provides access to the annex building. The roof for these areas is at elevation 160'-6".

Areas 5 and 6 include facilities for storage and handling of new and spent fuel. The spent fuel pool, fuel transfer canal, and cask loading and cask washdown pits have concrete walls and floors. They are lined on the inside surface with stainless steel plate for leak prevention. The walls and major floors are constructed using concrete filled steel plate modules. The new fuel storage area is a separate reinforced concrete pit providing temporary dry storage for the new fuel assemblies. A 150-ton cask handling crane travels in the east-west direction. The location and travel of this crane prevents the crane from carrying loads over the spent fuel pool to preclude them from falling into the spent fuel pool. Mechanical equipment is also located in this area for spent fuel cooling, residual heat removal, and liquid waste processing. This equipment is generally nonsafety-related.]*

3H.2.2 Description of Shield Building

The shield building is the structure and annulus area that surrounds the containment building. It shares a common basemat with the containment building and the auxiliary building. The shield building uses concrete-filled steel plate construction (SC) as well as reinforced concrete (RC) structure. The figures in Section 1.2 show the layout of the shield building and its interface with the other buildings of the nuclear island.

Figure 3.8.4-5 shows the following significant features and the principal systems and components of the shield building:

- Shield building cylindrical structure
- Shield building roof structure
- RC/SC connections
- Air inlets and tension ring
- Knuckle region (connection to exterior wall of PCS tank)
- Compression ring (connection to interior wall of PCS tank)
- Passive containment cooling system (PCS) water storage tank (PCCWST)

The overall configuration of the shield building is established from functional requirements related to radiation shielding, missile barrier, passive containment cooling, tornado, and seismic event protection. These functional requirements led to establishing the design based on two primary design codes used for nuclear plant structures: 1) ACI 349 for reinforced concrete design, and 2) ANSI/AISC N690 for structural steel design.

The shield building SC walls are anchored to the RC basemat and shield building RC wall by mechanical connections. These RC-to-SC connections are also used in the other regions of the shield building, including:

- Auxiliary building RC roof connection to the shield building SC wall
- Auxiliary building RC wall connection to shield building SC wall
- Tension ring connection to the shield building RC roof

The connections provide for the direct transfer of forces from the RC reinforcing steel to the SC liner plates.

The cylindrical shield wall has an outside radius of 72.5 feet and a thickness of 36 inches. The cylindrical wall section that is a few feet below the auxiliary building roof line is a reinforced concrete (RC) structure. The section that is not protected by the auxiliary building is a steel concrete (SC) composite structure (see Figure 3H.5-16). The overall thickness of 36 inches is the same as the RC wall below. The concrete for the SC portion is standard concrete with compressive strength of 6000

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psi. The SC portion is constructed with steel surface plates, which act as concrete reinforcement. The 0.75-inch tie bars are welded to the steel faceplates to develop composite behavior of the steel faceplates and concrete. The shear studs are welded to the inside surface of the steel plate. The tie bar spacing is reduced in the higher stress regions. A typical SC wall panel is shown in Figure 3H.5-13.

The tension ring is located at the interface of the shield building steel concrete composite air inlet structures and the shield building reinforced concrete roof. The top of the tension ring interfaces with the RC roof slab. The tension ring supports the roof girders that are located under the RC roof slab. The bottom of the tension ring is attached to the air inlets structure. The bottom of the air inlets structure is attached to the top of the cylindrical SC wall of the shield building. The connection of the tension ring to the roof is of RC design and is described above.

The primary function of the tension ring is to resist the thrust from the shield building roof. The air inlets structure is located directly below the tension ring and includes the air openings that provide for natural circulation of cooling air. Though its steel plates are connected to the concrete infill by studs and tie bars, the tension ring is conservatively designed as a hollow steel box girder. The concrete infill is credited only for out-of-plane shear transfer and for stability of the steel plates. The tension ring is designed to have high stiffness and to remain elastic under required load combinations.

The air inlets structure is a 4.5-foot-thick SC structure with through-wall openings for air flow. The air inlet openings consist of circular pipes at a downward inclination of 38 degrees from the vertical. Steel plates on each face, aligned with the inner and outer flanges of the tension ring, serve as primary reinforcement. The concrete infill is connected to the steel plates with tie bars and studs. The top of the air inlets structure is welded to the underside of the tension ring. The bottom of the air inlets structure is welded to the SC wall.

The shield building conical roof steel structure consists of 32 radial beams. Between each pair of radial beams there are circumferential beams. A steel plate is welded to the top flanges of each beam and forms a surface on which the concrete is placed. The steel structure forms a conical shell that spans the area from the compression ring to the tension ring.

The outside diameter of the PCS tank (passive containment cooling water storage tank) intersects with the shield building roof at the knuckle region. Outside of the PCS tank, the concrete roof slab thickness is 3 feet and at the bottom of the PCS tank, the concrete thickness is 2 feet. The wall from the PCS tank applies a load to the roof slab, and also provides stiffness and increases the strength of the roof in that region.

The inside diameter of the PCS tank intersects with the roof slab at the compression ring. The compression ring provides the compression support for the conical roof dome. It consists of a composite structure having a curved steel beam section, which supports the concrete roof directly above it. The inside wall of the PCS tank is located above the concrete roof. Studs are placed on the top flange of the steel girder to allow the steel and concrete sections to act as a composite unit. The curved girder is designed to provide support for the steel structure during construction and during the initial placement of the concrete roof before the concrete has hardened sufficiently.

The PCS tank sits on top of the shield building roof. It is supported by and acts integrally with the conical roof. The inside surface has a liner that functions to provide leak protection, but is not required to provide structural strength to the structure. Leak chase channels are provided over the liner welds. The top elevation of the water inside the tank for the PCS has sufficient freeboard to preclude impact on the roof during the SSE.

3H.3 Design Criteria

[*The auxiliary and shield building structures are reinforced concrete structures, structural modules, and horizontal concrete slabs supported by composite structural steel framing.*

- *Seismic forces are obtained from the response spectrum analysis of the three-dimensional finite element analysis models as described in Section 3H.4. The shear wall and floor slab design also considers out-of-plane bending and shear forces due to loading, such as live load, dead load, seismic, lateral earth pressure, hydrostatic, hydrodynamic, and wind pressure.*

- *The shield building roof and the passive containment cooling water storage tank are analyzed using three-dimensional finite element models with the ANSYS computer code*]* as described in subsection 3.8.4.4.1. *[Loads and load combinations include construction, dead, live, thermal, wind, and seismic. The response spectrum analysis of the nuclear island is supplemented by equivalent static acceleration analysis of a more detailed model of a quadrant of the shield building roof. The results from the more detailed analysis are used in the evaluation of the tension ring, air inlets, and radial beams. The seismic response of the water in the tank is analyzed in a separate analysis with seismic input defined by the floor response spectrum.*

- *The structural steel framing is used primarily to support the concrete slabs and roofs. Metal decking, supported by the steel framing, is used as form work for the concrete slabs and roofs.*

- *The finned floors for the main control room and the instrumentation and control room ceilings are designed as reinforced concrete slabs in accordance with American Concrete Institute standard ACI 349. The steel panels are designed and constructed in accordance with American Institute of Steel Construction Standard AISC N690. For positive bending, the steel plate is in tension and the steel plate with fin stiffeners serves as the bottom reinforcement. For negative bending, compression is resisted by the stiffened plate and tension by top reinforcement in the concrete.*]*

3H.3.1 Governing Codes and Standards

[*The primary codes and standards used in the design of the auxiliary and shield buildings are listed below:*

- *ACI 349-01, "Code Requirement for Nuclear Safety-Related Structure Steel" (refer to subsection 3.8.4.5 for supplementary requirements and subsection 3.8.4.4.1 for alternative requirements).* RN-13-018

- *ANSI/AISC N690-1994, "Specification for the Design, Fabrication and Erection of Safety-Related Steel Structures for Nuclear Facilities" (refer to subsection 3.8.4.5 for supplemental requirements).*]*

3H.3.2 Seismic Input

The SSE design response spectra are given in Figures 3.7.1-1 and 3.7.1-2. [*They are based on the Regulatory Guide 1.60 response spectra anchored to 0.30g, but are amplified at 25 Hertz to reflect larger high-frequency seismic energy content observed for eastern United States sites.*]* The nuclear island seismic analyses are summarized in subsection 3.7.2.

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3H.3.3 Loads

[*The auxiliary and shield buildings are seismic Category I structures. The loads listed in the following subsections are used for the design of the building structures. All the listed loads are not necessarily applicable to all structures and their elements. Loads for which each structural element is designed are based on the conditions to which that particular structural element is potentially subjected.*]*

Dead Load (D):

[*The weight of all permanent construction and installations, including fixed equipment, is included as the dead load during its normal operating condition.*

The weight of minor equipment (not specifically included in the dead load), piping, cables and cable trays, ducts, and their supports was included as equivalent dead load (EDL). A minimum of 50 pounds per square foot (psf) was used as EDL. For floors with a significant number of small pieces of equipment, the total weight of miscellaneous small pieces of equipment, divided by the floor area of the room plus an additional 50 psf was used as the equivalent dead load.]*

Earth Pressure (H):

[*The static earth pressure acting on the structures during normal operation is considered in the design of exterior walls. The dynamic soil pressure, induced during a safe shutdown earthquake (SSE), is included as a seismic load.*]*

Live Loads (L):

[*The load imposed by the use and occupancy of the building is included as the live load. Live loads include floor area loads, laydown loads, fuel transfer casks, equipment handling loads, trucks, railroad vehicles, and similar items. The floor area live load is not applied on areas occupied by equipment whose weight is specifically included in the dead load. Live load is applicable on areas under equipment where access is provided, for instance, the floor under an elevated tank supported on legs.*

Floor loading diagrams are prepared for areas for component laydown. The diagrams show the location of major pieces of equipment and their foot-print loads or equivalent uniformly distributed loads.

The following live load items are considered in design:

A. Building floor loads

The following minimum values for live loads are used.

- *Structural platforms and gratings* — *100 psf*
- *Ground floors* — *250 psf*
- *All other elevated floors* — *200 psf*
  (This load is reduced if the equivalent dead load for the floor is more than 50 psf. The sum of the live load and the equivalent dead load is 250 psf.)

B. Roof loads

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The roof is designed for a uniform snow load of 63 psf calculated in accordance with ASCE 7-98. This corresponds to ground snow load of 75 psf, exposure factor of 1.0, thermal factor of 1.0, and an importance factor of 1.2.

C. Concentrated loads for the design of local members

– *Concentrated load on beams and girders (in load combinations that do not include seismic load)*	*5,000 pounds so applied as to maximize moment or shear. This load is not carried to columns or walls. It is not applied in areas where no heavy equipment will be located or transported, such as the access control areas.*
– *Concentrated load on slabs (considered with dead load only)*	*5,000 pounds so applied as to maximize moment or shear. This load is not carried to columns or walls. It is not applied in access control areas.*

In design reconciliation analysis, if actual loads are established to be lower than the above loads, the actual loads are used for reconciliation.

D. Temporary exterior wall surcharge

When applicable, a minimum surcharge outside and adjacent to subsurface wall of 250 psf is applied.

E. Construction loads

The additional construction loads produced by cranes, trucks, and the like, with their pickup loads, are considered. For steel beams supporting concrete floors, the weight of the wet concrete plus 100 psf uniform load and 5,000 pounds concentrated load, distributed near points of maximum shear and moment, is applied. A one-third increase in allowable stress is permitted.

Metal decking and precast concrete panels, used as formwork for concrete floors are designed for the wet weight of the concrete plus a construction live load of 20 psf uniform or 150 pounds concentrated. The deflection during normal operation is limited to span in inches divided by 180, or 0.75 inch, whichever is less.

F. Crane loads

The impact allowance for traveling crane supports and runway horizontal forces is in accordance with AISC N690.

G. Elevator loads

The impact allowance used for the elevator supports is 100 percent, applied to design capacity and weight of car plus appurtenances, unless otherwise specified by the equipment supplier.

H. Equipment laydown and major maintenance

Floors are designed for planned refueling and maintenance activities as defined on equipment laydown drawings.]*

Wind Load

[*The wind loads are as follows:*

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- *Design wind (W)*

  For the design of the exterior walls, wind loads are applied in accordance with ASCE 7-98 with a basic wind speed of 145 mph. The importance factor is 1.15, and the exposure category is C. Wind loads are not combined with seismic loads.

- *Tornado load (W_t)*

  The exterior walls of the auxiliary and shield buildings are designed for tornado. A maximum wind speed of 300 mph (maximum rotational speed: 240 mph, maximum translational speed: 60 mph) is used to design the structures.]*

Seismic Loads (E_s)

[*The SSE (E_s) is used for evaluation of the structures of the auxiliary and shield buildings. E_s is defined as the loads generated by the SSE specified for the plant, including the associated hydrodynamic loads and dynamic incremental soil pressure.*]*

Operating Thermal Loads (T_o)

[*Normal thermal loads for the exterior walls and roofs are addressed in the design. These correspond to positive and negative linear temperature gradients with the inside surface at an average 70°F and the outside air temperature at -40°F and +115°F, respectively. These loads are considered for the seismic Category I structures in combination with the SSE also. All exterior walls of the nuclear island above grade not protected by adjacent buildings are designed for these thermal loads. The thermal gradient is also applied to the portion of the shield building between the upper annulus and the auxiliary building.*

Normal thermal loads for the passive containment cooling system (PCS) tank design are calculated based on the outside air temperature extremes specified for the safety-related design. The PCS tank is assumed to be at 40°F when the outside air temperature is -40°F. The water in the PCS tank is assumed to be at 70°F when the outside air temperature is postulated to be at 115°F.

Normal thermal loads due to a thermal gradient in the structures below the grade level (exterior walls and basemat) are small and are not considered in the design.]*

Effects of Pipe Rupture (Y)

[*The evaluations consider the following loads:*

- *Accident design pressure load, P_a, within or across a compartment and/or building generated by the postulated pipe rupture, including the dynamic effects due to the pressure time history.*

  Main steam isolation valve (MSIV) and steam generator blowdown valve compartments are designed for a pressurization load of 6 pounds per square inch (psi).

- *Accident thermal loads, T_a, due to thermal conditions generated by the postulated pipe break and including T_o.*

Temperature gradients are based on an exterior air temperature of -40°F.

The structural integrity of the west wall of the main control room is also evaluated for the jet impingement (Y_j)]*

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3H.3.4 Load Combinations and Acceptance Criteria

[*Concrete structures are designed in accordance with ACI 349 for the load combinations and load factors given in Table 3.8.4-2. Steel structures are designed in accordance with AISC N690 for the load combinations and stress limit coefficients given in Table 3.8.4-1. The following supplemental requirements are applied for the use of AISC N690:*

- *In Section Q1.0.2, the definition of secondary stress applies to stresses developed by temperature loading only.*
- *In Section Q1.3, where the structural effects of differential settlement are present, they are included with the dead load, D.*
- *In Table Q1.5.7.1, the stress limit coefficients for compression are as follows:*
  - *1.3 instead of 1.5 in load combinations 2, 5, and 6*
  - *1.4 instead of 1.6 in load combinations 7, 8, and 9*
  - *1.6 instead of 1.7 in load combination 11*
- *In Section Q1.5.8, for constrained members (rotation and/or displacement constraint such that a thermal load causes significant stresses) supporting safety-related structures, systems, or components, the stresses under load combinations 9, 10, and 11 are limited to those allowed in Table Q1.5.7.1 as modified above.*]*

3H.4 Seismic Analyses

[*A global seismic analysis of the AP1000 nuclear island structure is performed to obtain building seismic response for the seismic design of nuclear safety-related structures. The seismic loads for the design of the shear walls and the slabs in the auxiliary building are based on a response spectrum analysis of the auxiliary building and the shield building 3D finite element models.*]* This analysis is described in subsection 3.7.2. [*For determining the out-of-plane seismic loads on flexible slabs and wall segments, spectral accelerations are obtained from time history analyses or from the relevant response spectra, using the 7 percent damping curve. Hand calculations are performed to estimate the out-of-plane seismic forces and the corresponding bending moment in each shear wall and floor slab element to supplement the loads obtained from the global seismic analysis.*]*

3H.4.1 Live Load for Seismic Design

[*Floor live loads, based on requirements during plant construction and maintenance activities, are specified varying from 50 to 250 pounds per square foot.*

For the local design of members, such as the floors and beams, seismic loads include the response due to masses equal to 25 percent of the specified floor live loads or 75 percent of the roof snow load, whichever is applicable. These seismic loads are combined with 100 percent of the specified live loads, or 75 percent of the roof snow load, whichever is applicable. These live and snow loads are included as mass in calculating the vertical seismic forces on the floors and roof. The mass of equipment and distributed systems is included in both the dead and seismic loads.]*

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3H.5 Structural Design of Critical Sections

[*This subsection summarizes the structural design of representative seismic Category I structural elements in the auxiliary building and shield building. Critical sections are listed below and the corresponding location numbers are shown on Figure 3H.5-1 for twelve of the critical sections. Items 13 and 14 in the list below are located in the shield building cylinder and are discussed in APP-GW-GLR-602 (Reference 1). The basis for their selection to this list is also provided for each critical section.* RN-13-071

(1) *South wall of auxiliary building (column line 1), elevation 66'-6" to elevation 180'-0". (This exterior wall illustrates typical loads such as soil pressure, surcharge, temperature gradients, seismic, and tornado.) – see subsection 3H.5.1.1 and Figures 3H.5-2 and 3H.5-3*

(2) *Interior wall of auxiliary building (column line 7.3), elevation 66'-6" to elevation 160'-6" (This is one of the most highly stressed shear walls.) – see subsection 3H.5.1.2 and Figure 3H.5-4*

(3) *West wall of main control room in auxiliary building (column line L), elevation 117'-6" to elevation 153'-0". (This illustrates design of a wall for subcompartment pressurization.) – see subsection 3H.5.1.3 and Figure 3H.5-12*

(4) *North wall of MSIV east compartment (column line 11 between column lines L and M), elevation 117'-6" to elevation 153'-0". (The main steam line is anchored to this wall segment.) – see subsection 3H.5.1.4 and Figure 3H.5-5*

(5) *Roof slab at elevation 180'-0" adjacent to shield building cylinder. (This is the connection between the two buildings at the highest elevation.) – see subsection 3H.5.2.1 and Figure 3H.5-7* RN-13-027

(6) *Floor slab on metal decking at elevation 135'-3". (This is a typical slab on metal decking and structural steel framing.) – see subsection 3H.5.2.2 and Figure 3H.5-6*

(7) *2'-0" slab in auxiliary building (operations work area (tagging room) ceiling) at elevation 135'-3". (This illustrates the design of a typical 2'-0" thick concrete slab.) – see subsection 3H.5.3.1 and Figure 3H.5-8. (Note: The 'Tagging Room' has been renamed as "Operations Work Area." However, to avoid changing the associated design and analysis documents, this room is referred to as the 'Tagging Room.')*

(8) *Finned floor in the main control room at elevation 135'-3". (This illustrates the design of the finned floors.) – see subsection 3H.5.4 and Figure 3H.5-9*

(9) *Shield building roof/exterior wall of PCS water storage tank. (This is a unique area of the roof and water tank.) – see subsection 3H.5.6.3*

(10) *Shield building roof/interior wall of PCS water storage tank. (This is a unique area of the roof and water tank.) – see subsection 3H.5.6.2*

(11) *Shield building roof, tension ring, and air inlet. (This is the junction between the shield building roof and the cylindrical wall of the shield building.) – see subsection 3H.5.6 and 3H.5.6.1*

(12) *Divider wall between the spent fuel pool and the fuel transfer canal. (This wall is subjected to thermal and seismic sloshing loads.) – see subsection 3H.5.5.1 and Figure 3H.5-10*

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(13) Shield building SC cylinder is the exposed portions of the shield building that are not protected by the Auxiliary Building and is a steel concrete composite structure – see subsection 3H.5.7.1, Figure 3H.5-16, and Figures 5 and 6 of APP-GW-GLR-602 (Reference 1)

(14) Shield building SC to RC connection is the region of the shield building that anchors the SC cylindrical wall modules to the RC basemat and wall of the shield building – see subsection 3H.5.7.2, Figure 3H.5-16, and Figures 1, 2, and 3 of APP-GW-GLR-602 (Reference 1)

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.]*

3H.5.1 Shear Walls

Structural Description

[*Shear walls in the auxiliary building vary in size, configuration, aspect ratio, and amount of reinforcement. The stress levels in shear walls depend on these parameters and the seismic acceleration level. The range of these parameters and the stress levels in various regions of the most severely stressed shear wall are described in the following paragraphs.*

The height of the major structural shear walls in the auxiliary building ranges between 30 to 120 feet. The length ranges between 40 and 260 feet. The aspect ratio of these walls (full height/full length) is generally less than 1.0 and often less than 0.25. The walls are typically 2 to 5 feet thick, and are monolithically cast with the concrete floor slabs, which are 9 inches to 2 feet thick. Exterior shear walls are several stories high and do not have many large openings. Interior shear walls, however, are discontinuous in both vertical and horizontal directions. The in-plane behavior of these shear walls, including the large openings, is adequately represented in the analytical models for the global seismic response. Where the refinement of these finite element models is insufficient for design of the reinforcement, for example in walls with a large number of openings, detailed finite element models are used.

The shear walls are used as the primary system for resisting the lateral loads, such as earthquakes. The auxiliary building shear walls are also evaluated for flexure and shear due to the out-of-plane loads.]*

Design Approach

[*The auxiliary building shear walls are designed to withstand the loads specified in subsection 3H.3.3. Beside dead, live, and other normal operating condition loads, the following loads are considered in the shear wall design:*

- *Seismic loads*
  - *The SSE loads for the wall are obtained from the seismic analyses of auxiliary/shield buildings that are described in subsection 3H.4.*
  - *Calculations are performed by considering shear wall segments bounded by the floors below and above the segment and the adjacent walls perpendicular to, on both sides of, the segment under consideration. Appropriate boundary conditions are assumed for the four edges of the segment. Natural frequencies of wall segments are determined using finite element models or text book formulas for the frequency of plate structures. Corresponding spectral acceleration is determined from the applicable response spectrum.*

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- *Exterior walls, below grade level, are also evaluated for dynamic earth pressure exerted during an SSE for two cases:*
    - *Dynamic earth pressure calculated in accordance with ASCE 4-98*
    - *Passive earth pressure*

- *Accident pressure load*
    - *Shear walls of the main steam isolation valves (MSIV) rooms are designed for 6 pounds per square inch (psi) differential pressure acting in conjunction with the seismic loads. Member forces due to accident pressure and SSE are combined by absolute sum.*
    - *The main control room wall of the east MSIV compartment is evaluated for the pressure and the jet load due to a postulated main steamline break.*

- *Tornado load*

  For exterior walls above grade level, tornado loads are considered.

The design temperatures for thermal gradient are included in Table 3H.5-1.

The shear walls are designed for the load combinations, as applicable, contained in Table 3.8.4-2. The wall sections are designed in accordance with the requirements of ACI 349-01.]*

3H.5.1.1 Exterior Wall at Column Line 1

[*The wall at column line 1 is the exterior wall at the south end of the nuclear island. The reinforced concrete wall extends from the top of the basemat at elevation 66'-6" to the roof at elevation 180'-0". It is 3'-0" thick below the grade and 2'-3" thick above the grade.*

The wall is designed for the applicable loads including dead load, live load, hydrostatic load, static and dynamic lateral soil pressure loads, seismic loads, and thermal loads. For various segments of this wall, Table 3H.5-2 provides the listing and magnitude of the various design loads and Table 3H.5-3 presents the details of the wall reinforcement. The sections where the required reinforcement is calculated are shown in Figure 3H.5-2 (Sheet 1). Typical wall reinforcement is shown on Figure 3H.5-3.]*

3H.5.1.2 Wall at Column Line 7.3

[*The wall at column line 7.3 is a shear wall that connects the shield building and the nuclear island exterior wall at column line I. It extends from the top of the basemat at elevation 66'-6" to the top of the roof. The wall is 3 feet thick below the grade at elevation 100'-0" and 2 feet thick above the grade. Out-of-plane lateral support is provided to the wall by the floor slabs on either side of it and the roof at the top.*

The auxiliary building design loads are described in subsection 3H.3.3, and the wall is designed for the applicable loads.

For various segments of this wall, the corresponding governing load combination and associated design loads are shown in Table 3H.5-4. Table 3H.5-5 presents the details of the wall reinforcement. The sections where the required reinforcement is calculated are shown in Figure 3H.5-2 (Sheet 2). Typical wall reinforcement is shown on Figure 3H.5-4]*

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3H.5.1.3 Wall at Column Line L

[*The wall at column line L is a shear wall on the west side of the Main Control Room. It extends from the top of the basemat at elevation 66'-6" to the top of the roof. The wall is 2 feet thick. Out-of-plane lateral support is provided to the wall by the floor slabs on either side of it and the roof at the top. The segment of the wall that is a part of the main control room boundary is from elevation 117'-6" to elevation 135'-3".*

The auxiliary building design loads are described in subsection 3H.3.3, and the wall is designed for the applicable loads. In addition to the dead, live and seismic loads, the wall is designed to withstand a 6 pounds per square inch pressure load due to a pipe break in the MSIV room even though it is a break exclusion area. This wall segment is also designed to withstand a jet load due to the pipe break.

The governing load combination and associated design loads are those due to the postulated pipe rupture and are shown in Table 3H.5-6. Table 3H.5-7 and Figure 3H.5-12 present the details of the wall reinforcement. The sections where the required reinforcement is calculated are shown in Figure 3H.5-2 (Sheet 3).]*

3H.5.1.4 Wall at Column Line 11

[*The north wall of the MSIV east compartment, at column line 11 between elevation 117'-6" and elevation 153'-0", has been identified as a critical section.*

The segment of the wall between elevation 117'-6" and elevation 135'-3" is 4 feet thick, and several pipes such as the main steam line, main feed water line, and the start-up feed water line are anchored to this wall at the interface with the turbine building.

The wall segment from elevation 135'-3" to elevation 153'-0" does not provide support to any high energy lines, and is 2 feet thick. This portion does not have to withstand reactions from high energy line breaks.

The wall is designed to withstand loads such as the dead load, live load, seismic load and the thermal load. The MSIV room is a break exclusion area, but the design also considered the loads associated with one square foot pipe rupture in the MSIV room, such as compartment pressurization, jet load, and the reactions at the pipe anchors. The loads on the pipe anchor include pipe rupture loads for breaks in the turbine building.

The wall structure is analyzed using three dimensional finite element analyses supplemented by hand calculations. Analyses are performed for individual loads, and design loads are determined for applicable load combinations from Table 3.8.4-2.

Typical wall reinforcement is shown in Figure 3H.5-5.]*

3H.5.2 Composite Structures (Floors and Roof)

[*The floors consist of a concrete slab on metal deck, which rests on structural steel floor beams. Several floors in the auxiliary building are designed as one-way reinforced concrete slabs supported continuously on steel beams. Typically, the beams span between two reinforced concrete walls. The beams are designed as composite with formed metal deck spanning perpendicular to the members. Unshored construction is used. For the floors, beams are predominately spaced at about 5- to 6-feet intervals and spans are between 15 feet and 25 feet. Based on local geometry considerations, the intervals and spans are outside these ranges in a limited number of locations. The spacing between the beams or between beams and walls is as small as 3 feet and as large as 8 feet. The span of the* RN-13-071

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*beams is as small as 2 feet, 6 inches and as large as 38 feet, 6 inches. The designs of the beams satisfy the requirements in AISC N690 for composite structures.]** RN-13-071

Structural Description

[*A typical layout of these floors is shown in Figure 3H.5-6. The metal deck rests on the top flange of the structural steel floor beam, with the longitudinal axes of the metal deck ribs and floor beams placed perpendicular to each other. Figure 3H.5-6 shows the key structural elements in composite floors. The reinforcement size and spacing are based on loads and spans for this type of floor and are determined at each location based on the requirements in ACI 349 and ACI 318-11, Section 12.6. The development of the floor reinforcement in the walls can be either headed reinforcement or standard hooks. The beam size and spacing and beam support designs are based on loads and spans for this type of floor as noted on the figure. The beam support designs include beam seats or shear plates connected to the web of the beam. The detail design of the support for the beam, including the portion embedded in the concrete wall, is based on the load and structural system configuration as noted on the figure. The designs of these floors are in conformance with AISC N690 and ACI 349. The depth of the ribs for 9-inch concrete floor slabs, 9.5-inch concrete floor slabs, and 15-inch deep concrete roof slabs are 3 inches, 2.5 inches, and 4.5 inches respectively.* The concrete slab is tied to the structural steel floor beam by shear connectors, which are welded to the top flange of the floor beam. The concrete slab and the floor beams form a composite floor system. For the design loads after hardening of concrete, the transformed section is used to check the stresses. RN-13-071

The construction sequence is as follows:

- *The structural steel floor (floor beam, metal deck, and shear connectors) is fabricated in the shop, brought to the floor location, and placed in position. In some cases, the beams and deck are preassembled and placed as a module.*
- *The metal deck is used as the formwork, and concrete is poured on the metal deck. Until concrete hardens, the load is carried by the metal deck and the steel floor beam.*
- *During concreting, no shoring is provided.*]*

Design Approach

[*The floor design considers the dead, live, construction, extreme environmental, and other applicable loads identified in Section 3H.3.3. The design floor loading includes the equipment attached to the floor. The end condition for the steel beams is simply supported, or continuous. The seismic load is obtained using the applicable floor acceleration response spectrum (7 percent damping for the SSE loads).*

The load combinations applicable to the design of these floors are shown in Tables 3.8.4-1 and 3.8.4-2. The design of the floor system is performed in two parts:

- *Design of structural steel beams*
  - *The structural steel floor beams are evaluated to withstand the weight of wet concrete during the placement of concrete. The composite section is designed for the design loads during normal and extreme environment conditions. Shear connectors are also designed.*
- *Design of concrete slab*

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- *The concrete slab and the steel reinforcement of the composite section are evaluated for normal and extreme environmental conditions. The slab concrete and the reinforcement is designed to meet the requirements of American Concrete Institute standard ACI 349-01 "Code Requirements for Nuclear Safety-Related Structures."*

- *The slab design considers the in-plane and out-of-plane seismic forces. The global in-plane and out-of-plane forces are obtained from the response spectrum analysis of the 3D finite element model of the auxiliary and shield buildings. The out-of plane seismic forces due to floor self-excitation are determined by hand calculations using the applicable vertical seismic response spectrum and slab frequency.*]*

3H.5.2.1 Roof at Elevation 180′-0″, Area 6 (Critical Section is between Col. Lines N & K-2 and 3 & 4)

[*The layout of this segment of the roof is shown in Figure 3H.5-7 as Region "B." The concrete slab is 15 inches thick, plus 4.5-inch deep metal deck ribs. It is composite with 5 feet deep plate girders, spaced 14'-2" center to center, by using shear connectors. The girder flanges are 20" x 2" and the web is 56" x 7/16". The girders span approximately 64 feet in the north-south direction and are designed as simply supported. The concrete slab between the girders behaves as a one-way slab and is designed to span between the girders.*

The roof girders are designed for dead and live loads, including construction loads (with wet concrete) with simple support end conditions. A one-third increase in allowable stress is permitted for the construction load combination.

The girders are also evaluated as part of the composite beam after drying of concrete. The composite roof structure is designed to withstand dead and live load / snow load, as well as the wind, tornado and seismic loads.

*A typical connection of the roof slab to the shield building is shown in Figure 3H.5-7. The figure shows the arrangement of reinforcement at the connection in the fuel building portion of the auxiliary building roof, the shield building cylindrical wall, and the walls of the auxiliary building just below the roof. The design summary is shown in Table 3H.5-10. The details of the connections between the auxiliary building roof and the shield building wall in other locations vary because of loads on the connection and the orientation of the wall to the roof reinforcement arrangement. These connection design details satisfy the requirements identified in subsection 3.8.4.5.5.6.]** RN-13-027

3H.5.2.2 Floor at Elevation 135′-3″, Area 1 (Between Column Lines M and P)

[*The design of a typical composite floor is shown in Figure 3H.5-6. The design summary for the floor between column lines M and P at elevation 135’-3” is shown in Table 3H.5-11. The concrete slab is 9 inches thick, plus 3-inch deep metal deck ribs. The floor beam size is shown in Figure 3H.5-6.* RN-13-071

- *The floor beams are designed for construction load (with wet concrete) with simple support end conditions. The design loads include the dead load and a construction live load of 100 pounds per square foot (psf) distributed load plus 5000 pounds concentrated load near the point of maximum shear and moment. A one-third increase in allowable stress is permitted.*

- *The floor beams are also designed as part of the composite beam after drying of the concrete. Because of continuity of rebars into the wall and the connection of the bottom flange to the support embedment, the end support condition is considered as fixed.*]*

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3H.5.3 Reinforced Concrete Slabs

[Reinforced concrete floors in auxiliary building are 24 inch or 36 inch thick. These floors are constructed with reinforced concrete placed on top of 8 to 12 inch thick precast concrete panels. The precast concrete panels are installed at the bottom to serve as the framework and withstand the load of wet concrete slab. The spans of the floors are predominately 13 feet to 20 feet, and the precast panels are predominately 7 to 14 feet wide. Based on local geometry considerations, the widths and spans are outside these ranges in a limited number of locations. The spans of the floor are as small as 5 feet and as large as 21 feet. The width of the precast panels is as small as 4 feet and as large as 19 feet. The number of side-by-side precast panels ranges from one to eight. RN-13-071 RN-13-071

Examples of such floors are the Operations Work Area (Tagging Room) ceiling slab at elevation 135'-3' in Area 2, and the Area 5/6 elevation 100'-0" slab between column lines 1 & 2.

Figure 3H.5-8 shows the key structural elements in reinforced concrete floor slabs. The precast panels and the cast-in-place concrete are designed to act together as a composite reinforced slab so that the floor dynamic response is consistent with the auxiliary building finite element analysis. However, the precast panels are neglected in determining floor strength and load carrying capacity. The reinforcement size and spacing are determined for each location, based on specific loads and spans, and satisfy the requirements in ACI 349 and ACI 318-11, Section 12.6. The floor thickness and precast panel thickness for this type of floor are based on specific loads and spans as noted on the figure. The type and thickness of adjacent walls and floors vary as noted on the figure. The main reinforcement is provided in the cast-in-place concrete. Reinforcement is placed in both the top and bottom layers of the cast-in-place concrete in both directions. For the design of the reinforcement in the cast-in-place floors, post-construction loads are conservatively assumed to be resisted only by the cast-in-place concrete and the reinforcement placed within it. The reinforcement in the cast-in-place portion is fully developed into supporting adjacent walls such that the connection is assumed to be a fixed connection. The development of the floor reinforcement in the walls is achieved using either headed reinforcement or standard hooks. RN-13-071

The precast panel reinforcement is designed to resist the weight of the panel and the wet weight of the cast-in-place concrete during construction. Reinforcement is placed within the precast panel portion in both top and bottom layers in both directions. The precast panel reinforcement is contained within the panel. The reinforcement is discontinuous with a design gap between adjacent precast panels and between precast panels and walls. The precast panels are connected to the concrete placed above them by shear reinforcement, which satisfies the requirements of ACI 349 Chapter 17. The precast panels and the cast-in-place concrete are made to act together as a composite reinforced concrete slab by roughening the top surface of the precast panel and providing shear ties between the two elements. The detail designs of the supports for the precast panels are based on the loading and design requirements. RN-13-071

The finite element analysis model used for the auxiliary building seismic response assumes a homogenous thickness of concrete for the floor system, and includes floor-to-wall connections that are fixed over the full thickness of the reinforced concrete floor. The detailed design of the floor system includes a gap between the precast panel and the wall and between adjacent precast panels. Although the gap between the precast panels and the wall reduces the thickness of the floor in direct contact with the wall, the design of the floor system satisfies the requirements of ACI 349, including fully developing the floor reinforcement in the wall. The design of the floor system and the connection with the wall provide a fixed connection that transfers forces and moments from the floor to the wall. RN-13-071

Detailed analysis of the floor system connection design details, including the gap between the precast panel and wall, is performed for the floor constructed with precast panels and is consistent with the nuclear island seismic model. The effects of stiffness, reinforcement anchorage, and concrete cracking are considered in the detailed analyses. The detailed analyses demonstrate that RN-13-071

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*these floors have vertical response above 33 Hz and are rigid, which is consistent with the nuclear island seismic model.]** RN-13-071

3H.5.3.1 Operations Work Area (Tagging Room) Ceiling

The tagging room (room number 12401) location is shown on Figure 1.2-8. [*Figure 3H.5-8 shows the typical cross section and reinforcement. The design summary for this location is shown in Table 3H.5-12. Design dimensions of the Operations Work Area (Tagging Room) Ceiling are as follows:* RN-13-071

Room Size:	*16'-0" x 11'-10"*
Boundary Conditions:	*Fixed at Walls J and K*
Clear Span:	*16'-0"*
Slab Thickness:	*Total = 24 inches*
	Precast Panel = 8 inches
	Cast-in-Place = 16 inches

*The two precast concrete panels, each 5'-11" wide and spanning over 16'-0" clear span, are installed to serve as the formwork.]**

3H.5.4 Concrete Finned Floors

[*The ceilings of the main control room and the instrumentation and control rooms in the auxiliary building are designed as finned-floor modules. A typical floor design is shown in Figure 3H.5-9. A finned floor consists of a 24-inch-thick concrete slab poured over a stiffened steel plate ceiling. The fins, welded to stiffen the steel plate, are half inch by 9 inch rectangular sections perpendicular to the plate. Shear studs are welded on the other side of the steel plate, and the steel and concrete act as a composite section. The fins are exposed to the environment of the room and enhance the heat-absorbing capacity of the ceiling. Several shop-fabricated steel panels, cut to room width and placed side by side perpendicular to the room length, are used to construct the stiffened plate ceiling in a modularized fashion. The stiffened plate with fins is designed to withstand construction loads prior to concrete hardening.*

The main control room ceiling fin floor is designed for the dead, live, and the seismic loads. The design summary is shown in Table 3.H.5-13.

The finned floor structure is evaluated for the load combinations listed in Tables 3.8.4-1 and 3.8.4-2.]*

Design Methodology

[*The finned floors are designed as reinforced concrete slabs in accordance with ACI Standard 349. For positive bending, the steel plate is in tension. The steel plate with fin stiffeners serves the function of bottom rebars. For negative bending, the potential for buckling due to compression in this element is checked by using the criteria of American National Standards Institute/American Institute of Steel Construction standards ANSI/AISC N690-94. Twisting, and therefore lateral buckling of the stiffener, is restrained by the concrete.*

The finned floors resist vertical and in-plane forces for both normal and extreme loading conditions. For positive bending, the concrete above the neutral axis carries compressive stresses and the stiffened steel plate resists tension. Negative bending compression is resisted by the stiffened plate and tension by top rebars in the concrete. The neutral axis for negative bending is located in the

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stiffened plate section, and the concrete in tension is assumed inactive. Horizontal in-plane forces are resisted by the stiffened plate and longitudinal rebars.

Minimum top reinforcement is provided in the slab in each direction for shrinkage and temperature crack control. In addition, top reinforcement located parallel to the stiffeners is used as tension reinforcement in negative bending. The stiffened plate provides crack control capability for the bottom of the slab in the transverse direction.

Composite section properties, based on an all steel-transformed section, as detailed in Section Q1.11 of ANSI/AISC N690-94, are used to design the following:

- *Weld strength between stiffener and the steel plate*
- *Spacing of the shear studs for the composite action*

The stiffened plate alone is designed to resist all construction loads prior to the concrete hardening. The plate is designed against the criteria for bending and shear, specified in ANSI/AISC N690-94, Sections Q1.5.1.4 and Q1.5.1.2. In addition, the weld between the stiffener and the steel plate is designed to satisfy the code requirements.]*

3H.5.5 Structural Modules

[*Structural modules are used for some of the structural elements on the south side of the auxiliary building. These structural modules are structural elements built up with welded steel structural shapes and plates. The modules consist of steel faceplates connected by steel trusses as shown in Figure 3.8.3-2. The primary purpose of the trusses is to stiffen and hold together the faceplates during handling, erection, and concrete placement. The thickness of the steel faceplates is 0.5 inch except in a few local areas. The nominal spacing of the trusses is 30 inches. Shear studs are welded to the inside faces of the steel faceplates. Faceplates are welded to adjacent faceplates with full penetration welds so that the weld is at least as strong as the plate. 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.*

These modules include the spent fuel pool, fuel transfer canal, and cask loading and cask washdown pits. The structural modules are similar to the structural modules for the containment internal structures (see description in subsection 3.8.3 and Figures 3.8.3-8, 3.8.3-14, 3.8.3-15 and 3.8.3-17). Figure 3.8.4-5 shows the location of the structural modules in the auxiliary building. The structural modules extend from elevation 66'-6" to elevation 135'-3".

The loads and load combinations applicable to the structural modules in the auxiliary building are the same as for the containment internal structures]* (subsection 3.8.3.5.3) [*except that there are no ADS nor pressure loads due to pipe breaks.*

The design methodology of these modules in the auxiliary building is similar to the design of the structural modules in the containment internal structures]* described in subsection 3.8.3.5.3.

3H.5.5.1 West Wall of Spent Fuel Pool

[*Figure 3H.5-10 shows an elevation of the west wall of the spent fuel pool (column line L-2), and element numbers in the finite element model. The wall is a 4 feet thick concrete filled structural wall module.*

A finite element analysis is performed for seismic, thermal, and hydrostatic loads with the following assumptions:

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- *The seismic in-plane and out-of-plane forces are obtained from the response spectrum analysis of the 3D finite element model of the auxiliary and shield buildings.*

- *The thermal loads are applied as linearly varying temperatures between the inner and outer faces of the walls and floors.*

- *The hydrostatic loads are applied to the spent fuel pool walls and floors, which is considered full with water. This provides the loads for the design of the divider wall.*

- *The seismic sloshing is modeled in the spent fuel pool.*

The concrete filled structural wall modules are designed as reinforced concrete structures in accordance with the requirements of ACI-349. The face plates are treated as reinforcing steel.

Methods of analysis are based on accepted principles of structural mechanics and are consistent with the geometry and boundary conditions of the structures. Both computer codes and hand calculations are used.

Table 3H.5-8 shows the required plate thickness for certain critical locations. The steel plates are half inch thick.]*

3H.5.6 Shield Building Roof and Connections

[*The shield building roof is a reinforced concrete shell (supporting the passive containment cooling system tank and air diffuser), which is supported on a structural steel module. 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.*

The design of the shield building is shown in Figure 3H.5-11 (Sheets 1-6). These figures show the typical details of the "Tension Ring," the "Air Inlet Structure," and the "Exterior Wall of the Passive Containment Cooling System Tank." Figure 3H.5-16, Sheets 1 and 2, also shows the typical dimensions of the surface plates and the SC to RC connections on the shield building cylindrical segment.]* . The column line and auxiliary building roof information in Figure 3H.5-16 is shown for reference and is not Tier 2* information. RN-13-027

[*A detailed ANSYS model was used to represent these components of the enhanced design. Analyses were performed to determine the response of the structures for the dead weight, hydrostatic load due to PCS water, snow load, wind load, tornado load, seismic load (including seismic-induced pressure on PCS wall), and thermal loads. The design was evaluated to comply with the requirements of ANSI/AISC N690-94 and of ACI 349-01.*

The design summaries of the components are included in Table 3H.5-9.

The steel frame for the shield building roof and the concrete placed directly thereon is designed to AISC N690.

- *In the radial direction, the steel beams, the steel surface plate, and the concrete are evaluated as a composite section using the axial and bending member forces in the steel and concrete section from the finite element analyses. The steel stresses and the end connection*

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are calculated assuming the steel alone resists all loads applied before the concrete has reached 75 percent of its required strength and the effective composite section resists all loads applied after that time.

- *The concrete is evaluated using all member forces in the concrete and surface steel plate from the finite element analyses (in-plane and out-of-plane forces and moments). The circumferential channels are provided for construction only and are not modeled in the finite element analysis or credited for resisting permanent loads. The concrete section is evaluated by the strength method of ACI-349. The steel plate is not considered as reinforcement in the circumferential direction.*

Additional information is provided in Table 3H.5-15.]*

3H.5.6.1 Air Inlets and Tension Ring

[*The configuration and plate size of the air inlets enhance their structural performance. The air inlets structure (as shown on Figure 3H.5-14) is located at the top of the cylindrical wall portion of the shield building, beginning at approximately elevation 251' and rising to approximately elevation 266'. The air inlets serve as the intake for air as part of the PCS.*

Above the air inlets, at approximately elevation 266', is the connection designated as the tension ring that connects and supports the conical roof. The tension ring also contains 32 radial beam seat connections where the W36 x 393 radial beams for the conical roof are connected.

The air inlets region is 4.5-feet thick with steel plates on each face as the primary reinforcement, which are connected using tie bars. Near the bottom of the air inlet structure, the thickness transitions to 3 feet thick to connect with the shield building cylinder. The air inlet openings are formed using pipe at a downward inclination of 38 degrees from the vertical. The pipe spacing is approximately 2.81 degrees circumferentially with shear studs welded to the outside surface of the pipes. The tie bars are located with three bars between adjacent air inlets at each elevation at maximum design spacing of 8.5 inches vertically. At approximately the same elevations as the tie bars, two 3/4-inch by 6-inch (minimum) shear studs are located between the tie bars except at elevations where there is interference with the air inlet pipes. Tie bars and studs may be omitted in local areas due to design features and other obstructions.

The tension ring is designed as a structural steel box structure with concrete infill and shear studs. Also the connection of the RC conical roof to the tension ring is designed to be a mechanical connection. The air inlets and tension ring design methodology is supported by linear analysis and benchmarked nonlinear analysis. The tension ring is designed to ANSI/AISC N690 and is a concrete-filled box girder, with two continuous 1.5-inch-thick steel plates top and bottom, which connect the inner liner plate to the outer liner plate, as shown in Figure 3H.5-15.]*

3H.5.6.2 Compression Ring and Interior Wall of Passive Containment Cooling Water Storage Tank

[*The other areas of the shield building are designed to existing industry code requirements, and include the conical roof, the passive containment cooling water storage tank, the compression ring, the knuckle region, and their related attachments. These areas are designed as RC structures in accordance with ACI 349. The steel frame for the roof is designed for the applicable building code ANSI/AISC N690. The concrete roof is designed to ACI 349 requirements without credit for the steel plate on the bottom of the concrete. The configuration and reinforcement of the compression ring and the connection to the interior wall of the passive containment cooling water storage tank is shown in Figure 3H.5-11.*

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Additional information is provided in Table 3H.5-15.]*

3H.5.6.3 Knuckle Region and Exterior Wall of Passive Containment Cooling System Tank

[*The exterior wall of the passive containment cooling system tank is two feet thick. The wall starts at the tank floor elevation of 293' 9". There is a stainless steel liner on the inside surface of the tank. The wall liner consists of a plate with stiffeners and welded studs on the concrete side of the plate. Leak chase channels are provided over the liner welds. The reinforcement in the concrete wall is designed without taking credit for the strength provided by the liner. The governing loads for design of the exterior wall are the hydrostatic pressure of the water, the in-plane and out-of-plane seismic response, and the temperature gradient across the wall. The reinforcement is shown in Figure 3H.5-11. The reinforcement required and the reinforcement provided is summarized in Table 3H.5-9.*

Additional information is provided in Table 3H.5-15.]*

3H.5.7 Shield Building Cylinder (SC)

3H.5.7.1 Shield Building Cylindrical Wall

[*The shield building surrounds the containment vessel and shares a common basemat with the containment vessel and the auxiliary building. The cylindrical shield wall has an outside radius of 72.5 feet and a thickness of 36 inches. The cylindrical wall section that is below the auxiliary building roof line is a reinforced concrete structure. The section that is not protected by the auxiliary building is a steel concrete composite structure, where two 0.75-inch plates act compositely with 34.5 inches of concrete via tie bars and shear studs. The steel plate modules are connected to the reinforced concrete basemat and walls by mechanical connectors as described below.*

A typical configuration of the SC wall is shown in Figure 3H.5-13. The overall thickness of 36 inches is the same as the RC wall below. The concrete for the SC portion is standard concrete with a compressive strength of 6000 psi. The SC portion is constructed with steel surface plates, which act as concrete reinforcement. The nominal thickness of the steel faceplates is 0.75 inches. The faceplates are thicker (up to 1.0-inch nominal thickness), as necessary, to address loads from connections and attachments in the areas of these local loads. In each module, tie bars are welded to the steel faceplates to develop composite behavior of the steel faceplates and concrete. The shear studs are welded to the inside surface of the steel plate to provide composite action. The tie bars are at closer spacing in the higher stress regions. The reinforcement detailing incorporates ACI 349 requirements. RN-13-027

The panels of the SC wall are welded together with a complete joint penetration weld.

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.

Table 3H.5-14 shows the design summary for the enhanced shield SC cylindrical wall. The three sheets represent locations in the shield building cylinder that have some of the largest demands due to mechanical loads. The element on the west side at grade near the RC/SC connection has large tension forces due to overturning of the cylinder under seismic demand. This area is one of the most stressed elements in tension. The element near the fuel handling building roof at elevation 180' is an element with high out-of-plane shear due to the interaction between the fuel handling building and the cylinder during an earthquake. This element is located close to the fuel building roof. The element above wall 7.3 at elevation 175' has the largest demand for out-of-plane shear in the general part of the cylindrical wall away from the SC/RC connection and the interface with the auxiliary building roof.

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Additional discussion and information are provided in Section 4 and Figures 5 and 6 of APP-GW-GLR-602 (Reference 1).]*

3H.5.7.2 Reinforced Concrete (RC)/Steel Concrete Composite (SC) Horizontal and Vertical Connections

[*The steel plate modules are anchored to the RC basemat and walls of the shield building by mechanical rebar connections. The connectors provide for the direct transfer of forces from the RC reinforcing steel to the SC liner plates.*

At the horizontal connection at the interface with the RC structure that occurs on the bottom of the lowest SC wall module, vertical reinforcing bars in the RC basemat wall are connected to the module with a mechanical connection. A similar vertical connection occurs on the vertical edges of SC wall modules that interface with the RC portion of the shield building wall. In the vertical connection, hoop reinforcing bars in the RC wall are connected to a mechanical connection and forces are transferred directly from the hoop bars to the SC liner plate. The mechanical connections are designed to the stress limits of ANSI/AISC N690 for loads in the reinforcing bars equivalent to 125 percent of the specified yield strength of the reinforcing bar and are proven components used in existing structures. This design basis exceeds the maximum demand that occurs on the west side of the shield building at grade and is summarized in Sheet 3 of Table 3H.5-14. This connection improves the overall ductility of the RC/SC connection. RN-13-027

Additional discussion and information are provided in Section 4 and Figures 1, 2, 3, and 4 of APP-GW-GLR-602 (Reference 1).]*

3H.5.8 References

1. [*APP-GW-GLR-602, Revision 5 (Proprietary) and APP-GW-GLR-603, Revision 5 (Non-Proprietary), "AP1000 Shield Building Design Details for Select Wall and RC/SC Connections," Westinghouse Electric Company LLC.*]* RN-13-027

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Table 3H.5-1
Nuclear Island: Design Temperatures for Thermal Gradient

Structure (See detail in Subsection 3H.3.3.)	Load	Temperature (°F)		Remark
PCS Tank Walls		[*(Outside)*	*(Inside)*	
	Normal Thermal, T_o	*-40*	*+40*	–
		+115	*+70*]*	
Roofs and Exterior Walls Above Grade Air Temperatures		[*(Outside)*	*(Inside)*	
	Normal Thermal, T_o	*-40*	*+70*	–
		+115	*+70*	
	Accident Thermal, T_a	*-40*	*+132*	MSIV room
		-40	*+212*]*	Fuel handling area
Roofs and Exterior Walls Above Grade Concrete Temperatures		[*(Outside)*	*(Inside)*	
	Normal Thermal, T_o	*-21.6*	*+47*	24″ thickness
		-22.8	*+48.4*	27″ thickness
		-25.4	*+51.5*	36″ thickness
		+3.2	*+46.6*	15″ insulated roof
		+109.1	*+79.2*	24″ thickness
		+108.0	*+80.7*	27″ thickness
		+107.5	*+81.3*	36″ thickness
		+98.6	*+81.3*	15″ insulated roof
	Accident Thermal, T_a	*-40*	*+132*	MSIV room
		-40	*+212*	Fuel handling area
		+63	*+212*]*	Insulated roof
Interior Walls/Slabs Concrete Temperatures		[*(Side 1)*	*(Side 2)*	
	Normal Thermal, T_o	*N/R*	*N/R*	–
	Accident Thermal, T_a	*+70*	*+132*	MSIV room
		+70	*+212*]*	Fuel handling area
Exterior Walls Below Grade	Normal Thermal, T_o	N/R	N/R	–
	Accident Thermal, T_a	N/R	N/R	–
Basemat	Normal Thermal, T_o	N/R	N/R	–
	Accident Thermal, T_a	N/R	N/R	–
Shield Building (Between Upper Annulus and Auxiliary Building)		[*(Outside)*	*(Inside)*	
	Normal Thermal, T_o	*-40*	*+70*	–
		+115	*+70*	
	Accident Thermal, T_a	*-40*	*+132*	MSIV room wall
		N/R	*N/R*]*	Rest of wall

Notes:
1. N/R means loads due to a thermal gradient are not required to be considered.
2. Based on ACI 349-01 (Appendix A), the base temperature for the construction is assumed to be 70°F.

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Table 3H.5-2
Exterior Wall at Column Line 1 Forces and Moments in Critical Locations
(Units: kips, ft)

Load Combination	M_X	M_Y	M_{XY}	T_X	T_Y	T_{XY}
Elevation 180′-0″ to 135′-3″						
[*D + L + H + Ta*		177.8	3.1		115.5	8.8
1.05 D + 1.3 L + 1.3 H + 1.2 To]*	106.4		5.6	117.0		23.9
Elevation 135′-3″ to 100′-0″						
[*D + L + H + Ta*		50.8	0.3		89.8	104.8
D + L + H + Ta	82.9		7.6	172.9		24.8
D + L + H + Ta]*	60.0		3.6	165.7		106.0
Elevation 100′-0″ to 82′-6″						
[*1.05 D + 1.3 L + 1.3 H + 1.2 To*		48.1	8.4		106.1	17.3
D + L+ Es]*	1.8		5.4	15.6		58.6
Elevation 82′-6″ to 66′-6″						
[*D + L – Es*		93.8	26.5		170.7	31.5
0.9 D + Es		32.7	27.2		182.1	42.4
0.9 D + Es]*	15.5		27.2	18.6		42.4

Note:
X is along the horizontal direction, and Y is in the vertical direction.

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-3
Exterior Wall on Column Line 1 Details of Wall Reinforcement (in ^{2}/ft)
(See Figure 3H.5-2 for Locations of Wall Sections.)

Wall Segment (See detail in Subsection 3H.5.1.1.)	Location	Required(2)			*[Provided (Minimum)]**		
		Vertical	Horizontal	Shear(3)	*Vertical*	*Horizontal*	Shear(3)
Wall Section 1, 6							
Elevation 180′-0″ to 135′-3″				NR			None
	Outside Face	3.48	2.65		[*3.91*	*3.12*	
	Inside Face	1.94	1.52		*3.12*	*3.12*]*	
Wall Section 2, 3, 7							
Elevation 135′-3″ to 100′-0″				NR			None
	Outside Face	1.88	3.04		[*3.12*	*3.12*	
	Inside Face	1.77	2.23		*3.12*	*3.12*]*	
Wall Section 4, 8							
Elevation 100′-0″ to 82′-6″				0.003			[*0.44*]*
	Outside Face	1.42	0.70		[*3.12*	*1.56*	
	Inside Face	1.01	0.70		*3.12*	*1.27*]*	
Wall Section 5, 9							
Elevation 82′-6″ to 66′-6″				0.27			[0.88]*
	Outside Face	2.29	0.87		[*4.39*	*1.27*	
	Inside Face	1.87	0.87		*3.12*	*1.27*]*	

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Notes:
1. NR = not required.
2. Thermal loads have been considered in the design of critical sections. The required reinforcement values shown do not include the load case where seismic and normal thermal loads are numerically combined as the normal thermal loads were assessed to be insignificant. When the seismic and normal thermal loads are numerically combined, the value of required reinforcement may increase; however, in all cases the required reinforcement is less than the provided reinforcement and thus the design of the critical section reinforcement is acceptable.
3. Refer to subsection 3.8.4.4.1 for the requirements for shear reinforcement. RN-13-018

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-4
Interior Wall at Column Line 7.3 Forces and Moments in Critical Locations
(Units: kips, ft)

Load Combination	M_X	M_Y	M_{XY}	T_X	T_Y	T_{XY}
From Roof to Elevation 155′-6″						
[*1.05 D + 1.3 L + 1.2 To*		135.3	10.9		117.3	210.2
1.05 D + 1.3 L + 1.2 To]*	75.5		4.1	229.8		94.3
Elevation 155′-6″ to 135′-3″						
[*0.9 D – Es*		14.1	1.3		160.8	228.7
D + L – Es]*	28.0		1.0	29.8		231.7
Elevation 135′-3″ to 117′-6″						
[*0.9 D – Es*		3.3	1.3		142.2	140.9
D + L – Es]*	10.0		1.0	41.7		175.0
Elevation 117′-6″ to 100′-0″						
[*0.9 D – Es*		4.7	2.8		143.9	184.9
D + L + Es]*	6.4		1.5	172.8		107.9
Elevation 100′-0″ to 82′-6″						
[*0.9 D – Es*		15.4	2.6		90.4	169.8
D + L – Es]*	8.7		2.6	46.6		175.6
Elevation 82′-6″ to 66′-6″						
[*0.9 D – Es*		23.5	1.3		80.9	49.3
D + L – Es]*	0.8		1.3	1.7		74.1

Note:
X is along the horizontal direction, and Y is in the vertical direction.

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-5
Interior Wall on Column Line 7.3 Details of Wall Reinforcement
(See Figure 3H.5-2 for Locations of Wall Sections.)

Wall Segment (See detail in Subsection 3H.5.1.2.)	Location	Wall Section	Reinforcement on Each Face (in^2/ft)	
			Required(1)	[*Provided (Min.)*]*
From Roof to Elevation 155′-6″	Horizontal	1	3.96	[*4.12*
	Vertical	7	3.60	*3.72*
Elevation 155′-6″ to 135′-3″	Horizontal	2	2.80	*3.12*
	Vertical	8	3.59	*3.72*
Elevation 135′-3″ to 117′-6″	Horizontal	3	2.03	*2.54*
	Vertical	9	2.63	*3.12*
Elevation 117′-6″ to 100′-0″	Horizontal	4	2.29	*2.54*
	Vertical	10	2.98	*3.12*
Elevation 100′-0″ to 82′-6″	Horizontal	5	1.69	*2.54*
	Vertical	11	2.08	*3.12*
Elevation 82′-6″ to 66′-6″	Horizontal	6	0.85	*1.27*
	Vertical	12	0.98	*1.56*
Shear Reinforcement(2) (in^2/ft^2)				
From Roof to Elevation 155′-6″	Standard hook or T headed bar	7	0.38	*0.44*]*

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Notes: RN-13-018

1. Thermal loads have been considered in the design of critical sections. The required reinforcement values shown do not include the load case where seismic and normal thermal loads are numerically combined as the normal thermal loads were assessed to be insignificant. When the seismic and normal thermal loads are numerically combined, the value of required reinforcement may increase; however, in all cases the required reinforcement is less than the provided reinforcement and thus the design of the critical section reinforcement is acceptable.
2. Refer to subsection 3.8.4.4.1 for the requirements for shear reinforcement. RN-13-018

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-6
Interior Wall at Column Line L Forces and Moments in Critical Locations
(Units: kips, ft)

Load Combination	M_X	M_Y	M_{XY}	T_X	T_Y	T_{XY}
Elevation 154′-2″ to 135′-3″						
[*0.9 D + Es+ Pa + Yj*		6.0	3.5		115.4	170.2
0.9 D + Es+ Pa + Yj]*	14.3		3.5	46.0		170.2
Elevation 135′-3″ to 117′-6″						
[*0.9 D + Es+ Pa + Yj*		145.3	12.2		26.0	38.2
0.9 D + Es+ Pa + Yj]*	24.5		7.1	15.5		114.9

Note:
1. X is along the horizontal direction, and Y is in the vertical direction.

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-7
Interior Wall on Column Line L Details of Wall Reinforcement
(See Figure 3H.5-2, Sheet 3, for Locations of Wall Sections.)

Wall Segment (See detail in Subsection 3H.5.1.3.)	Location	Wall Section	Reinforcement on Each Face (in^2/ft^2)	
			Required[(1)]	[*Provided (Min.)*]*
Elevation 154′-2″ to 135′-3″	Horizontal	1	2.08	[*2.27*
	Vertical	3	2.59	*3.12*
Elevation 135′-3″ to 117′-6″	Horizontal	2	1.36	*4.39*
	Vertical	4	2.02	*5.66*]*
Shear Reinforcement[(2)] (in^2/ft^2)				
Elevation 154′-2″ to 135′-3″	Standard hook or T headed bar	5	0.01	[*0.11*
Elevation 135′-3″ to 117′-6″	Standard hook or T headed bar	6	0.33	*1.76*]*

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Notes:
1. Thermal loads have been considered in the design of critical sections. The required reinforcement values shown do not include the load case where seismic and normal thermal loads are numerically combined as the normal thermal loads were assessed to be insignificant. When the seismic and normal thermal loads are numerically combined, the value of required reinforcement may increase; however, in all cases the required reinforcement is less than the provided reinforcement and thus the design of the critical section reinforcement is acceptable.
2. Refer to subsection 3.8.4.4.1 for the requirements for shear reinforcement. RN-13-018

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-8 (Sheet 1 of 7)
Design Summary of Spent Fuel Pool Wall Design Loads, Load Combinations, and Comparisons to Acceptance Criteria – Element No. 20477

Load/ Combination	S_{xx} kip/ft	S_{yy} kip/ft	S_{xy} kip/ft	M_{xx} k-ft/ft	M_{yy} k-ft/ft	N_x kip/ft	N_y kip/ft	Comments
Dead (D)	-16.15	-22.92	-28.34	-1.34	-1.06	-0.32	-0.32	
Live (L)	1.46	0.32	-1.57	-0.06	-0.21	0.04	0.03	
Hydro (F)	37.52	12.36	-4.32	-100.50	-14.49	62.14	-9.95	
Seismic (Es)	46.21	56.51	183.20	81.72	28.70	103.00	14.79	
Thermal (To)	-561.80	-267.70	-51.15	-426.90	-145.50	90.32	-23.66	
Thermal (Ta)	-955.80	-444.60	-139.70	-1401.0	-450.00	227.50	-83.16	
LC(1a)	32.40	-14.25	-48.39	-142.68	-22.12	86.61	-14.33	[*1.4D+1.7L+1.4F*
LC(3a)	84.05	51.21	147.24	-60.38	7.15	189.71	0.56	*D+L+F+Es*
LC(3b)	84.05	51.21	-219.16	-223.82	-50.25	-16.29	-29.02	*D+L+F+E's*
LC(3e)	-267.08	-116.11	115.28	-327.19	-83.79	246.16	-14.22	*D+L+F+Es+To*
LC(3f)	-267.08	-116.11	-251.12	-490.63	-141.19	40.16	-43.80	*D+L+F+E's+To*
LC(3m)	84.20	53.18	151.64	-60.18	7.46	189.71	0.57	*0.9D+F+Es*
LC(3n)	84.20	53.18	-214.76	-223.62	-49.94	-16.29	-29.01	*0.9D+F+E's*
LC(3o)	-266.92	-114.13	119.68	-326.99	-83.47	246.16	-14.22	*0.9D+F+Es+To*
LC(3p)	-266.92	-114.13	-246.72	-490.43	-140.87	40.16	-43.80	*0.9D+F+E's+To*
LC(5a)	-574.55	-288.12	-121.54	-977.52	-297.00	204.04	-62.22	*D+L+F+Ta*
LC(5b)	-825.30	-421.18	-153.29	-53.19	-5.28	63.89	-15.73	*D+L+F+Ta*
LC(7a)	-397.01	-211.45	-74.69	-427.19	-125.72	132.70	-28.49	*1.05D+1.3L+1.05F+1.2To*]*

Notes:
x – direction is horizontal; y – direction is vertical.
See Figure 3H.5-10 for element location.

Plate thickness required for load combinations excluding thermal:	0.42 inches (Maximum)
[*Plate thickness provided:*	*0.50 -0.01 +0.10 inches*]*
Maximum principal stress for load combination 5 including thermal:	46.33 ksi
[*Yield stress:*	*65.0 ksi (Minimum)*]*
Maximum stress intensity range for load combination 5 including thermal:	46.3 ksi
Allowable stress intensity:	130.0 ksi (Minimum)

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-8 (Sheet 2 of 7)
Design Summary of Spent Fuel Pool Wall Design Loads, Load Combinations, and Comparisons to Acceptance Criteria – Element No. 10529

Load/ Combination	S_{xx} kip/ft	S_{yy} kip/ft	S_{xy} kip/ft	M_{xx} k-ft/ft	M_{yy} k-ft/ft	N_x kip/ft	N_y kip/ft	Comments
Dead (D)	-24.40	-96.30	-20.71	-1.16	-2.27	-0.28	-0.34	
Live (L)	-0.44	-2.48	-0.55	-0.01	-0.24	0.01	0.08	
Hydro (F)	9.86	-5.49	6.22	8.37	-73.49	16.94	16.02	
Seismic (Es)	110.80	335.20	95.73	19.03	93.81	22.15	29.34	
Thermal (To)	-215.70	-479.30	-150.10	-99.69	-357.90	16.39	19.34	
Thermal (Ta)	-389.40	-883.60	-273.20	-364.10	-982.20	40.42	17.26	
LC(1a)	-21.10	-146.72	-21.23	10.09	-106.48	23.34	22.09	[*1.4D+1.7L+1.4F*
LC(3a)	99.77	228.74	83.17	29.58	-11.59	45.60	51.51	*D+L+F+Es*
LC(3b)	99.77	228.74	-108.29	-8.48	-199.21	1.30	-7.17	*D+L+F+E's*
LC(3e)	-35.05	-70.83	-10.64	-32.72	-235.28	55.84	63.60	*D+L+F+Es+To*
LC(3f)	-35.05	-70.83	-202.10	-70.78	-422.90	11.54	4.92	*D+L+F+E's+To*
LC(3m)	102.64	240.85	85.80	29.71	-11.12	45.61	51.47	*0.9D+F+Es*
LC(3n)	102.64	240.85	-105.66	-8.35	-198.74	1.31	-7.21	*0.9D+F+E's*
LC(3o)	-32.17	-58.72	-8.02	-32.60	-234.81	55.86	63.55	*0.9D+F+Es+To*
LC(3p)	-32.17	-58.72	-199.48	-70.66	-422.43	11.56	4.87	*0.9D+F+E's+To*
LC(5a)	-258.35	-656.52	-185.79	-220.36	-689.88	41.93	26.55	*D+L+F+Ta*
LC(5b)	-362.67	-963.64	-260.17	7.94	-144.07	12.21	12.80	*D+L+F+Ta*
LC(7a)	-177.61	-469.58	-128.51	-67.20	-348.29	29.80	31.07	*1.05D+1.3L+1.05F+1.2To*]*

Notes:
x – direction is horizontal; y – direction is vertical.
See Figure 3H.5-10 for element location.

Plate thickness required for load combinations excluding thermal:	0.47 inches (maximum)
[*Plate thickness provided:*	*0.50 -0.01 +0.10 inches*]*
Maximum principal stress for load combination 5 including thermal:	40.3 ksi
[*Yield stress:*	*65.0 ksi (Minimum*]*
Maximum stress intensity range for load combination 5 including thermal:	50.8 ksi
Allowable stress intensity:	130.0 ksi (Minimum)

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-8 (Sheet 3 of 7)
Design Summary of Spent Fuel Pool Wall Design Loads, Load Combinations, and Comparisons to Acceptance Criteria – Element No. 10544

Load/ Combination	S_{xx} kip/ft	S_{yy} kip/ft	S_{xy} kip/ft	M_{xx} k-ft/ft	M_{yy} k-ft/ft	N_x kip/ft	N_y kip/ft	Comments
Dead (D)	-20.03	-75.69	-42.72	3.53	-2.18	-0.01	-1.93	
Live (L)	-0.64	-1.98	-1.22	0.36	-0.06	0.02	-0.07	
Hydro (F)	-4.13	-2.97	-4.10	39.78	3.54	0.99	-4.80	
Seismic (Es)	67.42	185.70	113.20	48.28	7.62	5.78	5.32	
Thermal (To)	-121.60	-387.30	-239.80	75.83	-107.40	39.64	49.91	
Thermal (Ta)	-215.20	-670.10	-416.60	184.20	-269.30	115.50	136.20	
LC(1a)	-34.91	-113.49	-67.62	61.25	1.81	1.40	-9.54	[*1.4D+1.7L+1.4F*
LC(3a)	40.97	103.87	63.52	107.86	10.34	7.18	-3.41	*D+L+F+Es*
LC(3b)	40.97	103.87	-162.88	11.30	-4.90	-4.39	-14.04	*D+L+F+E's*
LC(3e)	-35.03	-138.19	-86.36	155.26	-56.79	31.95	27.79	*D+L+F+Es+To*
LC(3f)	-35.03	-138.19	-312.76	58.70	-72.02	20.39	17.15	*D+L+F+E's+To*
LC(3m)	43.61	113.42	69.01	107.15	10.61	7.16	-3.14	*0.9D+F+Es*
LC(3n)	43.61	113.42	-157.39	10.59	-4.62	-4.41	-13.78	*0.9D+F+E's*
LC(3o)	-32.39	-128.64	-80.87	154.54	-56.51	31.93	28.05	*0.9D+F+Es+To*
LC(3p)	-32.39	-128.64	-307.27	57.98	-71.75	20.37	17.41	*0.9D+F+E's+To*
LC(5a)	-159.30	-499.45	-308.41	158.79	-167.01	73.19	78.32	*D+L+F+Ta*
LC(5b)	-267.05	-805.64	-503.54	51.38	-38.58	1.37	-9.65	*D+L+F+Ta*
LC(7a)	-117.40	-375.64	-230.60	102.82	-79.20	30.78	30.27	*1.05D+1.3L+1.05F+1.2To*]*

Notes:
x – direction is horizontal; y – direction is vertical.
See Figure 3H.5-10 for element location.

Plate thickness required for load combinations excluding thermal:	0.31 inches (Maximum)
[*Plate thickness provided:*	*0.50 -0.01 +0.10 inches*]*
Maximum principal stress for load combination 5 including thermal:	46.95 ksi
[*Yield stress:*	*65.0 ksi (Minimum)*]*
Maximum stress intensity range for load combination 5 including thermal:	84.9 ksi
Allowable stress intensity:	130.0 ksi (Minimum)

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-8 (Sheet 4 of 7)
Design Summary of Spent Fuel Pool Wall Design Loads, Load Combinations, and Comparisons to Acceptance Criteria – Element No. 10524

Load/ Combination	S_{xx} kip/ft	S_{yy} kip/ft	S_{xy} kip/ft	M_{xx} k-ft/ft	M_{yy} k-ft/ft	N_x kip/ft	N_y kip/ft	Comments
Dead (D)	-35.61	-104.80	0.68	-4.70	7.72	-0.55	-2.22	
Live (L)	-0.45	-2.21	-0.72	-0.25	-0.49	0.00	0.10	
Hydro (F)	11.85	-1.35	4.92	28.52	16.50	3.71	3.79	
Seismic (Es)	76.80	225.60	79.29	53.31	177.00	6.83	55.70	
Thermal (To)	-369.10	-433.40	179.90	-215.40	-109.40	-7.32	-59.63	
Thermal (Ta)	-696.60	-730.00	329.40	-555.10	-487.60	-13.58	-95.78	
LC(1a)	-34.04	-152.37	6.62	32.92	33.09	4.43	2.37	[*1.4D+1.7L+1.4F*
LC(3a)	57.33	116.69	86.14	88.29	207.34	11.48	58.89	*D+L+F+Es*
LC(3b)	57.33	116.69	-72.44	-18.33	-146.66	-2.18	-52.51	*D+L+F+E's*
LC(3e)	-173.36	-154.18	198.57	-46.34	138.96	6.90	21.62	*D+L+F+Es+To*
LC(3f)	-173.36	-154.18	39.99	-152.96	-215.04	-6.76	-89.78	*D+L+F+E's+To*
LC(3m)	61.34	129.38	86.78	89.00	207.05	11.53	59.02	*0.9D+F+Es*
LC(3n)	61.34	129.38	-71.80	-17.62	-146.95	-2.13	-52.38	*0.9D+F+E's*
LC(3o)	-169.35	-141.49	199.22	-45.62	138.68	6.96	21.75	*0.9D+F+Es+To*
LC(3p)	-169.35	-141.49	40.64	-152.24	-215.32	-6.71	-89.65	*0.9D+F+E's+To*
LC(5a)	-459.59	-564.62	210.75	-323.37	-281.01	-5.32	-58.19	*D+L+F+Ta*
LC(5b)	-741.71	-755.24	398.88	19.86	124.99	-105.77	-114.64	*D+L+F+Ta*
LC(7a)	-302.36	-439.4	139.9	136.9	57.2	-2.2	-42.9	*1.05D+1.3L+1.05F+1.2To*]*

Notes:
x – direction is horizontal; y – direction is vertical.
See Figure 3H.5-10 for element location.

Plate thickness required for load combinations excluding thermal:	0.32 inches (Maximum)
[*Plate thickness provided:*	*0.50 -0.01 +0.10 inches*]*
Maximum principal stress for load combination 5 including thermal:	42.1 ksi
[*Yield stress:*	*65.0 ksi (Minimum)*]*
Maximum stress intensity range for load combination 5 including thermal:	72.5 ksi
Allowable stress intensity:	130.0 ksi (Minimum)

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-8 (Sheet 5 of 7)
Design Summary of Spent Fuel Pool Wall Design Loads, Load Combinations, and Comparisons to Acceptance Criteria – Element No. 20462

Load/ Combination	S_{xx} kip/ft	S_{yy} kip/ft	S_{xy} kip/ft	M_{xx} k-ft/ft	M_{yy} k-ft/ft	N_x kip/ft	N_y kip/ft	Comments
Dead (D)	-7.31	-29.13	-1.51	-1.45	-3.75	-0.06	0.35	
Live (L)	-0.11	-0.55	0.21	-0.14	-0.60	0.00	0.05	
Hydro (F)	5.04	-0.04	-1.61	-16.58	64.59	-1.48	-20.87	
Seismic (Es)	25.64	33.82	32.90	10.45	114.90	2.48	12.55	
Thermal (To)	-286.10	-78.70	66.37	-208.70	-130.00	0.86	-1.51	
Thermal (Ta)	-616.80	-121.80	116.60	-650.20	-502.40	6.16	3.93	
LC(1a)	-3.36	-41.77	-4.01	-25.47	84.16	-2.15	-28.64	[*1.4D+1.7L+1.4F*
LC(3a)	25.28	4.09	29.35	-14.35	200.98	0.35	-16.27	*D+L+F+Es*
LC(3b)	25.28	4.09	-36.45	-35.25	-28.82	-4.61	-41.37	*D+L+F+E's*
LC(3e)	-153.54	-45.10	70.83	-144.78	119.73	0.89	-17.21	*D+L+F+Es+To*
LC(3f)	-153.54	-45.10	5.03	-165.68	-110.07	-4.07	-42.31	*D+L+F+E's+To*
LC(3m)	26.11	7.55	29.29	-14.06	201.95	0.35	-16.35	*0.9D+F+Es*
LC(3n)	26.11	7.55	-36.51	-34.96	-27.85	-4.61	-41.45	*0.9D+F+E's*
LC(3o)	-152.70	-41.63	70.77	-144.50	120.70	0.89	-17.29	*0.9D+F+Es+To*
LC(3p)	-152.70	-41.63	4.97	-165.40	-109.10	-4.07	-42.39	*0.9D+F+E's+To*
LC(5a)	-387.88	-105.84	69.97	-424.54	-253.76	2.31	-18.01	*D+L+F+Ta*
LC(5b)	-646.13	-113.41	80.41	35.38	175.18	-4.36	-31.38	*D+L+F+Ta*
LC(7a)	-217.10	-90.37	46.78	-175.63	-34.40	-0.96	-22.61	*1.05D+1.3L+1.05F+1.2To*]*

Notes:
x – direction is horizontal; y – direction is vertical.
See Figure 3H.5-10 for element location.

Plate thickness required for load combinations excluding thermal:	0.20 inches (Maximum)
[*Plate thickness provided:*	*0.50 -0.01 +0.10 inches*]*
Maximum principal stress for load combination 5 including thermal:	20.6 ksi
[*Yield stress:*	*65.0 ksi (Minimum)*]*
Maximum stress intensity range for load combination 5 including thermal:	20.6 ksi
Allowable stress intensity:	130.0 ksi (Minimum)

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-8 (Sheet 6 of 7)
Design Summary of Spent Fuel Pool Wall Design Loads, Load Combinations, and Comparisons to Acceptance Criteria – Element No. 21402

Load/ Combination	S_{xx} kip/ft	S_{yy} kip/ft	S_{xy} kip/ft	M_{xx} k-ft/ft	M_{yy} k-ft/ft	N_x kip/ft	N_y kip/ft	Comments
Dead (D)	-1.82	-17.93	4.00	0.92	0.93	-0.32	0.22	
Live (L)	-0.21	-0.98	0.41	0.19	-0.04	-0.02	-0.03	
Hydro (F)	7.14	0.29	-2.18	104.60	15.51	-16.65	3.08	
Seismic (Es)	36.81	21.41	17.68	139.90	28.75	12.42	12.08	
Thermal (To)	-228.50	-181.90	85.52	-291.30	-212.00	11.34	6.92	
Thermal (Ta)	-379.10	-378.40	159.80	-783.80	-661.10	41.72	28.29	
LC(1a)	7.08	-26.36	3.24	148.06	22.95	-23.80	4.56	[*1.4D+1.7L+1.4F*
LC(3a)	44.77	2.90	19.03	287.45	51.36	-11.24	16.58	*D+L+F+Es*
LC(3b)	44.77	2.90	-16.33	7.65	-6.14	-36.08	-7.58	*D+L+F+E's*
LC(3e)	-98.05	-110.78	72.48	105.39	-81.14	-4.15	20.90	*D+L+F+Es+To*
LC(3f)	-98.05	-110.78	37.12	-174.41	-138.64	-28.99	-3.26	*D+L+F+E's+To*
LC(3m)	45.16	5.68	18.23	287.17	51.31	-11.18	16.59	*0.9D+F+Es*
LC(3n)	45.16	5.68	-17.13	7.37	-6.19	-36.02	-7.57	*0.9D+F+E's*
LC(3o)	-97.65	-108.01	71.68	105.11	-81.19	-4.09	20.91	*0.9D+F+Es+To*
LC(3p)	-97.65	-108.01	36.32	-174.69	-138.69	-28.93	-3.25	*0.9D+F+E's+To*
LC(5a)	-231.84	-255.12	102.10	-384.16	-396.79	9.08	20.95	*D+L+F+Ta*
LC(5b)	-268.90	-468.00	168.35	-17.41	14.23	-18.83	13.88	*D+L+F+Ta*
LC(7a)	-166.1	-156.2	66.6	-107.4	-141.8	-9.3	8.6	*1.05D+1.3L+1.05F+1.2To*]*

Notes:
x – direction is horizontal; y – direction is vertical.
See Figure 3H.5-10 for element location.

Plate thickness required for load combinations excluding thermal:	0.28 inches (Maximum)
[*Plate thickness provided:*	*0.50 -0.01 +0.10 inches*]*
Maximum principal stress for load combination 5 including thermal:	25.1 ksi
[*Yield stress:*	*65.0 ksi (Minimum)*]*
Maximum stress intensity range for load combination 5 including thermal:	31.3 ksi
Allowable stress intensity:	130.0 ksi (Minimum)

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-8 (Sheet 7 of 7)
Design Summary of Spent Fuel Pool Wall Design Loads, Load Combinations, and Comparisons to Acceptance Criteria – Element No. 21414

Load/ Combination	S_{xx} kip/ft	S_{yy} kip/ft	S_{xy} kip/ft	M_{xx} k-ft/ft	M_{yy} k-ft/ft	N_x kip/ft	N_y kip/ft	Comments
Dead (D)	0.69	-10.62	-2.57	-0.52	-0.22	-0.03	0.12	
Live (L)	0.18	0.12	-0.45	0.00	-0.11	-0.01	0.02	
Hydro (F)	4.25	0.56	-2.73	-27.01	-31.06	-1.46	1.82	
Seismic (Es)	26.90	13.88	36.68	26.35	21.70	2.17	4.34	
Thermal (To)	-79.35	-40.69	49.04	-129.00	-119.30	10.01	6.90	
Thermal (Ta)	-129.60	-66.37	57.50	-374.60	-374.70	26.38	24.34	
LC(1a)	7.24	-13.89	-8.19	-38.54	-43.97	-2.09	2.75	[*1.4D+1.7L+1.4F*
LC(3a)	33.73	4.16	29.84	-11.98	-22.11	0.10	7.03	*D+L+F+Es*
LC(3b)	33.73	4.16	-43.52	-64.68	-65.51	-4.24	-1.66	*D+L+F+E's*
LC(3e)	-15.86	-21.27	60.49	-92.61	-96.67	6.36	11.34	*D+L+F+Es+To*
LC(3f)	-15.86	-21.27	-12.87	-145.31	-140.07	2.01	2.66	*D+L+F+E's+To*
LC(3m)	33.48	5.10	30.55	-11.93	-21.98	0.11	7.00	*0.9D+F+Es*
LC(3n)	33.48	5.10	-42.81	-64.63	-65.38	-4.23	-1.69	*0.9D+F+E's*
LC(3o)	-16.12	-20.33	61.20	-92.56	-96.54	6.37	11.31	*0.9D+F+Es+To*
LC(3p)	-16.12	-20.33	-12.16	-145.26	-139.94	2.02	2.62	*0.9D+F+E's+To*
LC(5a)	-75.87	-51.43	30.19	-261.65	-265.57	15.00	17.17	*D+L+F+Ta*
LC(5b)	-114.31	-96.07	55.47	-35.06	-36.08	2.55	-1.61	*D+L+F+Ta*
LC(7a)	-54.08	-40.93	30.63	-125.65	-122.46	5.94	7.24	*1.05D+1.3L+1.05F+1.2To*]*

Notes:
x – direction is horizontal; y – direction is vertical.
See Figure 3H.5-10 for element location.

Plate thickness required for load combinations excluding thermal:	0.14 inches (Maximum)
[*Plate thickness provided:*	*0.50 -0.01 +0.10 inches*]*
Maximum principal stress for load combination 5 including thermal:	22.1 ksi
[*Yield stress:*	*65.0 ksi (Minimum)*]*
Maximum stress intensity range for load combination 5 including thermal:	22.1 ksi
Allowable stress intensity:	130.0 ksi (Minimum)

*NRC Staff approval is required prior to implementing a change in this information.

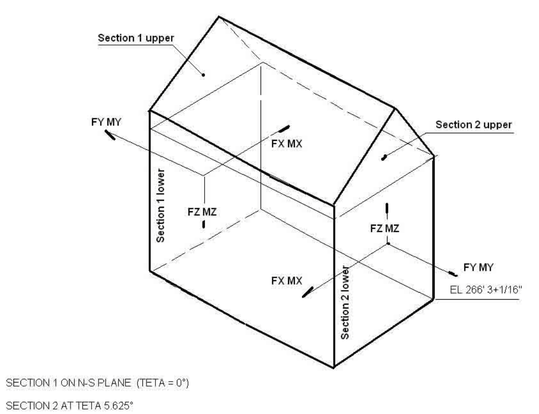
Table 3H.5-9 (Sheet 1 of 3)
Shield Building Roof Reinforcement Summary
(Tension Ring)

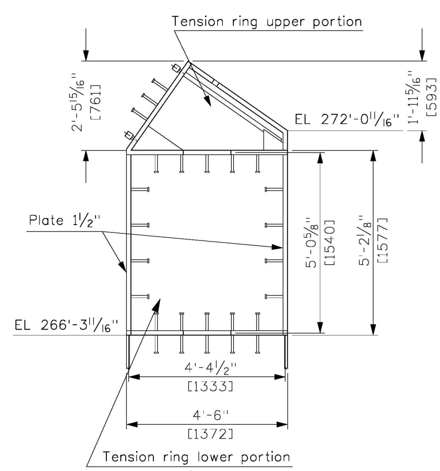
Tension Ring – Axial Force and Bending Verification

Location		Seismic Maximum Stresses						
Section	**Angles**	**Seismic L/C**	**f_a ksi**	**Maximum Stresses ksi**	**F_y ksi**	**Maximum Steel Area Required(2) (in^2/ft)**	**[*Steel Area Provided*]***	**[*Design Limit(1) for Ratio Max Required/ Provided*]***
2 lower	5.625°	9	14.31	14.31	50	7.74	[*Liner 1 1/2" = 18 (in^2/ft) (Min)*]*	[*0.43 + 2%*]*
	84.375°	17	12.52					
1 lower	0°	9	12.97					
	90°	17	11.39					

Tension Ring – Shear Force and Torsion Verification

Location		Seismic Maximum Stresses						
Section	**Angles**	**Seismic L/C**	**f_v ksi**	**Maximum Stresses ksi**	**F_y ksi**	**Maximum Steel Area Required(2) (in^2/ft)**	**[*Steel Area Provided*]***	**[*Design Limit for Ratio Max Required/ Provided*]***
2 lower	5.625°	17	4.83	5.52	50	5.04	[*Liner 1 1/2" = 18 (in^2/ft) (Min.)*]*	[*0.28 + 2%*]*
	84.375°	9	5.52					
1 lower	0°	18	3.20					
	90°	11	4.00					





Notes:
1. [*Two percent of the value may be added to the design limit as an allowance for minor variances in analysis results.*]*
2. Thermal loads have been considered in the design of critical sections. The required reinforcement values shown do not include the load case where seismic and normal thermal loads are numerically combined as the normal thermal loads were assessed to be insignificant. When the seismic and normal thermal loads are numerically combined, the value of required reinforcement may increase; however, in all cases the required reinforcement is less than the provided reinforcement and thus the design of the critical section reinforcement is acceptable.

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-9 (Sheet 2a of 3)
Shield Building Roof Reinforcement Summary
(Air Inlet)

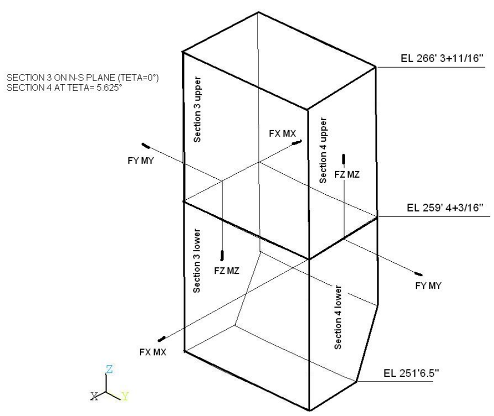
<table>
<tr><th colspan="7">AIS Reinforcement Summary – Horizontal Sections</th></tr>
<tr><th colspan="2" rowspan="2">Locations
(Figure 3H.5-11)</th><th colspan="5">Steel Area (Vertical Direction – Z Local Dir.)</th></tr>
<tr><th colspan="2">Required - Seismic Load Combinations
(in²/ft)</th><th rowspan="2">Maximum Required(2)
(in²/ft)</th><th rowspan="2">[Provided]*</th><th rowspan="2">[Design Limit(1) for Ratio Max Required/ Provided]*</th></tr>
<tr><th>Sections</th><th>Angles</th><th>Seismic L/C</th><th>Values</th></tr>
<tr><td rowspan="2">5+6</td><td>0°-5.625°</td><td>16</td><td>1.65</td><td rowspan="6">2.10</td><td rowspan="6">[Liner 1" = 12 (in²/ft) (Min.)]*</td><td rowspan="6">[0.175 + 2%]*</td></tr>
<tr><td>84.375°-90°</td><td>8</td><td>1.41</td></tr>
<tr><td rowspan="2">8</td><td>0°-5.625°</td><td>16</td><td>2.10</td></tr>
<tr><td>84.375°-90°</td><td>8</td><td>1.69</td></tr>
<tr><td rowspan="2">9</td><td>0°-5.625°</td><td>16</td><td>2.10</td></tr>
<tr><td>84.375°-90°</td><td>8</td><td>1.68</td></tr>
<tr><td rowspan="2">11</td><td>0°-5.625°</td><td>16</td><td>1.61</td><td rowspan="2">1.61</td><td rowspan="2">[Liner 3/4" = 9 (in²/ft) (Min.)]*</td><td rowspan="2">[0.18 + 2%]*</td></tr>
<tr><td>84.375°-90°</td><td>24</td><td>1.21</td></tr>
</table>

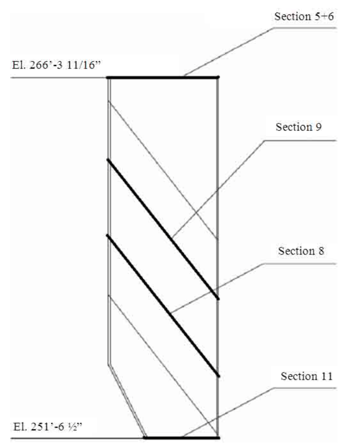
Notes:
1. [*Two percent of the value may be added to the design limit as an allowance for minor variances in analysis results.*]*
2. Thermal loads have been considered in the design of critical sections. The required reinforcement values shown do not include the load case where seismic and normal thermal loads are numerically combined as the normal thermal loads were assessed to be insignificant. When the seismic and normal thermal loads are numerically combined, the value of required reinforcement may increase; however, in all cases the required reinforcement is less than the provided reinforcement and thus the design of the critical section reinforcement is acceptable.

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-9 (Sheet 2b of 3)
Shield Building Roof Reinforcement Summary
(Air Inlet)

AIS Reinforcement Summary – Vertical Sections						
Locations (Figure 3H.5-11)		Steel Area (Hoop Direction – Y Local Dir.)				
		Required - Seismic Load Combinations (in^2/ft)		Maximum Required(2) (in^2/ft)		[*Design Limit*(1) *for Ratio Max Required/ Provided*]*
Sections	**Angles**	**Seismic L/C**	**Values**		[*Provided*]*	
3 Upper	0°	9	9.56	10.04	[*Liner 1" = 12 (in^2/ft) (Min.)*]*	[*0.84 + 2%*]*
	90°	17	8.32			
3 Lower	0°	9	8.14			
	90°	18	7.03			
4 Upper	5.625°	9	10.04			
	84.375°	17	8.69			
4 Lower	5.625°	9	7.98			
	84.375°	19	6.82			





Notes:
1. [*Two percent of the value may be added to the design limit as an allowance for minor variances in analysis results.*]*
2. Thermal loads have been considered in the design of critical sections. The required reinforcement values shown do not include the load case where seismic and normal thermal loads are numerically combined as the normal thermal loads were assessed to be insignificant. When the seismic and normal thermal loads are numerically combined, the value of required reinforcement may increase; however, in all cases the required reinforcement is less than the provided reinforcement and thus the design of the critical section reinforcement is acceptable.

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-9 (Sheet 2c of 3)
Shield Building Roof Reinforcement Summary
(Air Inlet)

Out of Plane Shear Reinforcement Summary – AIS							
Locations (Figure 3H.5-11)		Required – Seismic Load Combinations (in^2/ft)			Maximum Required(2) (in^2/ft)	[*Steel Area Provided*]*	[*Design Limit*(1) *for Ratio Max Required/ Provided*]*
Angles	Sections	Seismic L/C	Values	Sum			
0° - 5.625°	Max of Vertical Sections 3 upper - 4 upper	1	0.10	0.10	0.34	[*3 #6 TIE BAR @2.8125° (41.36") (8 1/2" in vertical direction) = 0.54 (in^2/ft) (Min.)*]*	[*0.63 + 2%*]*
	Horizontal Section 5+6		0.00				
84.375° - 90°	Max of Vertical sections 3 upper - 4 upper	1	0.10	0.10			
	Horizontal Section 5+6		0.00				
0° - 5.625°	Max of Vertical Sections 3 upper – 4 upper	9	0.10	0.34			
	Horizontal Section 8		0.24				
84.375° - 90°	Max of Vertical Sections 3 upper – 4 upper	1	0.10	0.30			
	Horizontal Section 8		0.20				
0° - 5.625°	Max of Vertical Sections 3 lower - 4 lower	0	0.093	0.22			
	Horizontal Section 9		0.127				
84.375° - 90°	Max of Vertical Sections 3 lower - 4 lower	0	0.183	0.18			
	Horizontal Section 9		0.000				
0° - 5.625°	Max of Vertical Sections 3 lower - 4 lower	1	0.167	0.17			
	Horizontal Section 11		0.000				
84.375° - 90°	Max of Vertical Sections 3 lower - 4 lower	0	0.02	0.02			
	Horizontal Section 11		0.00				

Notes:

1. [*Two percent of the value may be added to the design limit as an allowance for minor variances in analysis results.*]*
2. Thermal loads have been considered in the design of critical sections. The required reinforcement values shown do not include the load case where seismic and normal thermal loads are numerically combined as the normal thermal loads were assessed to be insignificant. When the seismic and normal thermal loads are numerically combined, the value of required reinforcement may increase; however, in all cases the required reinforcement is less than the provided reinforcement and thus the design of the critical section reinforcement is acceptable.

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-9 (Sheet 3 of 3)
Shield Building Roof Reinforcement Summary
(Exterior Wall Of Passive Containment Cooling System Tank)

Wall Segment	Location (Figure 3H.5-11 Sheet 5 of 6)	Reinforcement on Each Face, in^2/ft			Ratio Required/ Provided
		Maximum Required	Provided (Minimum)		
Bottom	Vertical	1.37	1#11@1.2°	[*1.72*	0.80
	Hoop	0.67	1#9@6"	*2*	0.33
	Shear	0.07	1#6@1.2°x12"	*0.48*	0.15
Mid-height	Vertical	0.64	1#11@1.2°	*1.72*	0.37
	Hoop	1.85	1#9@6"	*2*	0.92
Top	Vertical	0.52	1#11@1.2°	*1.72*	0.30
	Hoop	0.79	1#9@6"	*2*]*	0.39

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-10
Design Summary Of Roof At Elevation 180′-0″, Area 6
(Near Shield Building Interface)

Governing Load Combination (Roof Girder)	
Combination Number	3 – Extreme Environmental Condition Downward Seismic Acceleration
Bending Moment	= 7125 kips-ft
Corresponding Stress	= 24.1 ksi
Allowable Stress	= 38.0 ksi
Shear Force	= 447 kips
Corresponding Stress	= 17.0 ksi
Allowable Stress	= 20.1 ksi
Governing Load Combination (Concrete Slab)	
Parallel to Girders	
Combination Numbers	3 – Extreme Environmental Condition
Reinforcement (Each Face)	
Required(1)	= 1.74 in^2/ft
[*Provided*	= *2.54* in^2*/ft (Minimum)*]*
Perpendicular to Girders	
Combination Numbers	3 – Extreme Environmental Condition
Reinforcement (Each Face)	
Required(1)	= 1.68 in^2/ft
[*Provided*	= *3.12* in^2*/ft (Minimum)*]*

Note:

1. Thermal loads have been considered in the design of critical sections. The required reinforcement values shown do not include the load case where seismic and normal thermal loads are numerically combined as the normal thermal loads were assessed to be insignificant. When the seismic and normal thermal loads are numerically combined, the value of required reinforcement may increase; however, in all cases the required reinforcement is less than the provided reinforcement and thus the design of the critical section reinforcement is acceptable.

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-11
Design Summary Of Floor At Elevation 135′-3″ Area 1 (Between Column Lines M And P)

Governing Load Combination (Steel Beam)	
Load Combination	3 – Extreme Environmental Condition Downward Seismic
Bending Moment	=(-) 63.9 kips-ft
Corresponding Stress	= 17.0 ksi
Allowable Stress	=33.26 ksi
Shear Force	= 30.7 kips
Corresponding Stress	= 8.7 ksi
Allowable Stress	= 20.1 ksi
Governing Load Combination (Concrete Slab)	
Parallel to the Beams	
Load Combination	3 – Extreme Environmental Condition Downward Seismic
Bending Moment	=(-) 16.0 kips-ft/ft
In-plane Shear	=20.0 kips (per foot width of the slab)
Reinforcement (Each Face)	
Required(1)	= 0.41 in^2/ft
[*Provided*	*= 0.44 in^2/ft (Min.)*]*
Perpendicular to the Beams	
Combination Number	Normal Condition
Bending Moment	=(+) 6.66 kips-ft (per foot width of the slab)
Reinforcement (Each Face)	
Required(1)	= 0.28 in^2/ft
[*Provided*	*= 0.60 in^2/ft (Min.)*]*

Note:

1. Thermal loads have been considered in the design of critical sections. The required reinforcement values shown do not include the load case where seismic and normal thermal loads are numerically combined as the normal thermal loads were assessed to be insignificant. When the seismic and normal thermal loads are numerically combined, the value of required reinforcement may increase; however, in all cases the required reinforcement is less than the provided reinforcement and thus the design of the critical section reinforcement is acceptable.

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-12
Design Summary Of Floor At Elevation 135′-3″
(Operations Work Area (Previously Known As ‘tagging Room’) Ceiling))

Design of Precast Concrete Panels	
Governing Load Combination	Construction
Design Bending Moment (Midspan)	= 14.53 kip-ft/ft
Bottom Reinforcement (E/W Direction)	
Required(1)	= 0.58 in^2/ft
[*Provided*	*= 0.79 in^2/ft (Min.)*]*
Top Reinforcement (E/W Direction)	
Required(1)	= (Minimum required by Code)
[*Provided*	*= 0.20 in^2/ft (Min.)*]*
Top and Bottom Reinforcement (N/S Direction)	
Required(1)	= (Minimum required by Code)
[*Provided*	*= 0.20 in^2/ft (Min.)*]*
Design of 24-inch-Thick Slab	
Governing Load Combination	Extreme Environmental Condition (SSE)
Design Bending Moment (E/W Direction) Midspan	= 14.40 kips ft/ft
Design In-plane Shear	= 31.9 kips ft
Design In-plane Tension	= 21.9 kips ft
Bottom Reinforcement (E/W Direction)	
Required(1)	= 0.53 in^2/ft
[*Provided*	*= 0.79 in^2/ft (Min.)*]*
Design Bending Moment (E/W Direction) at Support	= 28.81 kips-ft/ft
Design In-plane Shear	= 31.9 kips/ft
Design In-plane Tension	= 21.9 kips/ft
Top Reinforcement (E/W Direction)	
Required(1)	= 0.93 in^2/ft
[*Provided*	*= 1.00 in^2/ft (Min.)*]*
Design Bending Moment (N/S Direction)	= 8.47 kips ft/ft
Design In-plane Shear	= 31.9 kips/ft
Design In-plane Tension	= 27.2 kip/ ft
Top and Bottom Reinforcement (N/S Direction)	
Required(1)	= 0.59 in^2/ft
[*Provided*	*= 0.79 in^2/ft (Min.)*]*

Note:

1. Thermal loads have been considered in the design of critical sections. The required reinforcement values shown do not include the load case where seismic and normal thermal loads are numerically combined as the normal thermal loads were assessed to be insignificant. When the seismic and normal thermal loads are numerically combined, the value of required reinforcement may increase; however, in all cases the required reinforcement is less than the provided reinforcement and thus the design of the critical section reinforcement is acceptable.

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-13
Design Summary Of Floor At Elevation 135′-3″ Area 1 (Main Control Room Ceiling)

The design of the bottom plate with fins is governed by the construction load.
For the composite floor, the design forces used for the evaluation of a typical 9-inch-wide strip of the slab are as follows: Maximum bending moment=+35.0 (-24.4) kips-ft Maximum shear force=22.3 kips
The design evaluation results are summarized below: [(1)] • *[The actual area of the tension steel is 9.0 in^2 (Min.),]* which provides a design strength of 518.5 kips-ft bending moment capacity.* • *[The design shear strength is 23.22 kips.* • *The shear studs are spaced a maximum of 9 inches c/c, in both directions.]* The calculated required spacing is 9.06 inches.*

Note:
1. Thermal loads have been considered in the design of critical sections. The required reinforcement values shown do not include the load case where seismic and normal thermal loads are numerically combined as the normal thermal loads were assessed to be insignificant. When the seismic and normal thermal loads are numerically combined, the value of required reinforcement may increase; however, in all cases the required reinforcement is less than the provided reinforcement and thus the design of the critical section reinforcement is acceptable.

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-14 (Sheet 1 of 3)
Design Summary of Enhanced Shield Building Cylindrical Wall Load Combinations, and Comparison to Acceptance Criteria Elevation 180 Feet Near Fuel Handling Building Roof

Load/Combination	TX kip/ft	TY kip/ft	TXY kip/ft	MX k-ft/ft	MY k-ft/ft	MXY k-ft/ft	NX kip/ft	NY kip/ft	Comments
Dead	-7	-118	15	-25	-18	4	-6	-5	
Live	1	-1	1	0	0	0	0	0	
Seismic	157	390	163	301	211	35	71	33	
1	-8	-168	22	-35	-24	5	-8	-7	1.4 D + 1.7 L
2	152	270	179	276	194	38	66	28	D + L + Es
3	152	270	-148	-326	-228	-31	-77	-38	D + L + E's
4	-163	-509	-148	-326	-228	-31	-77	-38	D + L - Es
5	-163	-509	179	276	194	38	66	28	D + L - E's
6	152	283	177	278	195	38	66	28	0.9 D + Es
7	152	283	-150	-324	-227	-31	-77	-38	0.9 D + E's
35(2)	205	399	233	449	303	69	105	31	0.9 D + E's + αTo(W1)
37(2)	221	387	238	460	311	68	108	31	0.9 D + E's + αTo(W2)

RN-13-027

x-direction is horizontal; y-direction is vertical.
Element number: 12164
[*Plate thickness required for load combinations excluding thermal:* *0.50 inches + 2%(1)*]*
[*Plate thickness required for load combinations including thermal:* *0.65 inches + 2%(1)*]*
[*Plate thickness provided:* *0.75 inches*]*(3)
[*Shear reinforcement required for load combinations excluding thermal:* *0.72 in^2/ft^2 + 2%(1)*]*
[*Shear reinforcement required for load combinations including thermal:* *1.00 in^2/ft^2 + 2%(1)*]*
Shear reinforcement provided: See [*APP-GW-GLR-602, Section 4.*]*

Notes:
1. [*The Tier 2* designation for "Plate thickness required" requires NRC approval if this value is exceeded as a result of design changes or detail design adjustments identified during preparation of fabrication or construction drawings or instructions.*]*
2. Load cases 35 and 37 are the two governing load combinations for element 12164 that include thermal and seismic loads combined numerically. W1 designates the winter conditions with the spent fuel pool at the normal operating temperature limit. W2 designates the winter conditions with the spent fuel pool and fuel transfer canal at the normal operating temperature limit. Es is SRSS (member forces are positive) of the SSE loads. E's is Es with all member forces except axial forces (TX, TY) reversed to negative.
3. The 0.75-inch plate thickness is the nominal plate size for the shield building away from connections, attachments, and other local loads. The plate may be thicker (up to 1.0-inch nominal thickness) in the area around these local loads. RN-13-027

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-14 (Sheet 2 of 3)
Design Summary of Enhanced Shield Building Load Combinations, and Comparison to Acceptance Criteria Elevation 175 Feet Near Intersection With Wall 7.3

Load/Combination	TX kip/ft	TY kip/ft	TXY kip/ft	MX k-ft/ft	MY k-ft/ft	MXY k-ft/ft	NX kip/ft	NY kip/ft	Comments
Dead	-7	-106	12	-6	5	1	0	2	
Live	0	-1	0	0	0	0	0	0	
Seismic	34	327	178	38	25	13	2	8	
1	-9	-150	17	-9	7	1	0	3	1.4 D + 1.7 L
2	28	220	190	32	30	14	2	10	D + L + Es
3	28	220	-166	-45	-21	-12	-3	-6	D + L + E's
4	-40	-434	-166	-45	-21	-12	-3	-6	D + L - Es
5	-40	-434	190	32	30	14	2	10	D + L - E's
6	28	232	189	33	30	14	2	10	0.9 D + Es
7	28	232	-167	-44	-21	-12	-3	-7	0.9 D + E's
19(2)	75	251	168	-39	-107	-20	-2	-5	D + L + E's + αTo(W1)
37(2)	75	251	168	-39	-107	-20	-2	-5	0.9 D + E's + αTo(W2)

RN-13-027

x-direction is horizontal; y-direction is vertical.
Element number: 11514
[*Plate thickness required for load combinations excluding thermal:* *0.45 inches + 2%*(1)]*
[*Plate thickness required for load combinations including thermal:* *0.50 inches + 2%*(1)]*
[*Plate thickness provided:* *0.75 inches*]*(3)
[*Shear reinforcement required for load combinations excluding thermal:* *0.09 in²/ft² + 2%*(1)]*
[*Shear reinforcement required for load combinations including thermal:* *0.12 in²/ft² + 2%*(1)]*
Shear reinforcement provided: See [*APP-GW-GLR-602, Section 4.*]*

Notes:
1. [*The Tier 2* designation for "Plate thickness required" requires NRC approval if this value is exceeded as a result of design changes or detail design adjustments identified during preparation of fabrication or construction drawings or instructions.*]*
2. Load cases 19 and 37 are the two governing load combinations for element 11514 that include thermal and seismic loads combined numerically. W1 designates the winter conditions with the spent fuel pool at the normal operating temperature limit. W2 designates the winter conditions with the spent fuel pool and fuel transfer canal at the normal operating temperature limit. Es is SRSS (member forces are positive) of the SSE loads. E's is Es with all member forces except axial forces (TX, TY) reversed to negative.
3. The 0.75-inch plate thickness is the nominal plate size for the shield building away from connections, attachments, and other local loads. The plate may be thicker (up to 1.0-inch nominal thickness) in the area around these local loads. RN-13-027

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-14 (Sheet 3 of 3) Design Summary of Enhanced Shield Building Load Combinations, and Comparison to Acceptance Criteria Elevation Grade on West Side

Load/Combination	TX kip/ft	TY kip/ft	TXY kip/ft	MX k-ft/ft	MY k-ft/ft	MXY k-ft/ft	NX kip/ft	NY kip/ft	Comments
Dead	-4	-129	0	2	16	0	0	-2	
Live	0	1	0	0	0	0	0	0	
Seismic	80	489	234	2	20	18	4	8	
1	-5	-179	0	3	23	0	0	-2	1.4 D + 1.7 L
2	77	362	234	5	36	19	4	7	D + L + Es
3	77	362	-234	0	-4	-18	-4	-10	D + L + E's
4	-84	-617	-234	0	-4	-18	-4	-10	D + L - Es
5	-84	-617	234	5	36	19	4	7	D + L - E's
6	77	374	234	5	34	19	4	7	0.9 D + Es
7	77	374	-235	0	-5	-18	-4	-10	0.9 D + E's
23(2)	202	377	-240	113	151	-18	-4	-32	D + L + E's + αTo(W1)
41(2)	203	393	-240	112	149	-17	-4	-32	0.9 D + E's + αTo(W2)

RN-13-027

x-direction is horizontal; y-direction is vertical.

Element number:	23752
[*Plate thickness required for load combinations excluding thermal:*	*0.65 inches + 2%(1)*]*
[*Plate thickness required for load combinations including thermal:*	*0.66 inches + 2%(1)*]*
[*Plate thickness provided:*	*0.75 inches*]*(3)
[*Shear reinforcement required for load combinations excluding thermal:*	*0.08 in²/ft² + 2%(1)*]*
[*Shear reinforcement required for load combinations including thermal:*	*0.26 in²/ft² + 2%(1)*]*
Shear reinforcement provided:	See [*APP-GW-GLR-602, Section 4.*]*

Notes:

1. [*The Tier 2* designation for "Plate thickness required" requires NRC approval if this value is exceeded as a result of design changes or detail design adjustments identified during preparation of fabrication or construction drawings or instructions.*]*
2. Load cases 23 and 41 are the two governing load combinations for element 23752 that include thermal and seismic loads combined numerically. W1 designates the winter conditions with the spent fuel pool at the normal operating temperature limit. W2 designates the winter conditions with the spent fuel pool and fuel transfer canal at the normal operating temperature limit. Es is SRSS (member forces are positive) of the SSE loads. E's is Es with all member forces except axial forces (TX, TY) reversed to negative.
3. The 0.75-inch plate thickness is the nominal plate size for the shield building away from connections, attachments, and other local loads. The plate may be thicker (up to 1.0-inch nominal thickness) in the area around these local loads. RN-13-027

*NRC Staff approval is required prior to implementing a change in this information.

Table 3H.5-15
Shield Building Roof Reinforcement Ratio of Code Required Versus Provided

Critical Sections	Stress Component	Required in^2/ft	Provided (Minimum) in^2/ft	Reinforcement Ratio
[*Conical Roof Steel Beams*]* (1)	Axial + Bending	-	[*Radial Beams W36 X 393*]*	1.33
	Shear	-		8.33
[*Conical Roof Near Tension Ring*]*	Radial	1.80	[*1.96*]*	1.09
	Hoop	4.31	[*4.68*]*	1.09
[*Knuckle Region*]*	Vertical	1.37	[*1.72*]*	1.25
	Radial	1.52	[*2.23*]*	1.47
	Hoop	1.37	[*3.12*]*	2.28
[*Compression Ring*]*	Vertical	1.04	[*1.48*]*	1.42
	Radial	3.09	[*4.42*]*	1.43
	Hoop	2.14	[*3.12*]*	1.45

Note:
1. Steel beams are not considered as reinforcement for the reinforced concrete roof. Ratio for conical roof steel beams is based on demand and allowable stresses in psi.

*NRC Staff approval is required prior to implementing a change in this information.

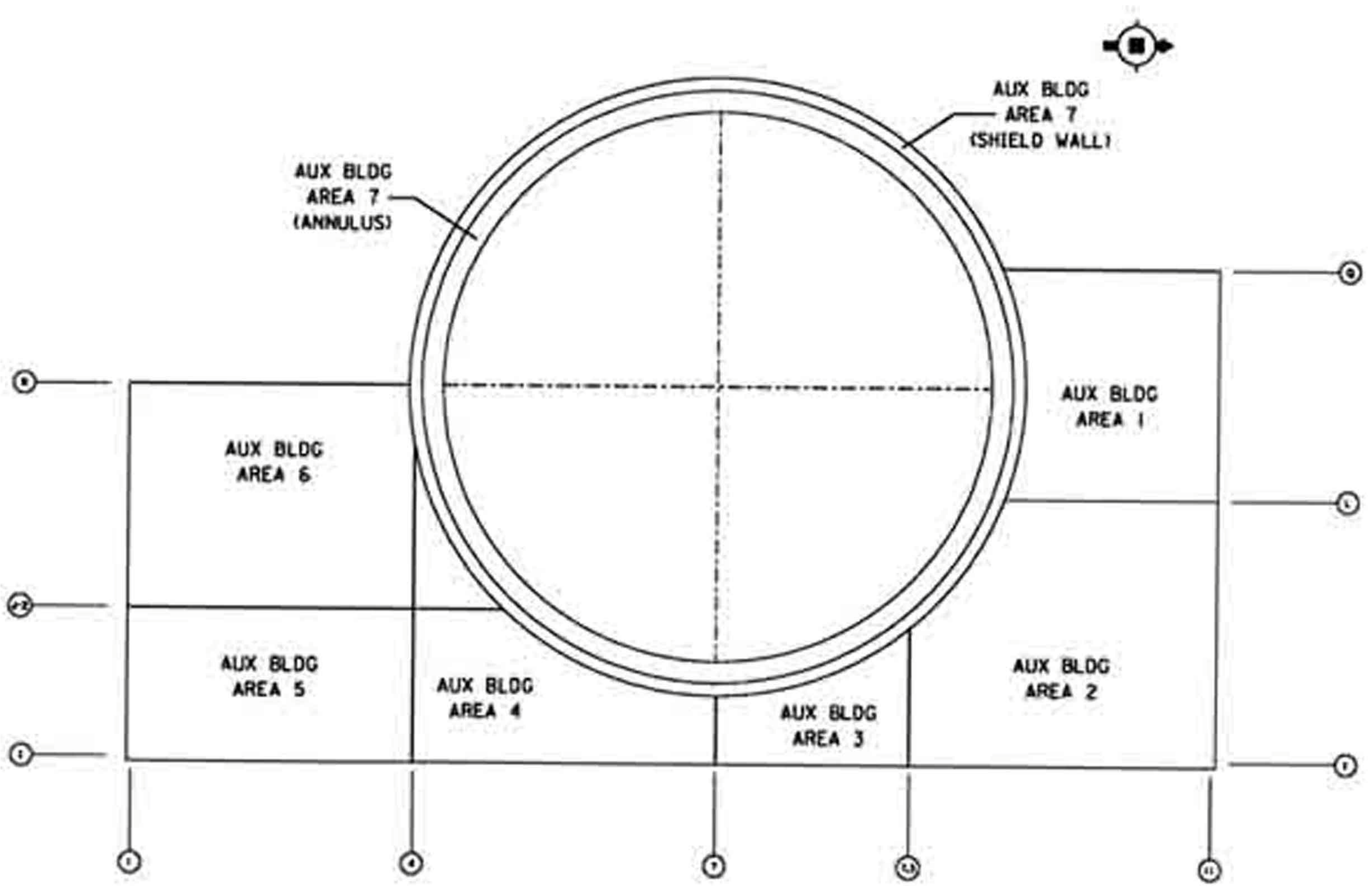


Figure 3H.2-1 [*General Layout of Auxiliary Building*]*

*NRC Staff approval is required prior to implementing a change in this information.

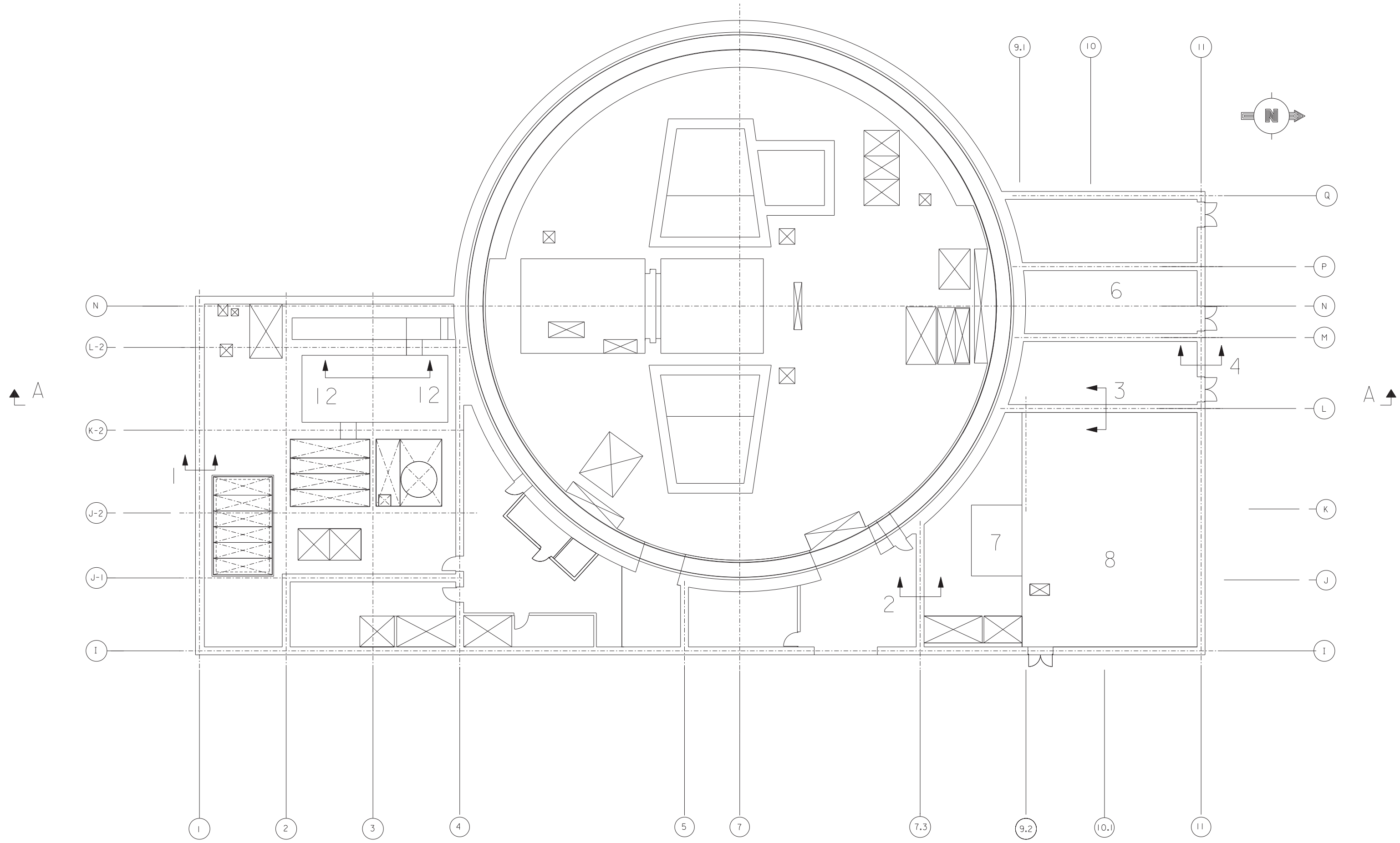


Figure 3H.5-1 (Sheet 1 of 3) [*Nuclear Island Critical Sections Plan at El. 135'-3"*]* RN-13-071

*NRC Staff approval is required prior to implementing a change in this information.

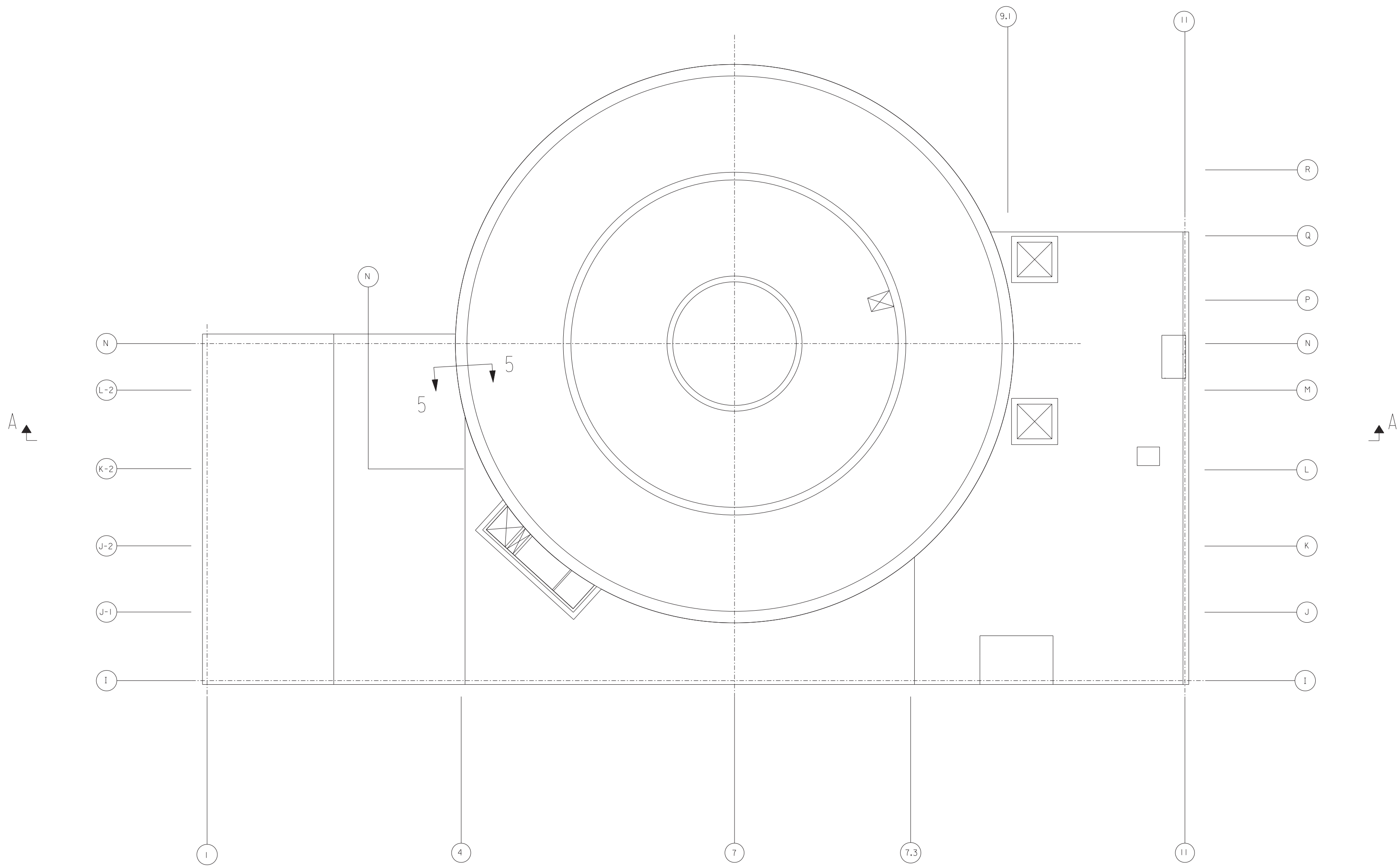


Figure 3H.5-1 (Sheet 2 of 3) [*Nuclear Island Critical Sections Plan at El. 180'-0"*]* RN-13-071 RN-12-072

*NRC Staff approval is required prior to implementing a change in this information.

Redacted Information, Withheld Under 10 CFR 2.390d

Figure 3H.5-1 (Sheet 3 of 3) [*Nuclear Island Critical Sections Section A-A*]* RN-13-071 RN-12-072

*NRC Staff approval is required prior to implementing a change in this information.

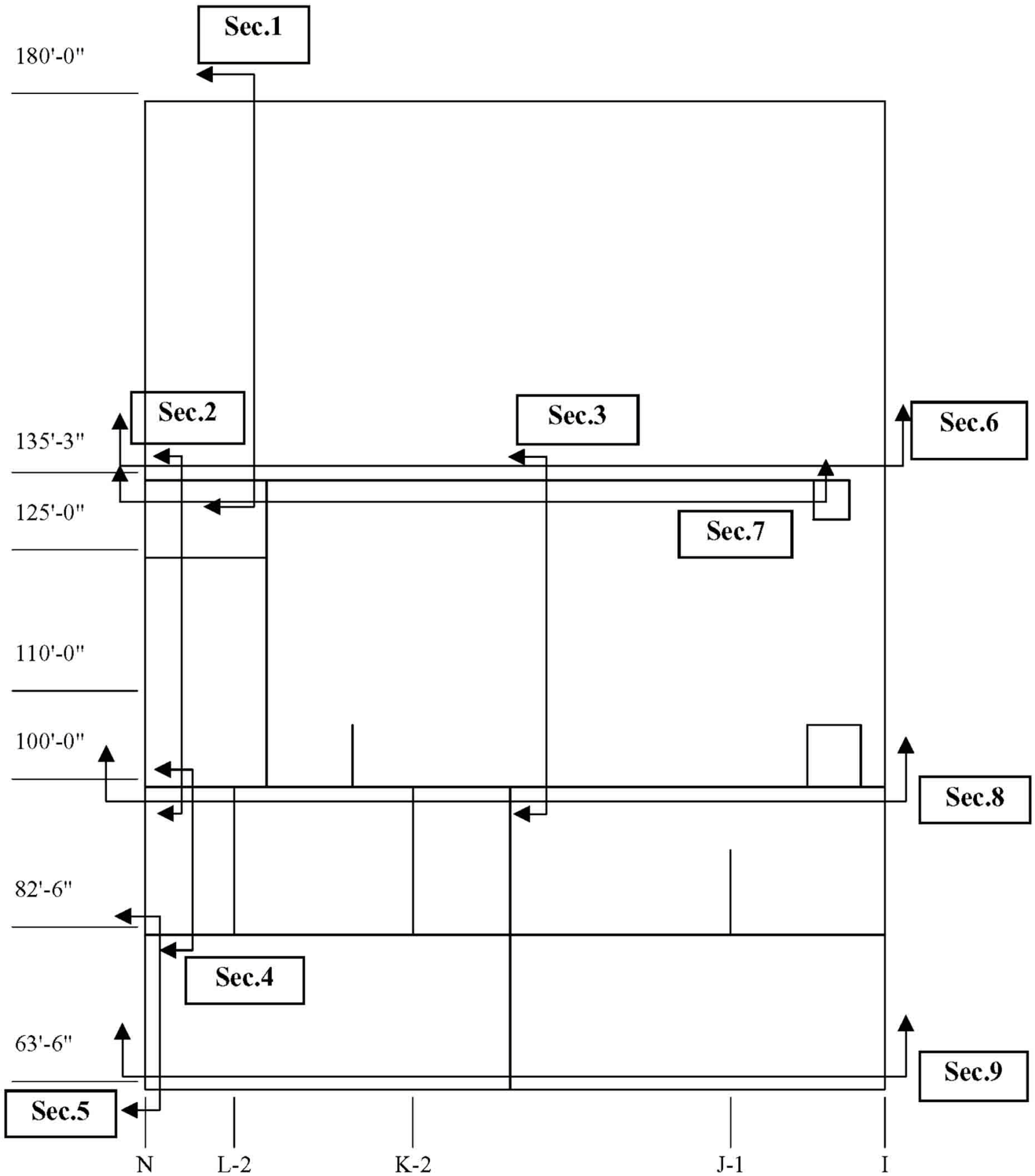


Figure 3H.5-2 (Sheet 1 of 3) [*Wall on Column Line 1*]*

*NRC Staff approval is required prior to implementing a change in this information.

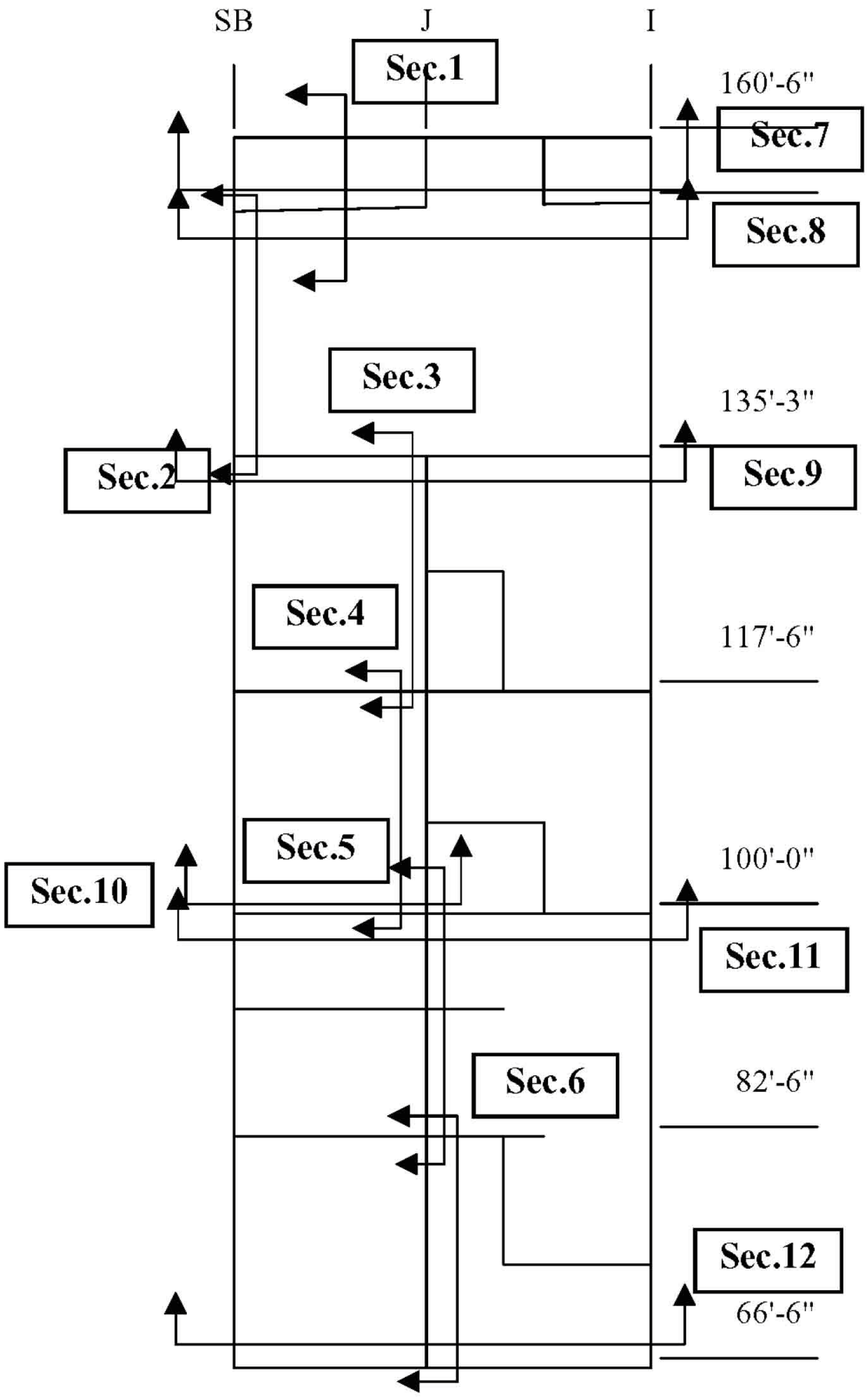


Figure 3H.5-2 (Sheet 2 of 3) [*Wall on Column Line 7.3*]*

*NRC Staff approval is required prior to implementing a change in this information.

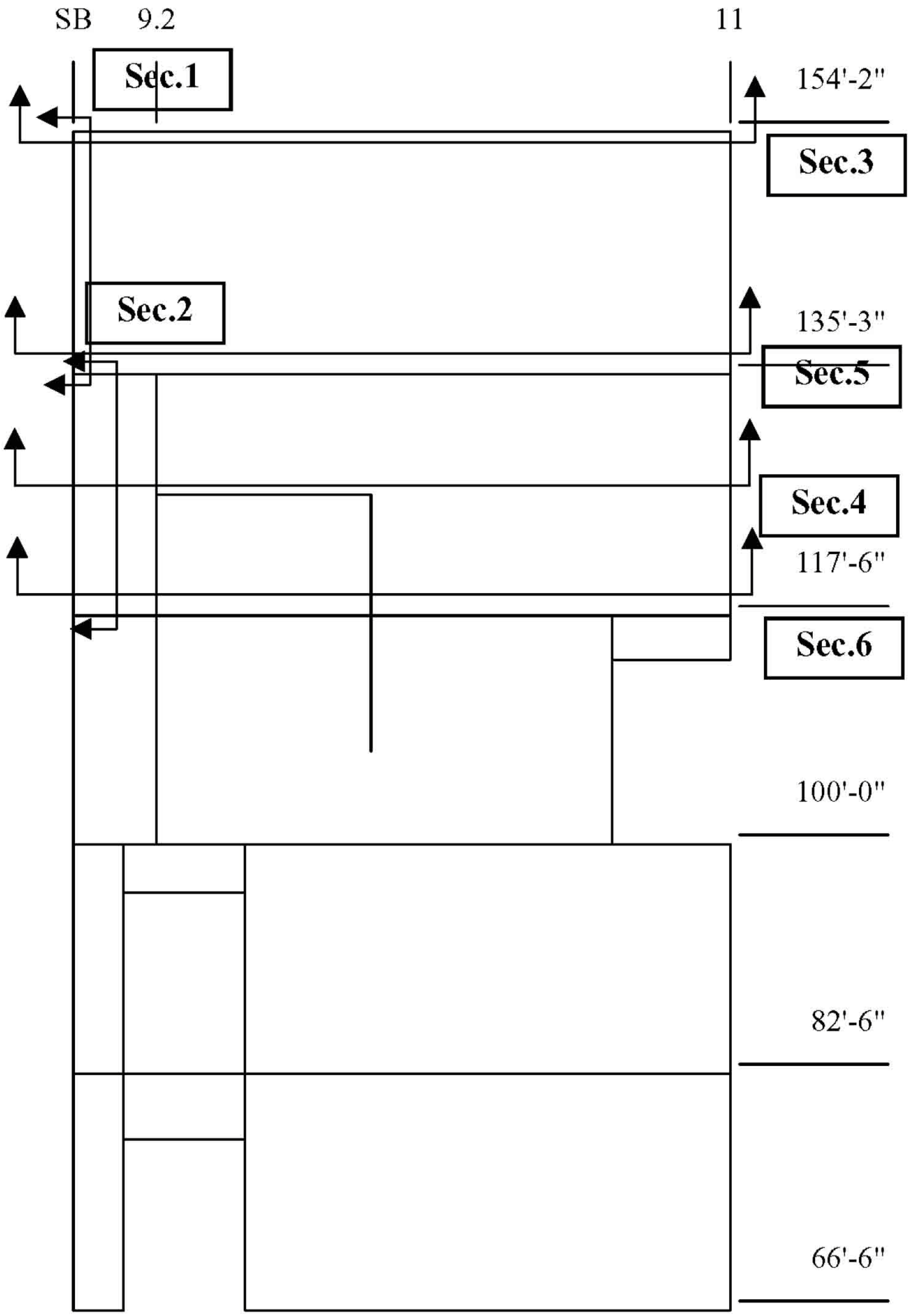


Figure 3H.5-2 (Sheet 3 of 3) [*Wall on Column Line L*]*

*NRC Staff approval is required prior to implementing a change in this information.

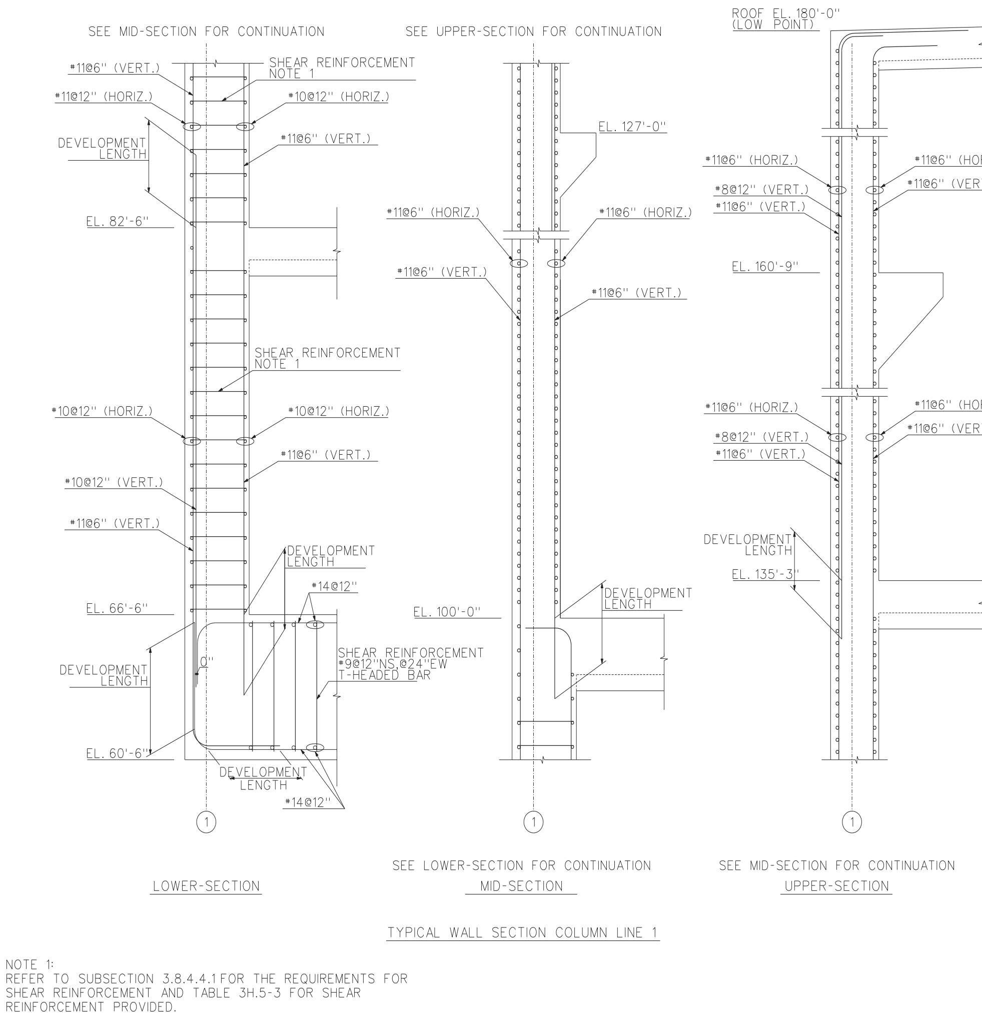
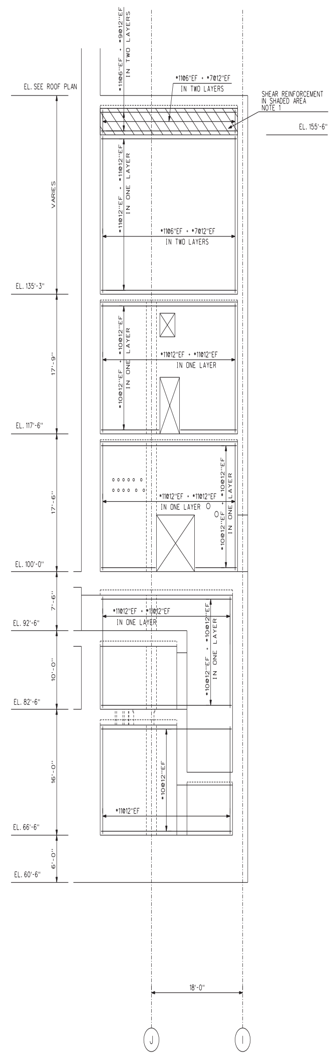


Figure 3H.5-3 [*Typical Reinforcement in Wall on Column Line 1*]* RN-13-018

*NRC Staff approval is required prior to implementing a change in this information.



NOTE 1:
REFER TO SUBSECTION 3.8.4.4.1 FOR THE REQUIREMENTS FOR SHEAR REINFORCEMENT AND TABLE 3H.5-5 FOR SHEAR REINFORCEMENT PROVIDED.

Figure 3H.5-4 [*Typical Reinforcement in Wall 7.3*]* RN-13-018

*NRC Staff approval is required prior to implementing a change in this information.

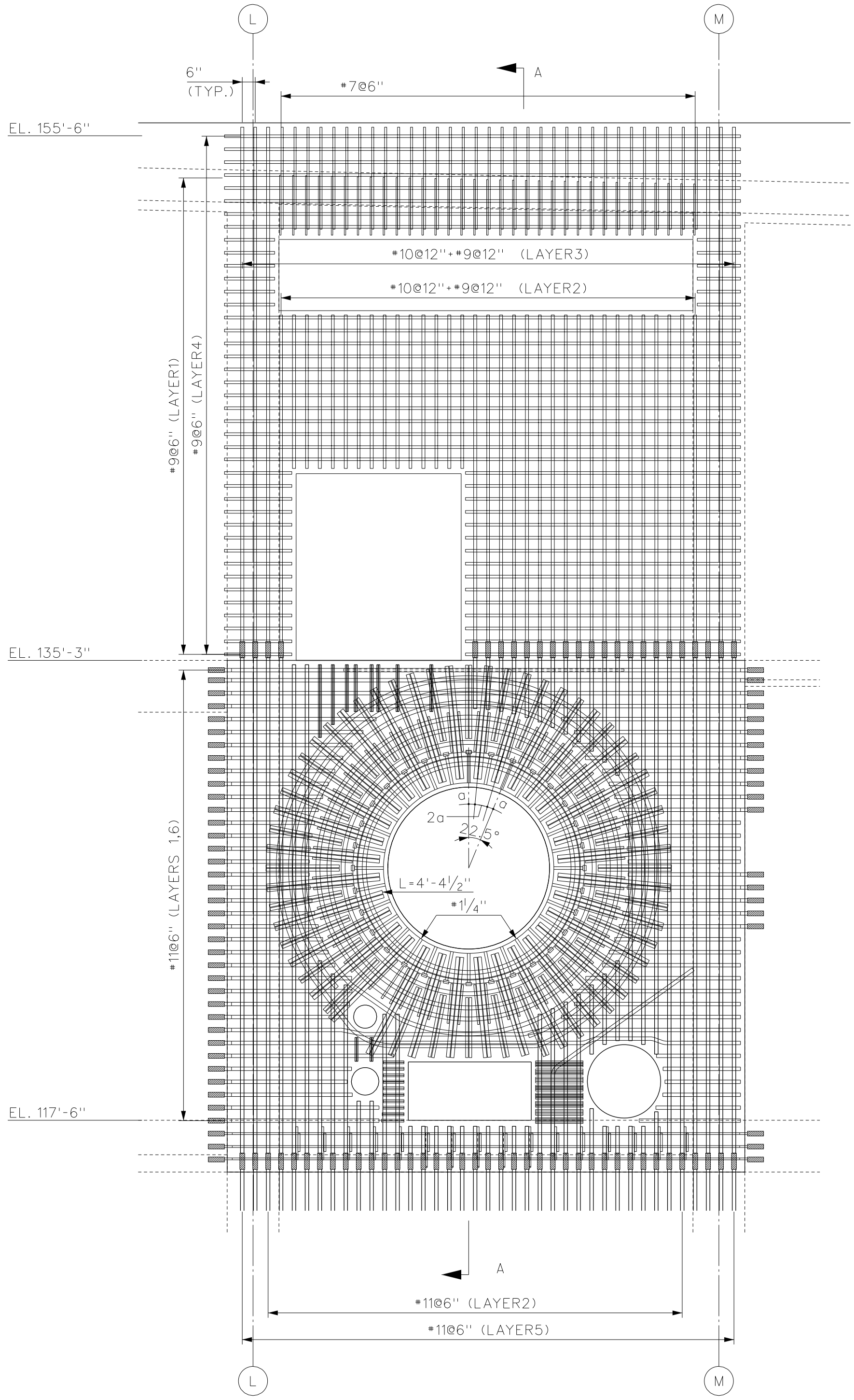


Figure 3H.5-5 (Sheet 1 of 3) [*Concrete Reinforcement in Wall 11*]*

*NRC Staff approval is required prior to implementing a change in this information.

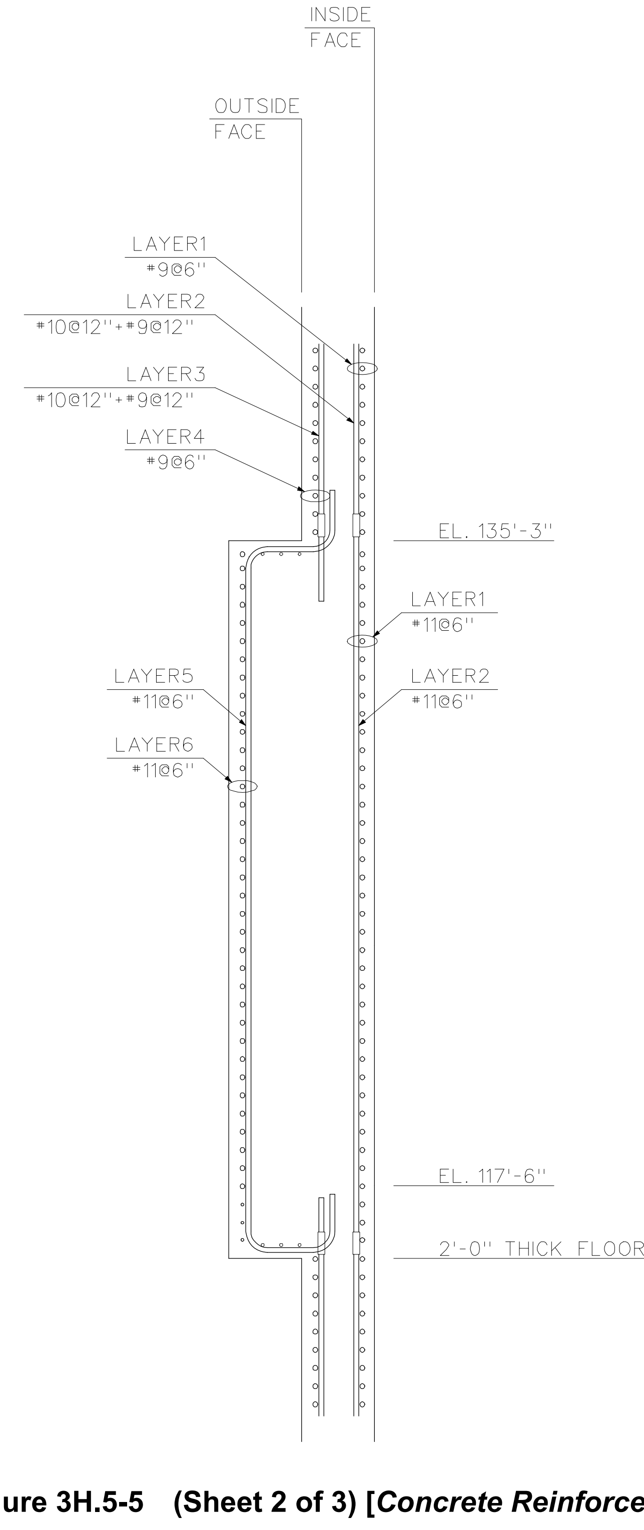


Figure 3H.5-5 (Sheet 2 of 3) [*Concrete Reinforcement Layers in Wall 11 (Looking East)*]*

*NRC Staff approval is required prior to implementing a change in this information.

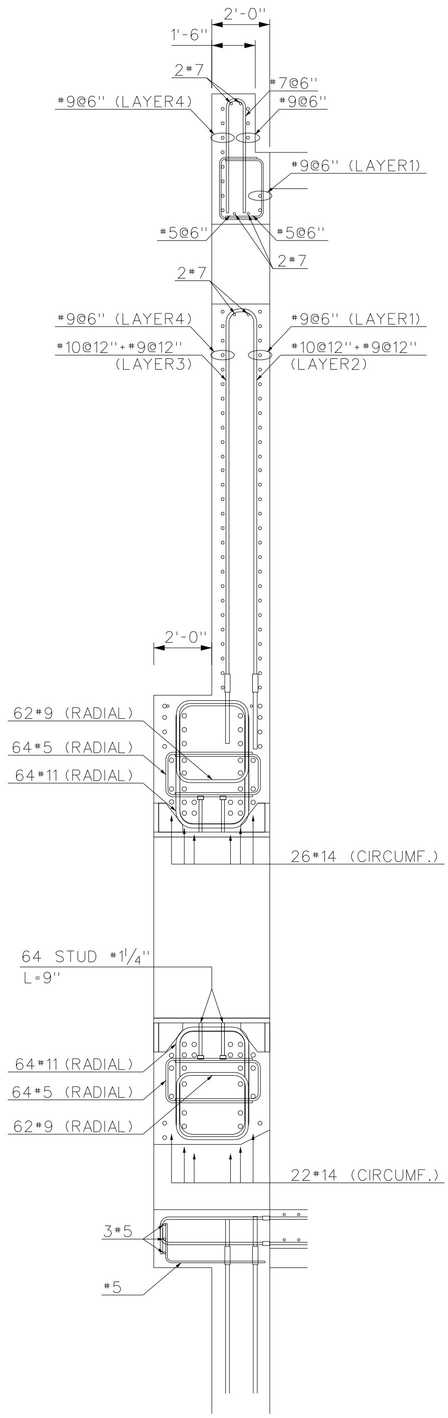
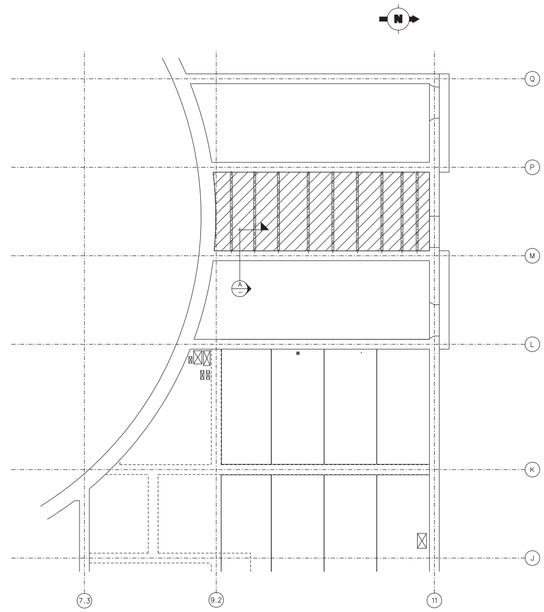
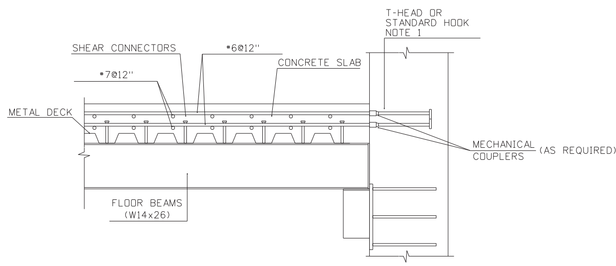


Figure 3H.5-5 (Sheet 3 of 3) [*Wall 11 at Main Steamline Anchor Section A-A*]*

*NRC Staff approval is required prior to implementing a change in this information.



PLAN VIEW
NOTES 1, 3, 6



SECTION A-A
NOTES 1,2,3,4,5,6, & 7

NOTES:

1. DETAIL SHOWN IS SPECIFIC TO THE COMPOSITE FLOOR AT EL. 135'-3" AT INTERSECTION WITH WALL M. REFER TO SUBSECTION 3H.5.2 AND OTHER NOTES FOR ADDITIONAL INFORMATION ABOUT DESIGN DETAILS FOR OTHER FLOOR SECTIONS.
2. REFER TO SUBSECTION 3.8.4.4.1 FOR THE REQUIREMENTS FOR DEVELOPMENT OF HEADED REINFORCEMENT.
3. FLOOR BEAM SIZE AND SPACING ARE DESIGNED BASED ON FLOOR LOAD AND GEOMETRY TO SATISFY AISC N690 REQUIREMENTS. THE BEAM SIZES USED ARE PREDOMINATELY W14x26 AND W14x48. THE RANGE OF BEAM SIZES USED IN OTHER LOCATIONS IS FROM W10 TO W44. THE SPACING BETWEEN THE BEAMS IS PREDOMINATELY IN A RANGE OF 5 TO 6 FEET.
4. THE REINFORCEMENT SHOWN IS FOR LOCATIONS AWAY FROM OPENINGS, PENETRATIONS, EMBEDMENTS, AND OTHER OBSTRUCTIONS.
5. REINFORCEMENT SIZE AND SPACING ARE BASED ON THE REQUIREMENTS IN ACI 349 AND ACI 318-11, SECTION 12.6.
6. THE ADJACENT WALL MAY BE DESIGNED AS A STRUCTURAL WALL MODULE.
7. THE DETAIL DESIGN, LOCATION, AND EMBEDMENT OF THE BEAM SUPPORTS ARE DESIGNED TO THE REQUIREMENTS OF AISC N690 AND ACI 349 AS APPLICABLE. SUPPORT CONFIGURATION, INCLUDING THE USE OF PLATES, STRUCTURAL SHAPES, AND STIFFENERS, IS BASED ON LOADING AND LOCAL GEOMETRY CONSIDERATIONS.THE DESIGN OF EMBEDMENT ANCHORAGE INCLUDING TYPE, SIZE, AND SPACING SATISFIES THE REQUIREMENTS OF APPENDIX B AS WELL AS OTHER APPLICABLE SECTIONS OF ACI 349.

Figure 3H.5-6 [*Auxiliary Building Typical Composite Floor*]* RN-13-071

*NRC Staff approval is required prior to implementing a change in this information.

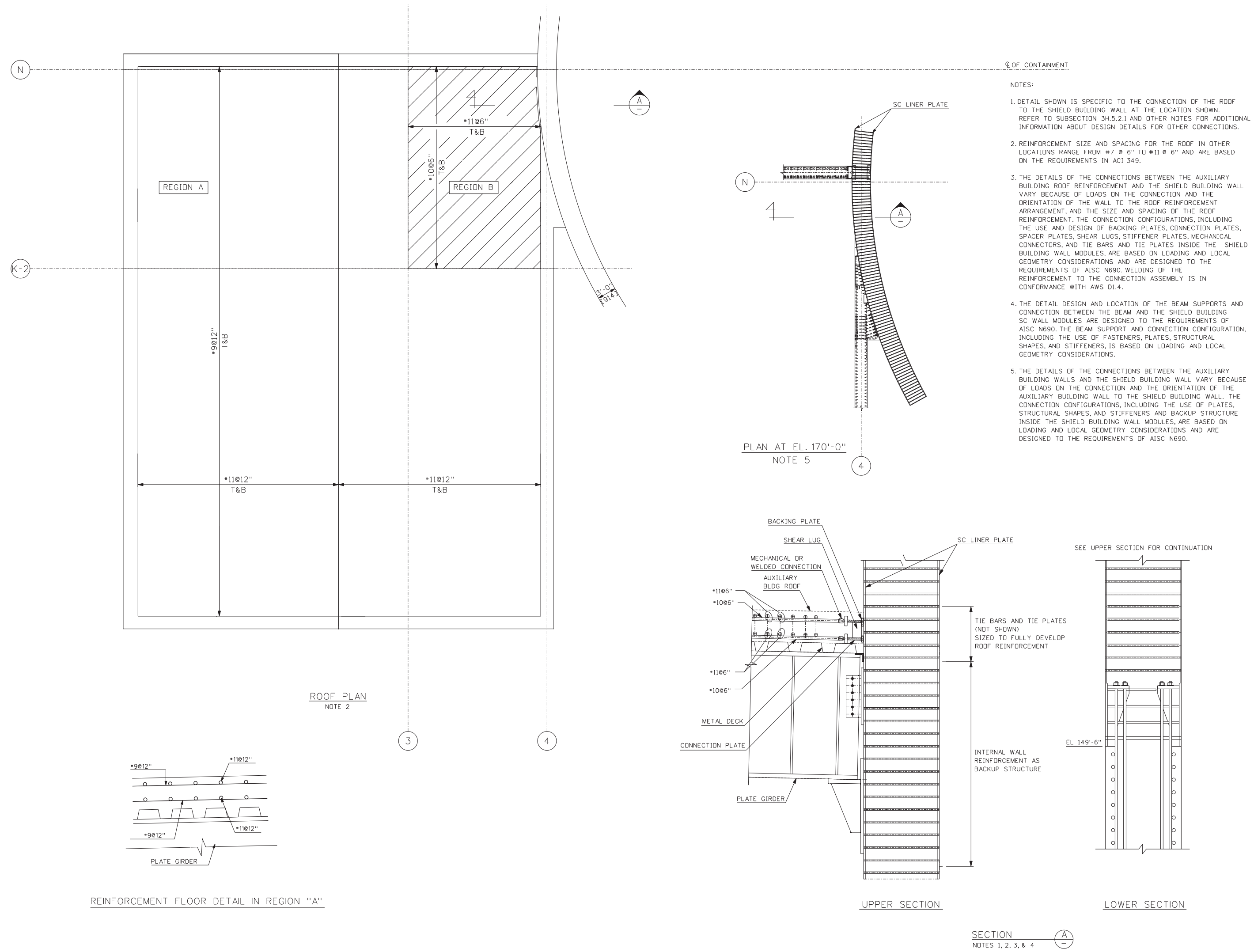


Figure 3H.5-7 [*Typical Reinforcement and Connection to Shield Building*]* RN-13-027

*NRC Staff approval is required prior to implementing a change in this information.

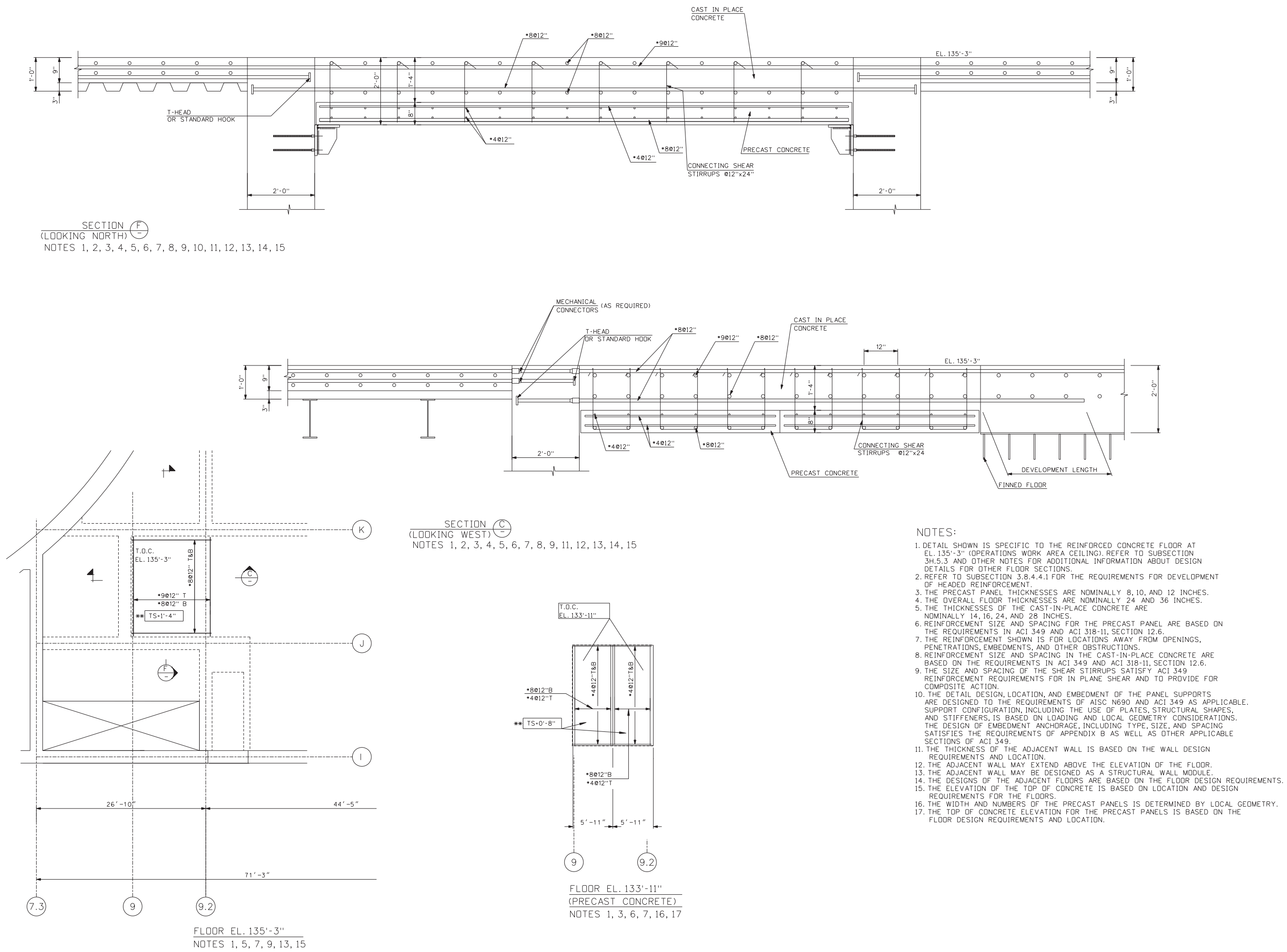


Figure 3H.5-8 [*Auxiliary Building Operations Work Area (Tagging Room) Ceiling*]* RN-13-071

*NRC Staff approval is required prior to implementing a change in this information.

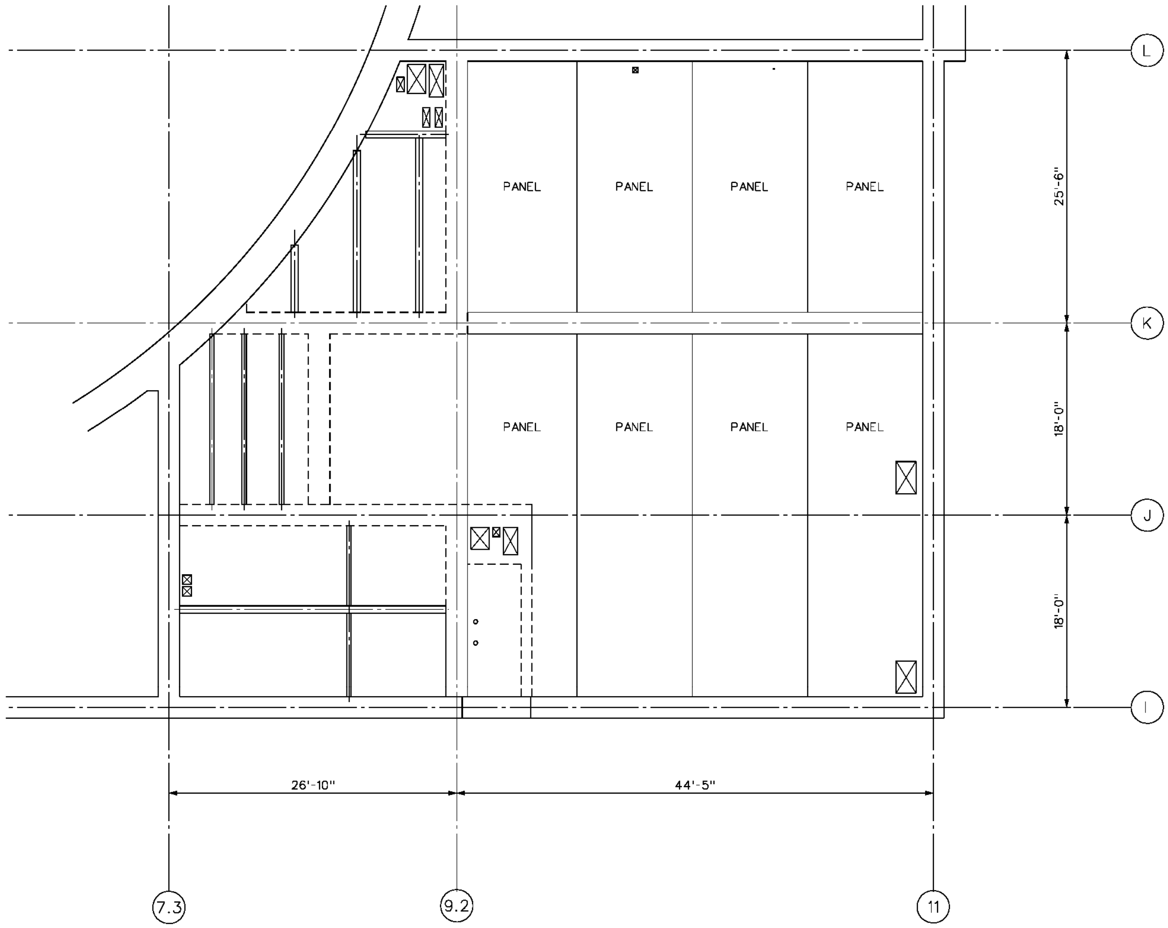


Figure 3H.5-9 (Sheet 1 of 3) [*Auxiliary Building Finned Floor*]*

*NRC Staff approval is required prior to implementing a change in this information.

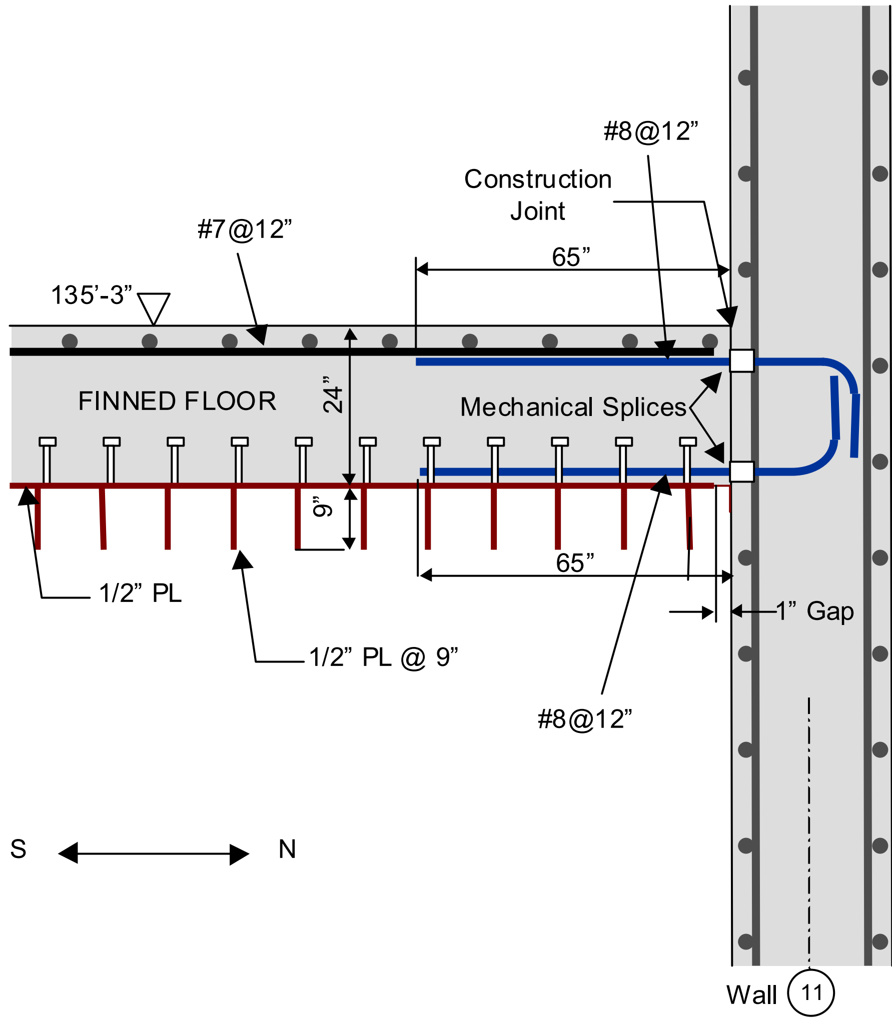


Figure 3H.5-9 (Sheet 2 of 3) [*Auxiliary Building Finned Floor*]*

*NRC Staff approval is required prior to implementing a change in this information.

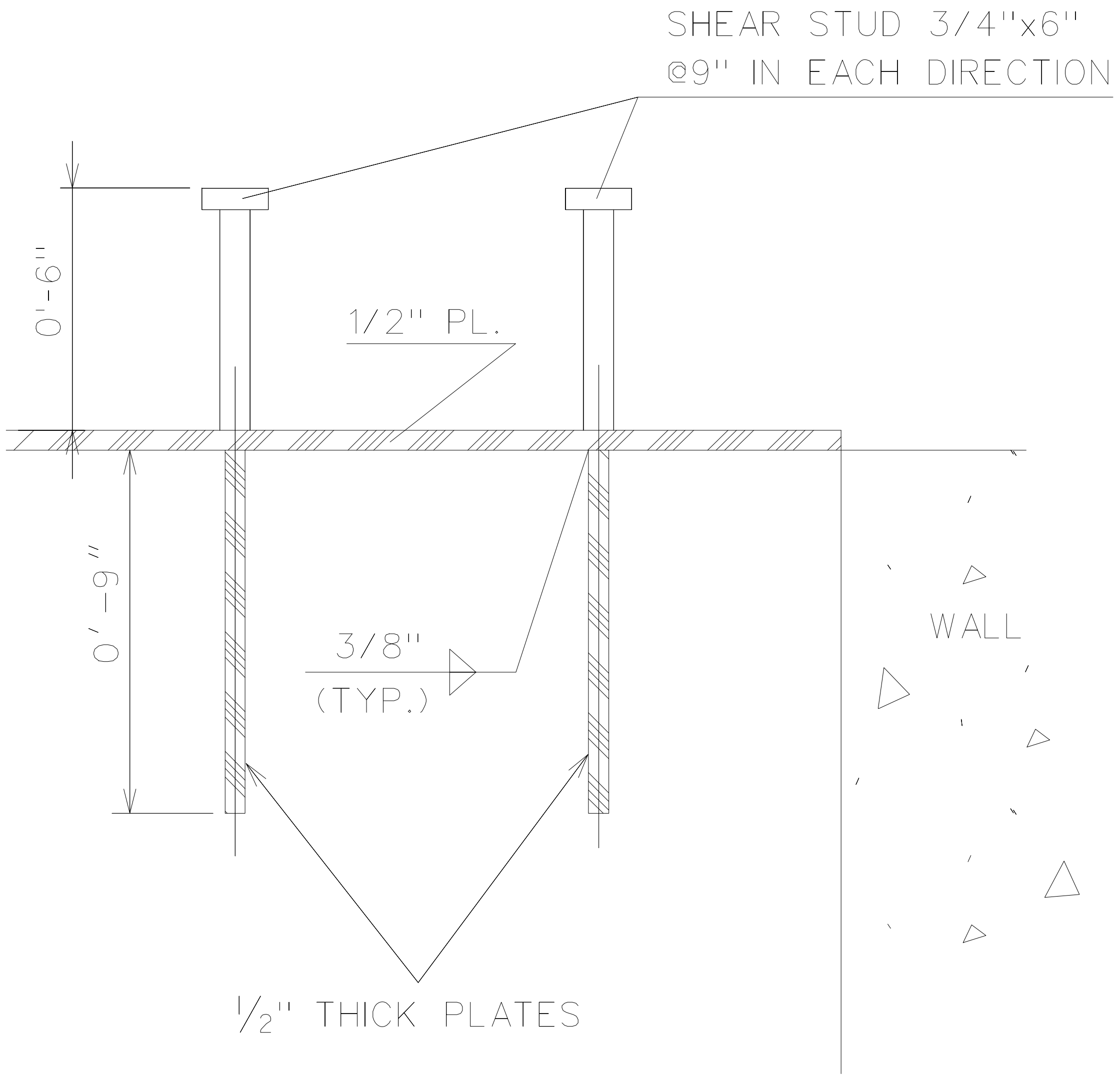


Figure 3H.5-9 (Sheet 3 of 3) [*Auxiliary Building Finned Floor*]*

*NRC Staff approval is required prior to implementing a change in this information.

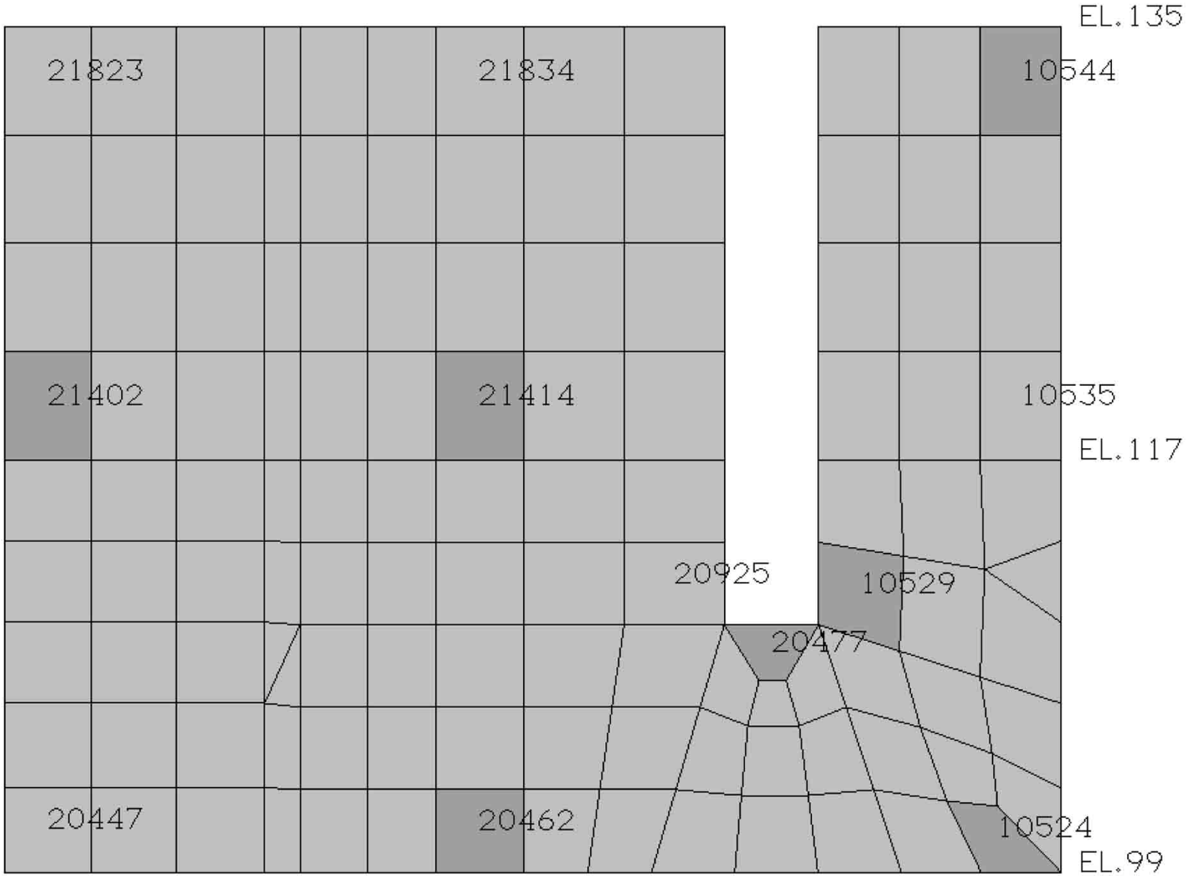


Figure 3H.5-10 [*Spent Fuel Pool Wall Divider Wall Element Locations*]*

*NRC Staff approval is required prior to implementing a change in this information.

Redacted Information, Withheld Under 10 CFR 2.390d

Figure 3H.5-11 (Sheet 1 of 6) [*Design of Shield Building: Roof and Air Inlets*]*

*NRC Staff approval is required prior to implementing a change in this information.

Redacted Information, Withheld Under 10 CFR 2.390d

Figure 3H.5-11 (Sheet 2 of 6) [*Design of Shield Building: Concrete Detail at Tension Ring*]*

*NRC Staff approval is required prior to implementing a change in this information.

Redacted Information, Withheld Under 10 CFR 2.390d

Figure 3H.5-11 (Sheet 3 of 6) [*Design of Shield Building: Roof/Air Inlet Interface*]*

*NRC Staff approval is required prior to implementing a change in this information.

Redacted Information, Withheld Under 10 CFR 2.390d

Figure 3H.5-11 (Sheet 4 of 6) [*Design of Shield Building at Air Inlets*]*

*NRC Staff approval is required prior to implementing a change in this information.

Redacted Information, Withheld Under 10 CFR 2.390d

Figure 3H.5-11 (Sheet 5 of 6)[*Design of Shield Building: Tank/Roof Interface Reinforcement*]*

*NRC Staff approval is required prior to implementing a change in this information.

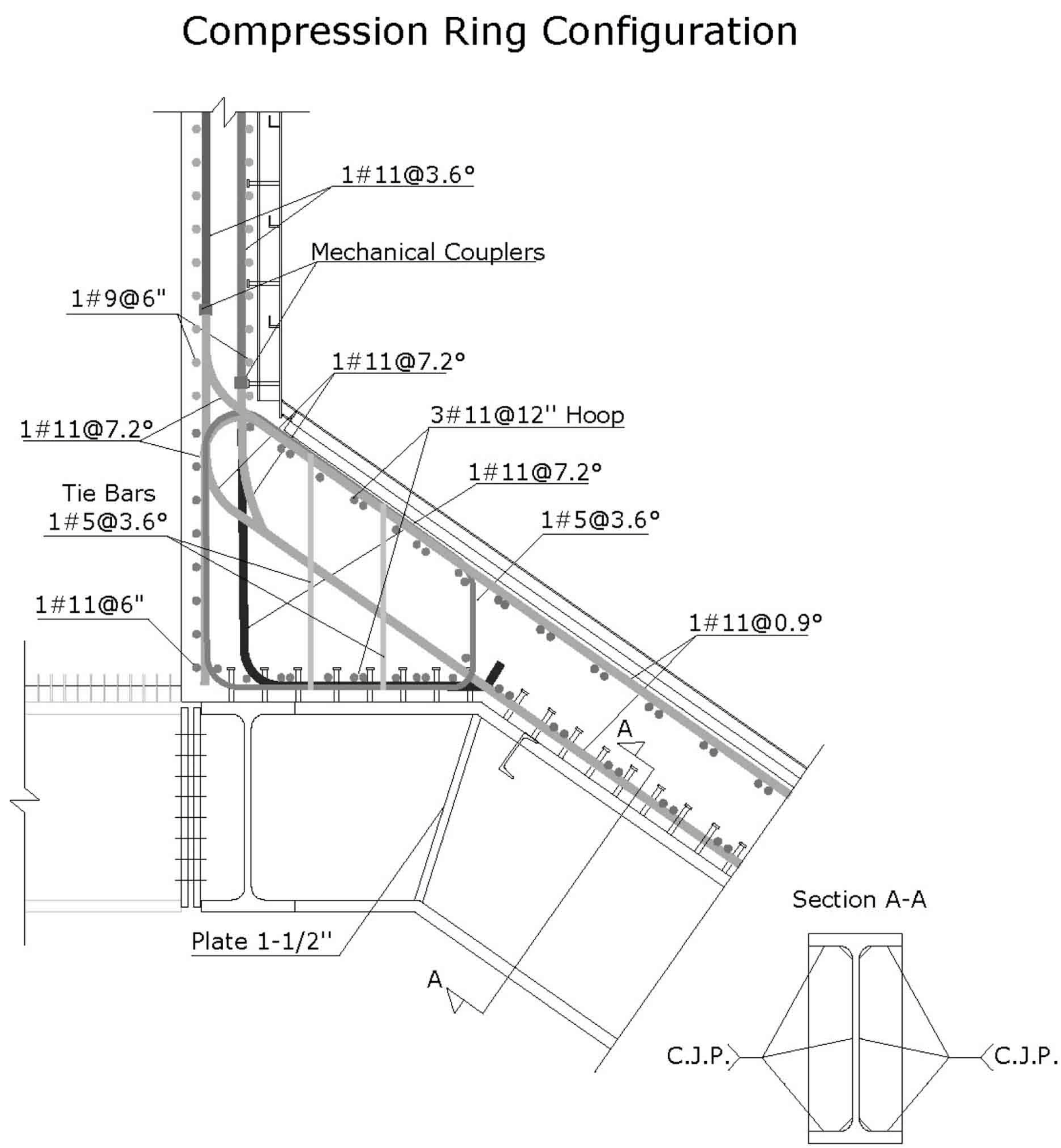
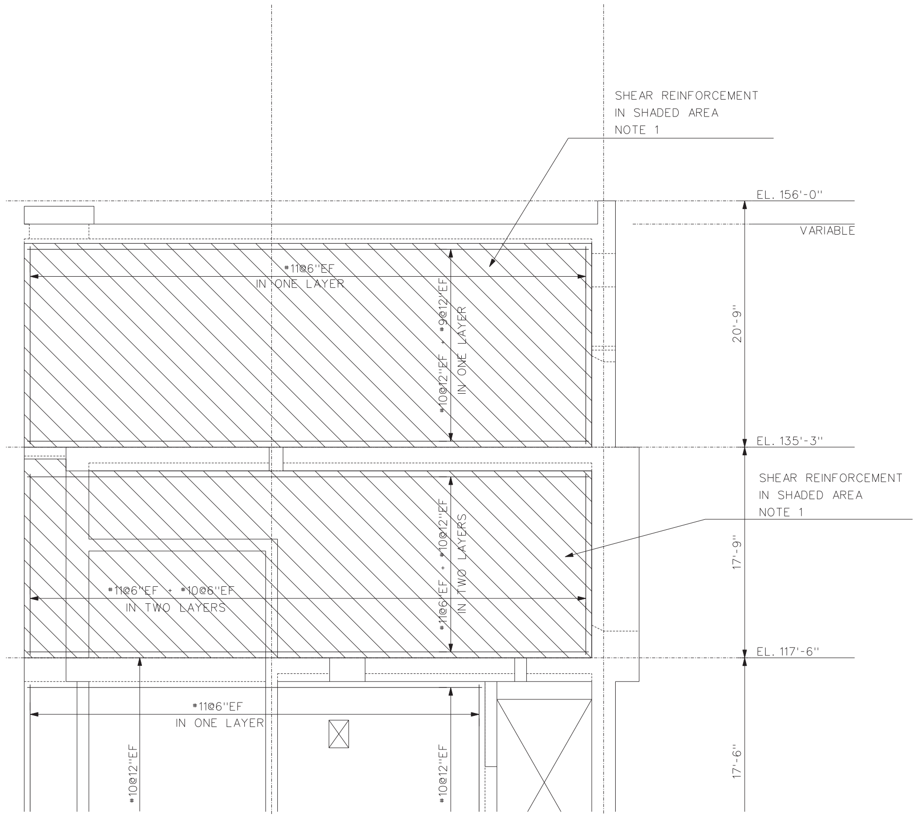


Figure 3H.5-11 (Sheet 6 of 6) Design of Shield Building: Tank/Compression Ring Roof Interface Reinforcement

*NRC Staff approval is required prior to implementing a change in this information.



NOTE 1:
REFER TO SUBSECTION 3.8.4.4.1 FOR THE REQUIREMENTS FOR SHEAR REINFORCEMENT AND TABLE 3H.5-7 FOR SHEAR REINFORCEMENT PROVIDED.

Figure 3H.5-12 [*Typical Reinforcement in Wall L*]* RN-12-072

*NRC Staff approval is required prior to implementing a change in this information.

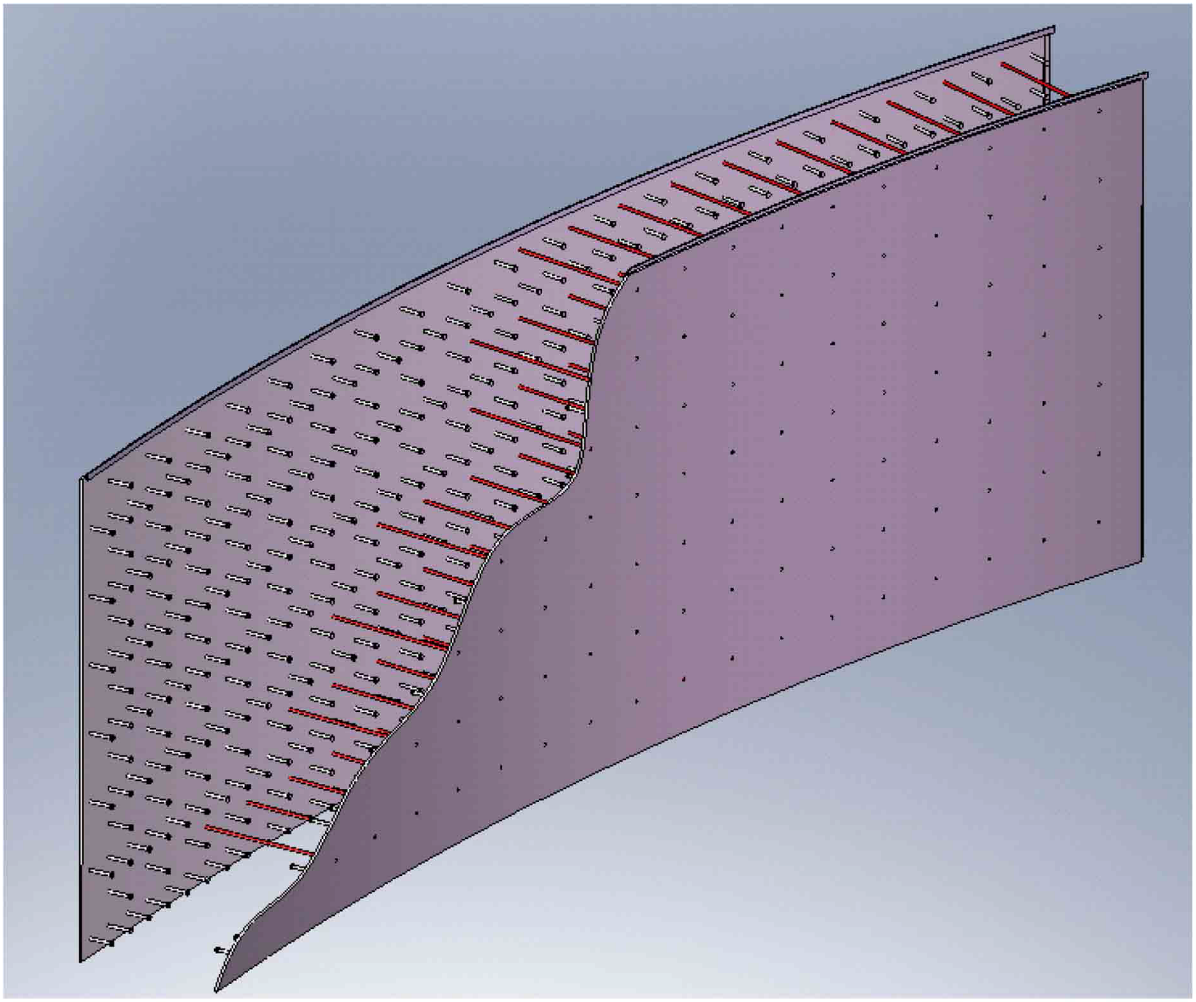


Figure 3H.5-13 Enhanced Shield Building Wall Panel Layout

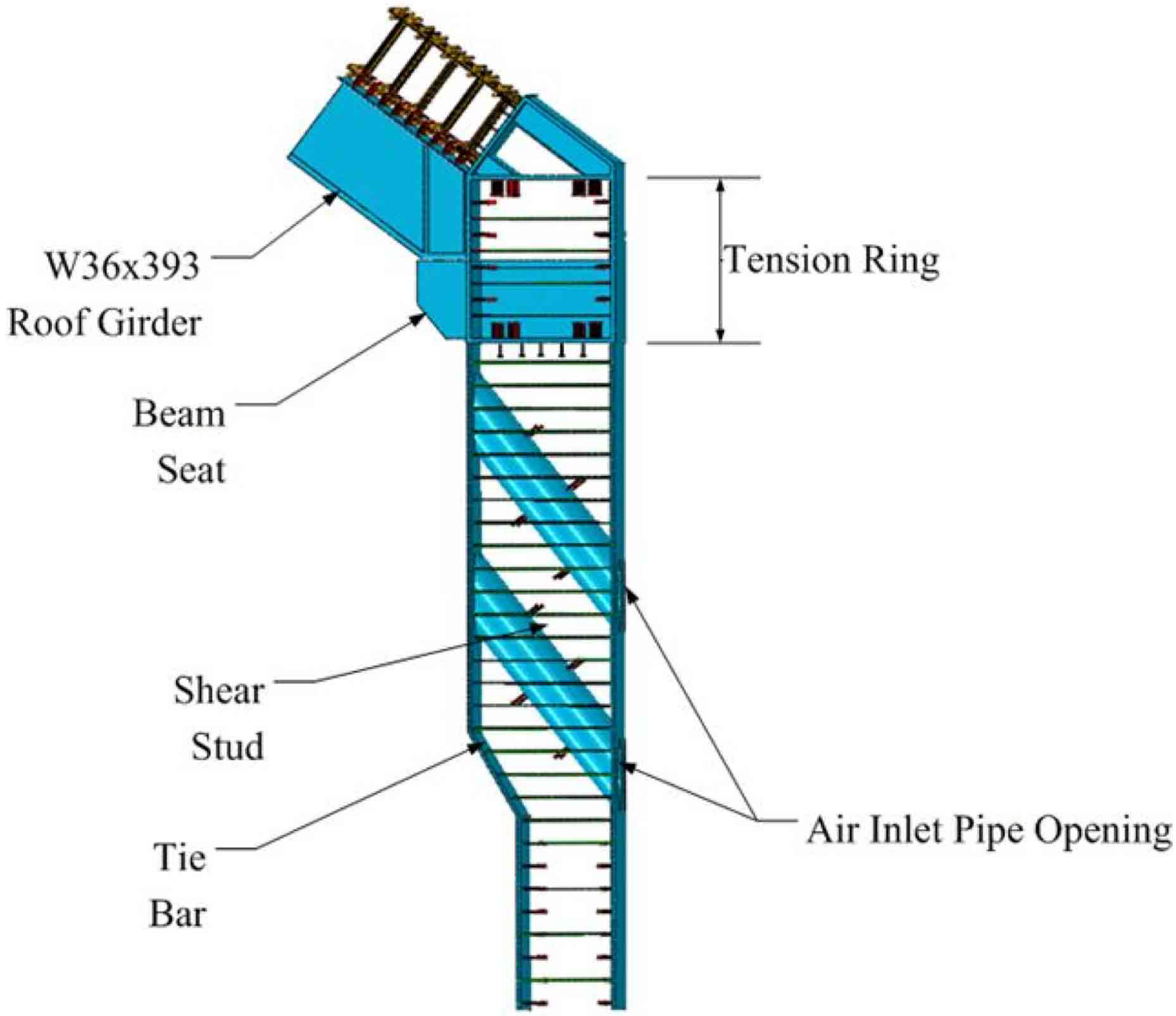


Figure 3H.5-14 Elevation View of Tension Ring and Air Inlets

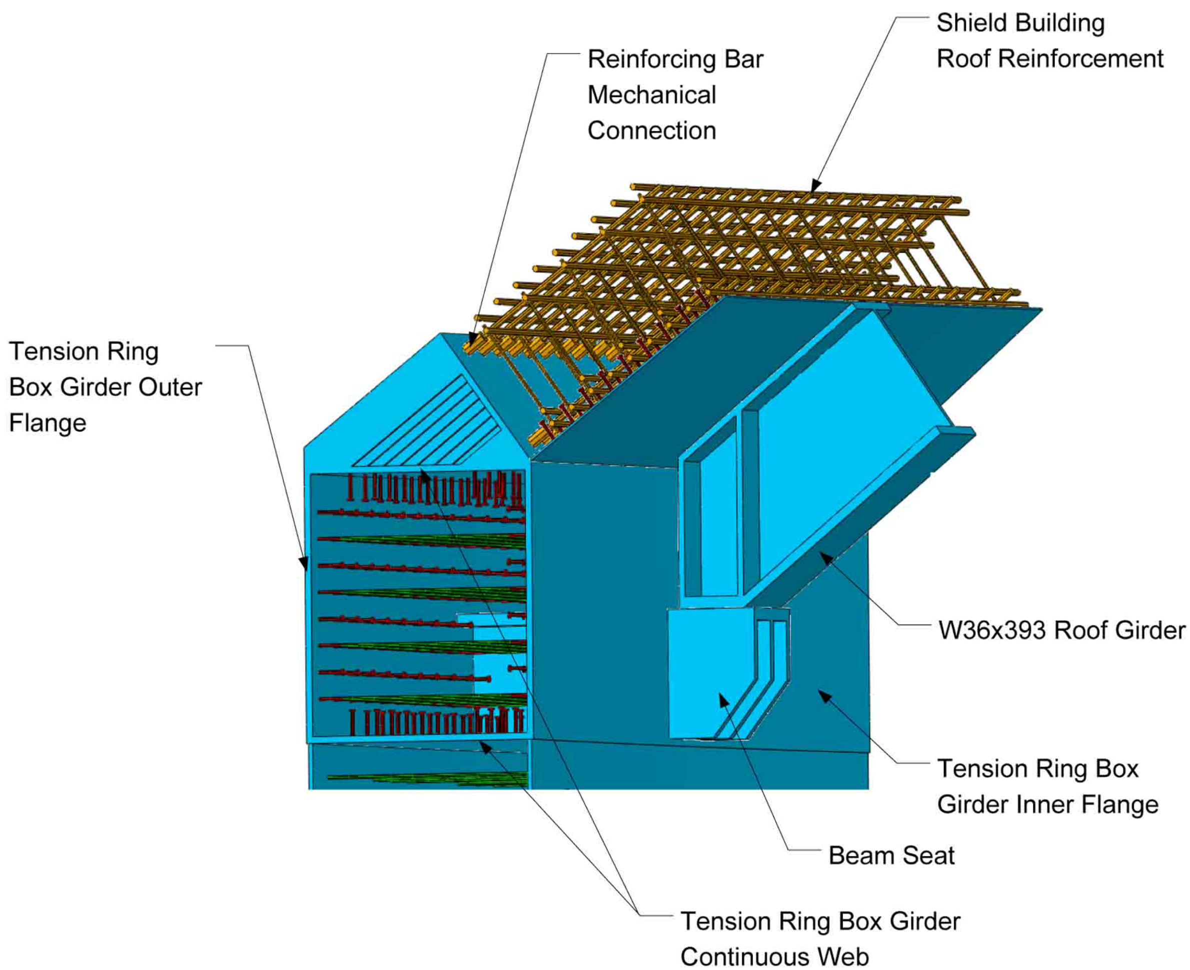


Figure 3H.5-15 Shield Building Tension Ring

Redacted Information, Withheld Under 10 CFR 2.390d

Figure 3H.5-16 (Sheet 1 of 2) [*Design of Shield Building: Surface Plates on Cylindrical Section – Developed View 90-270 Degrees*]* RN-12-072 RN-13-027

*NRC Staff approval is required prior to implementing a change in this information.

Redacted Information, Withheld Under 10 CFR 2.390d

Figure 3H.5-16 (Sheet 2 of 2) [*Design of Shield Building: Surface Plates on Cylindrical Section – Developed View 270-90 Degrees*]* RN-13-027

*NRC Staff approval is required prior to implementing a change in this information.