3E Critical Sections for Safety-Related Category I Structures

This appendix provides details of structural design and analysis for the critical sections relevant to Seismic Category I structures. Information is presented for the Nuclear Island (NI) Common Basemat Structures (3E.1), Emergency Power Generating Buildings (EPGB) (3E.2), and Essential Service Water Buildings (ESWB) (3E.3).

The following information is provided:

- Description of the critical section.
- Applicable loadings and design method.
- Results of structural analysis.

A COL applicant that references the U.S. EPR design certification will address critical sections relevant to site-specific Seismic Category I structures.

3E.1 Nuclear Island Structures

Description of Critical Sections in Nuclear Island Structures

The critical sections presented in this section are structures supported on the NI Common Basemat. This includes the Reactor Containment Building (RCB) containing the Reactor Building (RB) Internal Structure, the Fuel Building (FB), Safeguard Building (SB) 1, 2, 3, and 4 and the Reactor Shield Building (RSB).

The RCB is located inside of the reinforced concrete RSB, and is separated by an annular space to protect against interaction of the two structures when subjected to postulated design basis loading conditions. Figure 3.8-2, Figure 3.8-3, and Figure 3.8-4 show arrangements of the RCB. Figure 3.8.1.1 provides a description of the RCB.

The critical sections relating to the RCB consist of the following major structural elements:

- Reactor Containment Building—Wall to foundation connection (3E.1.1).
- Reactor Containment Building—Equipment hatch area (3E.1.2).
- Reactor Containment Building—Typical cylinder wall and buttress (3E.1.3).

The RB Internal Structures consist of concrete walls and floors, steel framing members, and other concrete and steel structural elements that are located inside of the RCB. Figure 3.8-32, Figure 3.8-33, Figure 3.8-34, Figure 3.8-35, Figure 3.8-36, and Figure 3.8-37 show arrangements of the RB Internal Structures. Section 3.8.3.1 provides a description of the RB Internal Structures.

The critical sections relating to RB Internal Structures consist of the following major structural elements:

- Reactor Building Internal Structures—Steam generator and reactor coolant pump support and typical cavity wall (3E.1.4).
- Reactor Building Internal Structures—Pressurizer support and typical cavity wall (3E.1.5).
- Reactor Building Internal Structures—Operating floor area (3E.1.6).

The RSB completely encloses the RCB, and is connected to the external walls of SB 2 and 3 and the FB. Figure 3E.1-11 shows the arrangement of the RSB and RB Annulus. Section 3.8.4.1.1 provides a description of the RSB.

- The critical section relating to the RSB is the connection of FB and SB 2 and 3 Roofs to RSB Wall (3E.1.7).

The SBs are comprised of four buildings connected around the periphery of the RSB. Figure 3.8-53, Figure 3.8-54, Figure 3.8-55, Figure 3.8-56, Figure 3.8-57, Figure 3.8-58, Figure 3.8-59, Figure 3.8-60, Figure 3.8-61, Figure 3.8-62, and Figure 3.8-63 show the arrangement of SB 1; Figure 3.8-64, Figure 3.8-65, Figure 3.8-66, Figure 3.8-67, Figure 3.8-68, Figure 3.8-69, Figure 3.8-70, Figure 3.8-71, Figure 3.8-72, Figure 3.8-73, and Figure 3.8-74 show the arrangement of SBs 2 and 3; and Figure 3.8-75, Figure 3.8-76, Figure 3.8-77, Figure 3.8-78, Figure 3.8-79, Figure 3.8-80, Figure 3.8-81, Figure 3.8-82, Figure 3.8-83 show the arrangement of SB 4. Section 3.8.4.1.3 provides a description of the SBs.

- The critical section relating to the SBs is external walls below grade level (3E.1.8).

Section 3.8.5.1.1 provides a description of the NI foundation basemat. The NI foundation basemat is a cruciform-shaped, heavily-reinforced concrete slab that supports all NI Common Basemat Structures. Figure 3.8-103 shows the NI foundation with the RB Internal structures base slab.

- The critical section relating to the NI foundation basemat is the foundation of NI Buildings and base slab of the RB Internal structures (3E.1.9).

Design Criteria

Sections 3.8.1.2, 3.8.2.2, 3.8.3.2, 3.8.4.2, and 3.8.5.2 describe codes, standards, and specifications applicable to the design of the RCB (Concrete), RCB (Steel), RB internal structures, RSB, and NI foundation basemat, respectively.

A global ANSYS Finite Element Model (FEM) (addressed in Sections 3.8.1.4.1, 3.8.3.4.1, 3.8.4.4.2, and 3.8.5.4.2) is developed and loaded with various independent loads and load combinations per the applicable codes and standards and solved to produce forces and moments throughout the structure. Sections 3.8.1.3, 3.8.2.3, 3.8.3.3, 3.8.4.3, and 3.8.5.3 describe loads and loading combinations applicable to the design of NI Common Basemat Structures.

The independent loads shown in Table 3E.1-1—Independent Loads Considered in the FEM, are applied to the NI common basemat global ANSYS FEM to analyze and evaluate the overall structural response of the NI Common Basemat Structures as described in Section 3.8.1.4, 3.8.2.4, 3.8.3.4, 3.8.4.4, and 3.8.5.4. Additional loads shown in Table 3E.1-2—Independent Loads Not Considered in the FEM, and addressed in Sections 3.8.1.3, 3.8.2.3, 3.8.3.3, 3.8.4.3, and 3.8.5.3 are not considered by the ANSYS FEM and are independently added and analyzed for in the design process for completeness.

Results from the global ANSYS analysis provide shell element forces and moments in accordance with Figure 3E.1-1—ANSYS Analysis Results for Nuclear Island Elements. Forces and moments shown in Figure 3E.1-1 are defined as:

T_x = axial or membrane load in x-direction (kips/foot).

T_y = axial or membrane load in y-direction (kips/foot).

T_{xy} = in-plane shear load (kips/foot).

N_x = out-of-plane shear load along y-axis of element (kips/foot).

N_y = out-of-plane shear load along x-axis of element (kips/foot).

M_x = bending moment about y-axis through element (kip-feet/foot).

M_y = bending moment about x-axis through element (kip-feet/foot).

M_{xy}= twisting moment (kip-feet/foot).

3E.1.1 Reactor Containment Building—Wall to Foundation Connection

This critical section presents the structural design of the reinforced concrete containment gusset (cylindrical containment wall to foundation connection) section located between elevations -36 ft – 5 in and -7 ft – 6 $^{9}/_{16}$ in of the containment shell. The gusset section lies between a radius of approximately 68 ft – 7 $^{13}/_{16}$ in and 91 ft – 2 $^{1}/_{2}$ in from the center of the RCB. The RCB is a post-tensioned reinforced concrete structure with a steel liner supported on a non post-tensioned reinforced concrete basemat. The RCB is a safety-related, Seismic Category 1 structure, as described in Section 3.8.1.

Description of the Critical Section and Computer Model

The gusset section is located at the base of the cylindrical RSB and RCB walls and is at the perimeter of the Containment basemat. The gusset is shaped as an annular ring and connects the walls to the basemat. Forces and moments are transferred from the walls of the building structures through the gusset and into the foundation basemat. A cross-section of the gusset is shown in Figure 3E.1-2—Gusset Section of RCB and Figure 3E.1-3—Cross-Section of Gusset.

The design of the reinforced concrete gusset section initiates with the FEM described in Section 3.8.1.4.1. The gusset section portion of the ANSYS FEM is constructed from solid (Solid45) elements. The typical element dimension is 3 ft – 3 $^{3}/_{8}$ in, and multiple layers of elements are used throughout the RCB ANSYS FEM.

An approximately 180° segment (Azimuth 270° to Azimuth 90°) of the FEM gusset is shown in Figure 3E.1-4—180° FEM Gusset Segment of Containment Foundation.

Applicable Loadings, Analysis, and Design Methods

The methodology used for the structural design of this critical section is to determine the reinforcement configuration for the concrete gusset section of the RCB using forces and moments generated from a FEM of the NI Common Basemat Structures. The design of the containment gusset is performed using hand calculations utilizing the applicable codes, standards, and specifications for the RCB as described in Section 3.8.1.2.

Loads applied to the concrete gusset section of the RCB are described in Section 3.8.1.3.1. Additional loads are generated due to the physical configuration and direct interaction of the RB Internal Structure with the RCB foundation and gusset shown in Figure 3E.1-2, because shear is transferred from the RB Internal Structure into the gusset by bearing. The maximum lateral thrust is 150,000 kips.

A separate analysis was performed to estimate the effects of cracked concrete. Based on the results of this analysis, the thermal moments carried by the portions of the RCB were reduced.

All load combinations applied to the gusset section of the RCB are described in Section 3.8.1.2. This section is also designed for all soil analysis cases shown in Table 3.7.1-6—Generic Soil Profiles for the U.S. EPR Standard Plant.

Results of Critical Section Design

The gusset section is the transition component between the RCB and RSB walls and the RCB basemat. Table 3E.1-3—Summary of Governing Design Data for the Wall to Foundation Connection shows the governing forces and moments from the applied loads. The results are divided into two main sections of the gusset: primary gusset between elevations -36 ft – 5 in and -14 ft – 1 $^5/_{16}$ in and upper gusset between elevations -14 ft – 1 $^5/_{16}$ in and -7 ft – 6 $^9/_{16}$ in. In general, the load combination that includes: Dead (D) + Live (L) + Post-tension (J) + Relief Valve (G) + Accidental Pressure (P_a) + Accidental Temperature (T_a) + Earthquake (E') + Accident Pipe Reaction (R_a) + Pipe Break (R_r) load controls the design of the gusset section.

The gusset section is designed for the resultant forces and moments determined based on the applicable range of applied loading and soil conditions. It should be noted that the design maximum or minimum, as appropriate, forces and moments may not occur at the same location and may not be from the same load combination and soil analysis case.

Table 3E.1-4—Summary of Typical Gusset Reinforcement summarizes the reinforcement provided to meet the area of steel required for the associated direction and given forces and moments.

The typical reinforcing pattern described in Table 3E.1-4 is shown in Figure 3E.1-5—Gusset Section - Typical Reinforcement.

Section thicknesses and reinforcing quantities may be optimized based on subsequent analysis results.

3E.1.2 Reactor Containment Building—Equipment Hatch Area

This critical section presents the structural design of the reinforced concrete section around the equipment hatch of the RCB, which is located between elevations 48 ft – 6 $^{11}/_{16}$ in and 103 ft – 4 $^3/_{16}$ in and between azimuths 126° and 174°. The RCB is a post-tensioned reinforced concrete structure with a steel liner and is a safety-related, Seismic Category 1 structure, as described in Section 3.8.1.

Description of the Critical Section and Computer Model

The equipment hatch area is located in the RCB wall with the post-tensioned tendons routed around the opening. Figure 3E.1-6—Plan View of Equipment Hatch Area, shows a plan view of the equipment hatch area of the RCB. FEM views of the equipment hatch area are shown in Figure 3E.1-7—FEM of Equipment Hatch Area - Outer View and Figure 3E.1-8—FEM of Equipment Hatch Area - Inner View. Figure 3E.1-9—Cross-Section of Equipment Hatch Area, shows a cross section view of the equipment hatch area.

The concrete section around the equipment hatch area of the RCB is divided into sub-sections and the required reinforcement in each subsection is investigated using ANSYS sub-modeling techniques, which are described in Section 3.8.1.4.1. An elevation view of the equipment hatch area with the sub-sections used to determine the reinforcement configuration is shown in Figure 3E.1-10—Elevation View of Equipment Hatch Area Showing Cuts.

The ANSYS FEM constructed for the equipment hatch area is modeled using solid (Solid92) elements, which are 3D, ten-node tetrahedrons having three degrees of freedom at each node.

Applicable Loadings, Analysis, and Design Methods

The methodology used for the structural design of this critical section is to determine the reinforcement configuration for the concrete section around the equipment hatch of the RCB structure, using an ANSYS FEM. All applicable codes, standards, and specifications for the RCB are used for the design of the equipment hatch area, as described in Section 3.8.1.2.

A separate analysis was performed to estimate the effects of concrete cracking on thermal moments. Based on the results of this analysis, the thermal moments carried by the portions of the RCB were reduced.

Loads applied to the equipment hatch area of the RCB are described in Section 3.8.1.3.1. All load combinations applied to the equipment hatch area of the RCB are described in Section 3.8.1.3.2. This section is also designed for all soil analysis cases shown in Table 3.7.1-6.

The equipment hatch area of the RCB is equally divided into 168 sub-sections (42 sub-sections per quadrant about the center line of the equipment hatch), which are dimensioned at approximately 5 ft – 0 in by 5 ft – 0 in as shown in Figure 3E.1-10.

Results of Critical Section Design

A summary of the governing design data for factored loads is shown in Table 3E.1-5—Governing Design Data for the Equipment Hatch Area (Factored Loads); a summary of the governing design data for service loads is shown in Table 3E.1-6—Governing Design Data for the Equipment Hatch Area (Service Loads). The typical reinforcement summary for the equipment hatch area is shown in Table 3E.1-7—Summary of Typical Reinforcement for the Equipment Hatch Area.

The vertical and horizontal cuts are identified in Figure 3E.1-10. The typical reinforcement sketches for the equipment hatch area are shown for section cuts 1-1, 2-2, and 3-3, in Table 3E.1-12—Governing Design Data for Radial Shear Design (Typical RCB Wall Section), Table 3E.1-13—Reinforcing Summary (Typical RCB Wall Section), and Figure 3E.1-14—Reinforcement Pattern for Section 3-3 of the Equipment Hatch Area, respectively. The locations of section cuts 1-1 and 2-2, and 3-

3 are shown in Figure 3E.1-11—Sections 1-1 and 2-2 of the Equipment Hatch Area and Figure 3E.1-12, respectively.

Section thicknesses and reinforcing quantities may be optimized based on subsequent analysis results.

3E.1.3 Reactor Containment Building—Typical Cylinder Wall and Buttress

This critical section presents the structural design of several portions of the RCB containing a typical wall section, typical section through a wide buttress (width ≈ 19 ft – 8 in), and typical section through a narrow buttress (width ≈ 13 ft – 1 in). The wall sections are designed to be applicable to any typical portion of the RCB wall, between elevations -7 ft – 7 in and +144 ft – 1 in. Non-typical portions of the RCB wall (e.g., at penetrations or discontinuities) may require additional reinforcing.

The RCB is a post-tensioned reinforced concrete structure with a steel liner and is a safety-related, Seismic Category 1 structure, as described in Section 3.8.1.

Description of the Critical Section and Computer Model

The RCB wall contains three buttresses. The buttresses are located at azimuth 0° (Buttress 1), azimuth 112° (Buttress 2), and azimuth 230° (Buttress 3). Two of the buttresses contain major penetrations. Buttress 1 contains a personnel airlock; Buttress 3 contains a construction opening and the emergency airlock. These two buttresses are wider in the vicinity of the penetrations, and narrow above the discontinuities. The third buttress does not contain any major penetrations, and therefore, it maintains the narrow profile over its full height.

Following are several views, taken from the ANSYS FEM, of the portions of the RCB designed in this critical section.

- Figure 3E.1-15—Elevation View of the Entire RCB shows an elevation view of the entire RCB.
- Figure 3E.1-16—Section Cut Through Entire RCB shows a section cut through the entire RCB.
- Figure 3E.1-17—Elevation View of Critical Section shows an elevation view of the portion of the RCB designed by this critical section.
- Figure 3E.1-18—Section View Cut Through Critical Section shows a section cut through the portion the RCB designed by this critical section.
- Figure 3E.1-19—Plan View Cut Through Critical Section shows a plan view cut through the portion of the RCB designed by this critical section.

- Figure 3E.1-20—Elevation View of Buttress 3 shows an elevation view of Buttress 3, which contains both the narrow and wide profiles designed by this critical section.
- Figure 3E.1-21—Plan View Cut Through Typical Narrow Buttress shows a plan view cut through the narrow portion of Buttress 3.
- Figure 3E.1-22—Plan View Cut Through Typical Wide Buttress shows a plan view cut through the wide portion of Buttress 3.

A FEM is used to determine the forces and moments necessary to design the typical cylinder wall and buttress sections addressed in this critical section, as addressed in Section 3.8.1.4.1.

Applicable Loadings, Analysis, and Design Methods

The ANSYS global static model considers the independent loadings described in Section 3.8.1.

A separate analysis was performed to determine the magnitude of in-plane shear produced by accidental torsion in the various walls of the NI Common Basemat Structures. The accidental torsion, tangential shear loads, for the RCB are as shown in Table 3E.1-8—Accidental Torsion Loadings for the Typical Cylinder Wall and Buttress Section.

A separate analysis was performed to estimate the effects of concrete cracking on thermal moments. Based on the results of this analysis, thermal moments carried by the portions of the RCB were reduced as shown in Table 3E.1-9—Reduction of Thermal Bending Moments Due to Cracked Concrete for the Typical Cylinder Wall and Buttress Section.

All load combinations applied to the typical wall and buttress sections of the RCB are described in Section 3.8.1.3.2. This section is also designed for all soil analysis cases shown in Table 3.7.1-6.

Results of Critical Section Design

The structural design for the critical sections addressed herein provides reinforcement to resist element forces and moments as described below for each of the three typical sections considered.

The governing design data for the typical RCB wall section is presented in Table 3E.1-10—Governing Design Data for Tangential Shear Design (Typical RCB Wall Section), Table 3E.1-11—Governing Design Data for Membrane and Bending Design (Typical RCB Wall Section), and Table 3E.1-12—Governing Design Data for Radial Shear Design (Typical RCB Wall Section); the reinforcing summary is presented in Table 3E.1-12—Governing Design Data for Radial Shear Design (Typical RCB Wall Section). The reinforcement pattern is shown in Figure 3E.1-23—Containment Wall Reinforcement (Typical Section).

The governing design data for the typical RCB narrow buttress section is presented in Table 3E.1-14—Governing Design Data for Tangential Shear Design (Typical RCB Narrow Buttress Section), Table 3E.1-15—Governing Design Data for Combined Membrane and Bending Design (Typical RCB Narrow Buttress Section), and Table 3E.1-16—Governing Design Data for Radial Shear Design (Typical RCB Narrow Buttress Section); the reinforcing summary is presented in Table 3E.1-17—Reinforcing Summary (Typical RCB Narrow Buttress Section). The reinforcement pattern is shown in Figure 3E.1-24—Containment Buttress Reinforcement (Typical Narrow Section).

The governing design data for the typical RCB wide buttress section is presented in Table 3E.1-18—Governing Design Data for Tangential Shear Design (Typical RCB Wide Buttress Section), Table 3E.1-19—Governing Design Data for Combined Membrane and Bending Design (Typical RCB Wide Buttress Section), and Table 3E.1-20—Governing Design Data for Radial Shear Design (Typical RCB Wide Buttress Section); the reinforcing summary is presented in Table 3E.1-21—Reinforcing Summary (Typical RCB Wide Buttress Section). The reinforcement pattern is shown in Figure 3E.1-25—Containment Buttress Reinforcement (Typical Wide Section).

Section thicknesses and reinforcing quantities may be optimized based on subsequent analysis results.

3E.1.4 Reactor Building Internal Structures—Steam Generator and Reactor Coolant Pump Support and Typical Cavity Wall

This critical section presents the structural design of the Steam Generator and Reactor Coolant Pump floor slab at elevation 4 ft – 11 $^{1}/_{16}$ in and the typical cavity walls of the RB Internal Structures. The floor slab provides vertical support for the reactor coolant pumps (RCP) and steam generators (SG); the typical cavity walls provide lateral support for the SGs and RCPs.

This critical section focuses on the design of the following cavity walls: walls that separate steam generators, and walls that separate reactor coolant pumps and steam generators. The typical cavity walls span between elevations 4 ft – 11 $^{1}/_{16}$ in and 63 ft – 11 $^{11}/_{16}$ in.

The reinforced concrete walls and slab designed are RB Internal Structure elements that are safety-related, Seismic Category 1 structures, as described in Section 3.8.3.

Description of the Critical Section and Computer Model

The floor slab at elevation 4 ft – 11 $^{1}/_{16}$ in is a circular slab with varying thicknesses. The portion of the slab designed with a thickness of 6 ft – 6 ¾ in provides the vertical supports for the four steam generators as well as two of the reactor coolant pumps. A second portion of the slab is designed with a thickness of 3 ft – 3 $^{3}/_{8}$ in and supports two of the reactor coolant pumps. These two areas of the slab with different thicknesses are divided by the supporting walls underneath, at elevation -7 ft – 6 $^{9}/_{16}$ in.

Figure 3E.1-26—Floor Slab Plan View at Elevation 4'-11 1/16" displays the two floor areas; the center of the RB is the center of Figure 3E.1-26. The larger portion of the slab is designed with a thickness of 6 ft - 6 $^{3}/_{4}$ in and the smaller portion of the slab is designed with a thickness of 3 ft – 3 $^{3}/_{8}$ in.

There are four SG/RCP wing walls, which divide the reactor coolant pump cavities from the steam generator cavities. The walls span from 16 ft – 10 $^{3}/_{4}$ in to 63 ft – 11 $^{11}/_{16}$ in and can be divided into three segments: the first segment is from elevation 16 ft - 10 $^{3}/_{4}$ in to 30 ft – 9 $^{5}/_{16}$ in with thickness 3 ft – 11 $^{1}/_{4}$ in, the second segment is from elevation 30 ft - 9 $^{5}/_{16}$ in to 52 ft – 5 $^{15}/_{16}$ in with thickness 3 ft – 3 $^{3}/_{8}$ in, and the third segment is from 52 ft – 5 $^{15}/_{16}$ in to 63 ft – 11 $^{11}/_{16}$ in with thickness 3 ft – 3 $^{3}/_{8}$ in. This critical section presents the design of the first segment from 16 ft – 10 $^{3}/_{4}$ in to 30 ft – 9 $^{5}/_{16}$ in and the third segment from 52 ft – 5 $^{15}/_{16}$ in to 63 ft – 11 $^{11}/_{16}$ in since these wall areas contain the lateral supports for the SG and RCP and are considered to be critical.

There are two SG separation walls that separate the SG rooms (SG1 and SG2, SG3 and SG4) and provide lateral support for the SGs. These walls are not continuous along the height of the reactor cavity. Each wall consists of two segments: elevation 16 ft – 10 $^{3}/_{4}$ in to 30 ft – 9 $^{5}/_{16}$ in and elevation 52 ft– 5 $^{15}/_{16}$ in to 63 ft – 11 $^{11}/_{16}$ in. Therefore, there are four SG separation walls. The SG separation walls are designed with a thickness of 3 ft - 3 $^{3}/_{8}$ in.

The typical cavity walls designed in this critical section (i.e., SG/RCP wing walls and SG separation walls) are shown in Figure 3E.1-27—Typical Cavity Walls Plan View, the center of the RB is the center of Figure 3E.1-27.

The design of the reinforced concrete floor slab and typical cavity wall sections initiates with the ANSYS computer model described in Section 3.8.3.4.1. The floor slab and typical cavity walls portion of the ANSYS FEM are constructed from shell (Shell43) elements. The slab and walls are auto-meshed with a typical element dimension of approximately 5 ft – 0 in by 5 ft – 0 in. An isolated section of the floor slab and typical cavity walls from the ANSYS FEM is presented in Figure 3E.1-28—Isolated View of FEM For Floor Slab and SG/RCP Wing Wall. Figure 3E.1-29—Isolated View of FEM For Floor Slab and SG/RCP Separation Wall, displays the same view; however, the SG/RCP wing wall is removed to show the SG separation walls. This figure depicts the east side of the typical cavity walls and floor slab.

Applicable Loadings, Analysis, and Design Methods

The methodology used for the structural design of this critical section is to determine the reinforcement configurations for the concrete sections of the floor slab and typical cavity walls using forces and moments generated from the ANSYS FEM, which is described in Section 3.8.3.4.1. Critical cases are selected for design based on: maximum axial forces, maximum bending moments, maximum out-of-plane shear reinforcement force required, maximum in-plane shear forces, and maximum areas of total required steel. Design of required reinforcement is accomplished by averaging results from elements within a justifiable distance and selecting the maximum reinforcement required from all cases considered for longitudinal and out-of-plane shear reinforcement. The process is done independently for each wall and slab section considered.

Loads applied to the floor slab and typical cavity walls of the RB Internal Structures are described in Section 3.8.3.3.1. In addition to these loads, the upper portion of the SG/RCP wing wall and SG separation wall are subject to a sub-compartment pressurization load of 20 psi. Additional bending moments and out-of-plane shear forces are added to the extracted forces and moments from ANSYS.

Additional shear forces and bending moments are also added to the floor slab to account for the remaining 75% of the live load that is not included in the results from the ANSYS FEM. These loads are conservatively estimated using a plate with an area equal to that of the free span of the floor slab with fixed-fixed boundary conditions and an applied load of 375 psf (0.75 * 500psf).

All load combinations applied to the floor slab and typical cavity walls of the RB Internal Structures are described in Section 3.8.3.3.2. The floor slab and typical cavity walls are designed to accommodate all soil analysis cases shown in Table 3.7.1-6.

Results of Critical Section Design

The structural design for the critical sections addressed herein provides reinforcement to resist element forces and moments as described below for each of the sections considered.

Table 3E.1-22—Governing Design Cases for the SG and RCP Supports and Typical Cavity Wall shows the governing load cases along with the forces and moments from the elements, which are the maximum out of all of the elements that are averaged for the governing load case. The values for M_x and M_y include the addition of M_{xy}.

Table 3E.1-23—Summary of Reinforcement for SG and RCP Floor Slab and Table 3E.1-24—Typical SG and RCP Cavity Wall Reinforcement summarize the reinforcement provided to meet the area of steel required for the associated forces and moments.

The typical reinforcing patterns described in Table 3E.1-23 and Table 3E.1-24 are shown in Figure 3E.1-30—Area of Detail for Floor Slab at Elevation 4'-11 1/16", Figure 3E.1-31—Reinforcement of Floor Slab at Elevation 4'-11 1/16", Figure 3E.1-32—Area of Detail for Floor Slab at Elevation 4'-11 1/16", Figure 3E.1-34—Reinforcement of Floor Slab Section 2-2, Figure 3E.1-33—Reinforcement of Floor Slab Section 3-3, Figure 3E.1-35—Area of Detail for SG/RCP Wing Wall Bottom, Figure 3E.1-36—SG/RCP Wing Wall Bottom Reinforcement, Figure 3E.1-37—Area of Detail for SG/RCP Wing Wall Top, Figure 3E.1-38—SG/RCP Wing Wall Top Reinforcement, Figure 3E.1-39—Area of Detail for SG Separation Wall Bottom, Figure 3E.1-40—SG Separation Wall Bottom Reinforcement, Figure 3E.1-41—Area of Detail for SG Separation Wall Top, and Figure 3E.1-41—Area of Detail for SG Separation Wall Top.

The shaded area shown in Figure 3E.1-30 represents the area of the floor slab at elevation 4 ft – 11 $^1/_{16}$ in that is designed with a thickness of 6 ft – 6 $^3/_4$ in. The reinforcement pattern for this area of the slab is shown in Figure 3E.1-31.

The two shaded areas shown in Figure 3E.1-32 represent the area of the floor slab at elevation 4 ft – 11 $^1/_{16}$ in that is designed with a thickness of 3 ft – 3 $^3/_8$ in. The reinforcement pattern for the area shaded in solid black (Section 3-3) is shown in Figure 3E.1-33. The reinforcement pattern for the area diagonally hatched (Section 2-2) is shown in Figure 3E.1-34.

Figure 3E.1-35 displays the plan view of the bottom segment of the SG/RCP wing walls (shaded in solid black). The reinforcement pattern for these walls is displayed in Figure 3E.1-36.

Figure 3E.1-37 displays the plan view of the top segment of the SG/RCP wing walls (shaded in solid black). The reinforcement pattern for these walls is displayed in Figure 3E.1-38.

Figure 3E.1-39 displays the plan view of the bottom segment of the SG separation walls (shaded in solid black). The reinforcement pattern for these walls is displayed in Figure 3E.1-40.

Figure 3E.1-41 displays the plan view of the top segment of the SG separation walls (shaded in solid black). The reinforcement pattern for these walls is displayed in Figure 3E.1-42.

Section thicknesses and reinforcing quantities may be optimized based on subsequent analysis results.

3E.1.5 Reactor Building Internal Structures—Pressurizer Support and Typical Cavity Wall

This critical section presents the structural design of the reinforced concrete supports and typical cavity wall sections required for the RB Pressurizer (PZR) cubicle. The PZR cubicle is located in the RCB as part of the RB Internal Structures and lies northwest of the Loop 3 RCP (RCP3) as shown in Figure 3E.1-43—Location of PZR Cubical. The PZR cubicle structure is a reinforced concrete, safety-related, Seismic Category I structure, as described in Section 3.8.3.

Description of the Critical Section and Computer Model

The PZR is supported by three brackets anchored to the concrete floor slab at elevation 49 ft – 1 $^{3}/_{8}$ in and by eight radial pins anchored to the floor slab at elevation 67 ft – 10 $^{15}/_{16}$ in. An isometric view of these supports is shown in Figure 3E.1-44—PZR Isometric View Showing Support Locations. All of these supports apply concentrated loads to the floor slabs. The three brackets (PZR1, PZR2 and PZR3) transfer vertical and horizontal reactions to the floor slab and the eight radial pins (U1 thru U8) transfer only horizontal radial reactions to the floor slab.

Two areas of the PZR cubicle, one floor slab, and one wall panel are selected as critical based on section thickness, span, and loading so that maximum moments and shears are obtained. The slab at elevation 49 ft – 1 $^{3}/_{8}$ in is considered to be critical due to the fact that it supports the PZR vertical reactions. The wall lying west of the PZR is considered critical because of the placement of the supports and the thickness of the section. This wall spans from elevation 20 ft – 11 $^{3}/_{16}$ in to 92 ft – 8 $^{3}/_{16}$ in.

The design of the PZR cubicle critical areas initiates with the computer model described in Section 3.8.3.4.1. The PZR cubicle portion of the ANSYS FEM is constructed from shell (Shell 43) elements. The typical element dimensions are approximately 5 ft – 0 in by 5 ft – 0 in and multiple layers of elements are used throughout the Internal Structure ANSYS FEM. An element plot of each of the critical areas is shown in Figure 3E.1-45—Plan View of FEM for Floor Slab of PZR Cubical and Figure 3E.1-46—Elevation View of FEM for Wall Section of PZR Cubical.

Applicable Loadings, Analysis, and Design Methods

The methodology used for the structural design of this critical section is to determine the reinforcement configuration for the reinforced concrete PZR cubicle using forces and moments generated from the ANSYS FEM. The design of the PZR cubicle is performed using design macros, which utilize the applicable codes, standards, and specifications for RB Internal Structures as described in Section 3.8.3.2.

Loads applied to the PZR cubicle are described in Section 3.8.3.3.1. Additional loads, which are not applied to the PZR cubicle using the ANSYS FEM described in Section 3.8.3.4.1, include an additional 75% of the applicable live load on the floor slab, as well as a subcompartment pressurization load on the wall section. These loads are added separately to the results obtained from the ANSYS FEM.

An additional local concentrated moment is also added at the location of the lower supports (PZR1-PZR3).

All load combinations considered in the PZR cubicle critical section are described in Section 3.8.3.3.2. The PZR cubical is designed to accommodate all soil analysis cases shown in Table 3.7.1-6.

Results of Critical Section Design

The structural design for the critical sections addressed herein provides reinforcement to resist element forces and moments as described below for each of the sections considered.

The governing forces and moments from the applied loads are shown in Table 3E.1-25—Summary of Governing Design Data. In general the governing load case is the one that includes the following loads: Dead (D) + Hydrostatic (F) + Live (L) + Accident Temperature (T_a) + Accident Pipe Reaction (R_a) + Internal Flood (F_a) + Accident Pressure (P_a) + Pipe Break (R_r) + Earthquake (E').

Table 3E.1-26—Summary of Typical PZR Cubical Reinforcement, summarizes the reinforcement provided to meet the area of steel requirements for the PZR cubical. The typical reinforcing patterns described in Table 3E.1-26 are shown in Figure 3E.1-47—PZR Floor Slab Section - Reinforcement at Support and Figure 3E.1-48—PZR Wall Section - Typical Reinforcement.

Section thicknesses and reinforcing quantities may be optimized based on subsequent analysis results.

3E.1.6 Reactor Building Internal Structures—Operating Floor Area

This critical section presents the structural design of the reinforced concrete operating floor slab at elevation +63 ft – 11 $^{11}/_{16}$ in of the RB. The RB operating floor is part of RB Internal Structures, which is reinforced concrete, safety-related, Seismic Category 1 structures, as described in Section 3.8.3.

Description of the Critical Section and Computer Model

The RB operating floor at EL. +63 ft – 11 $^{11}/_{16}$ in consists of the slab sections shown in Figure 3E.1-49—RB Operating Floor - Elevation 63'-11 11/16" Showing Section Locations.

The operating floor at elevation +63 ft – 11 $^{11}/_{16}$ in is divided into six floor sections shown in Figure 3E.1-50—Plan View of RB Operating Floor Showing Rooms. The areas shown in Figure 3E.1-50 have the following slab thicknesses:

- RM15: 2 ft – 7 ½ in.
- RM22: 2 ft – 7 ½ in.
- RM16-1: 3 ft – 3 $^{3}/_{8}$ in.
- RM16-2: 3 ft – 3 $^{3}/_{8}$ in.
- RM16-3: 4 ft – 3 $^{3}/_{16}$ in.
- RM18: 2 ft – 7 ½ in.

The design of the RB operating floor initiates with the computer model described in Section 3.8.3.4.1, and is constructed from shell (Shell43) elements. The typical element size is 5 ft – 0 in by 5 ft – 0 in, which is used throughout the Internal Structures ANSYS FEM.

Applicable Loadings, Analysis, and Design Methods

The methodology used for the design of this critical section is to determine the reinforcement required for the RB operating floor at elevation +63 ft – 11 $^{11}/_{16}$ in.

The RB operating floor is part of RB Internal Structures and is designed in accordance with the applicable codes, standards, and specifications for RB Internal Structures as described in Section 3.8.3.2.

The loads used to design the operating floor are described in Section 3.8.3.3.1. An additional 75% of applicable live load is applied to the operating floor separately from the ANSYS FEM.

All load combinations considered in the operating floor critical section design are described in Section 3.8.3.3.2. The operating floor is designed to accommodate all soil analysis cases shown in Table 3.7.1-6.

Results of Critical Section Design

The structural design for the critical sections addressed herein provides reinforcement to resist element forces and moments as described below for each of the sections considered.

The governing forces and moments from the applied loads are shown in Table 3E.1-27—Summary of Governing Design Data for the Operating Floor Area. Each RB operating floor sub-area has governing design data for both radial and tangential shear. Table 3E.1-28—Summary of Typical Reinforcement for the Operating Floor Area, summarizes the reinforcement provided to meet the area of steel requirements for the RB operating floor. The typical reinforcing patterns described in Table 3E.1-28 are shown in Figure 3E.1-51—RB Operating Floor Reinforcement - Section 1-1, Figure 3E.1-52—RB Operating Floor Reinforcement - Section 2-2, Figure 3E.1-53—RB Operating Floor Reinforcement - Section 3-3 and 4-4, Figure 3E.1-54—RB Operating Floor Reinforcement - Section 5-5, Figure 3E.1-55—RB Operating Floor Reinforcement - Section 6-6, Figure 3E.1-56—RB Operating Floor Reinforcement - Section 7-7, and Figure 3E.1-57—RB Operating Floor Reinforcement - Section 8-8.

Section thicknesses and reinforcing quantities may be optimized based on subsequent analysis results.

3E.1.7 Reactor Shield Building – Connection of FB and SB 2 and 3 Roofs to RSB Wall

This critical section presents the structural design of the reinforced concrete of the connections from the RSB wall to the FB roof slab as well as the roof slab of SB 2 and 3.

The RSB connections to the FB and SB 2 and 3 roofs are considered to be critical sections because these areas are sections of the plant where high levels of stresses are anticipated as a result of seismic loadings and geometry changes. The RSB connections designed are reinforced concrete, safety-related, Seismic Category I structures, as described in Section 3.8.4.

Description of the Critical Section and Computer Model

The RSB wall is a 5 ft – 10 $^7/_8$ in thick wall above the FB roof and the SB 2 and 3 roof, but reduces to a thickness of 4 ft – 3 $^3/_{16}$ in below the roofs. The vertical boundaries of the shield wall considered at the connection to the FB roof are taken from an elevation of +95 ft – 10 $^3/_8$ in to an elevation of +121 ft – 9 $^7/_{16}$ in as shown in Figure 3E.1-58—

RSB Wall Vertical Design Boundaries. Figure 3E.1-58 also shows that the vertical portion of the shield wall considered at the connection to SB 2 and 3 is taken from an elevation of +77 ft – 5 $^{1}/_{2}$ in to an elevation of +104 ft – 0 $^{1}/_{16}$ in.

The cylindrical portion of the RSB wall that intersects the FB is taken from azimuth 207.5° to azimuth 332.5° as shown in Figure 3E.1-59—FB Roof and RSB Wall Design Boundaries. The cylindrical portion of the RSB wall that intersects SB 2 and 3 is taken from an azimuth of 27.5° to an azimuth of 152.5° as shown in Figure 3E.1-60—SB 2&3 Roof and RSB Wall Design Boundaries.

Figures 3E.1-59 and 3E.1-60 also show the areas considered for design of the FB and SB 2 and 3 roofs. The FB and SB 2 and 3 roofs are 5 ft – 10 $^{7}/_{8}$ in thick. A radial portion of about 11 ft – 9 $^{3}/_{4}$ in away from the outer edge of the RSB wall is considered for the FB and SB 2 and 3. This is shown in Figures 3E.1-59 and 3E.1-60.

The design of the connections of the RSB to the FB and SB 2 and 3 roofs when subjected to dead, live, wind, tornado, and seismic loading initiates with the ANSYS FEM as described in Section 3.8.4.4.2.

The FEM is auto-meshed generating shell (Shell43) elements dimensioned at roughly 5 ft – 0 in throughout the RSB. Figure 3E.1-61—Isometric FEM of FB Roof to RSB Wall Connection and Figure 3E.1-62—Isometric FEM of SB 2 and 3 Roof to RSB Wall Connection, represent an isometric view of the ANSYS FEM displaying the sections analyzed along with the shape of the elements.

Applicable Loadings, Analysis, and Design Methods

The methodology used for the structural design of this critical section is to determine the reinforcement configuration for the concrete section of the RSB Wall connection to the FB roof and the SB 2 and 3 roof using the forces and moments generated from the FEM of the NI Common Basemat Structures. The design of the connection is performed using calculations utilizing the applicable codes, standards and specifications described in Section 3.8.4.2.

The ANSYS FEM considers all loads shown in Table 3E.1-1, which are described in Section 3.8.4.3.1 except for additional live loads, thermal loads, and accidental torsion loads, which are applied separately to this critical section.

A precipitation load of 75 psf is applied as a live load on all roofs in addition to what is applied in the ANSYS FEM for all load combinations that include seismic loads. This is due to the ANSYS FEM only considering 25% of the 100 psf live load for all load combinations containing seismic loads. Construction loads are considered to be enveloped by the precipitation load based on the assumption that both are not applied concurrently.

An accidental torsion load of 27.6 kip/ft is applied as an in-plane shear load to the entire RSB area that is considered for design.

All load combinations applied to the RSB wall to roof connection are described in Section 3.8.4.3.2. This section is also designed to accommodate all soil analysis cases shown in Table 3.7.1-6.

Results of Critical Section Design

The structural design for the critical sections addressed herein provides reinforcement to resist element forces and moments as described below for each of the sections considered.

Table 3E.1-29—Controlling Nodal Forces and Moments for FB Roof, TTable 3E.1-30—Controlling Nodal Forces and Moments for SB 2 and 3 Roof, Table 3E.1-31—Controlling Nodal Forces and Moments for RSB Wall below FB Roof and SB 2 and 3 Roof, and Table 3E.1-32—Controlling Nodal Forces and Moments for RSB Wall above FB Roof and SB 2 and 3 Roof show the governing forces and moments from the applied loads.

Results of the reinforcement design are shown in Table 3E.1-33—Specified Reinforcement Pattern for RSB Wall to Roof Connection, and the typical reinforcement sketch is shown in Figure 3E.1-63—RSB Wall to Roof Connection - Typical Reinforcement.

Section thicknesses and reinforcing quantities may be optimized based on subsequent analysis results.

3E.1.8 Safeguard Buildings—Walls Below Grade

This critical section presents the structural design of the reinforced concrete external walls below grade level, from elevation -31 ft – 6 in to 0 ft – 0 in for SBs 1, 2, 3, and 4 and the FB. The walls below grade are chosen as critical sections to assess the impact of the soil on the walls under all applicable load combinations.

The external walls below grade are part of the NI Common Basemat Structures and are therefore considered to be safety-related, Seismic Category I, as described in Section 3.8.4.

Description of the Critical Section and Computer Model

SBs 2 and 3 and the FB are enclosed by a shield structure, only SBs 1 and 4 are analyzed as critical sections because the section thickness is smaller and therefore are considered critical.

Section Location within SB1

The sections under investigation are the SB1 South wall (labeled as A13001) and SB1 West wall (labeled as A13003) below grade (El. -31 ft – 6 in to 0 ft – 0 in), which are shown in Figure 3E.1-64—Location of SB1 South and West Walls Below Grade. SB1 walls below grade span from global coordinate z = -31 ft – 6 in to z = 0 ft – 0 in (below grade portion only) in the ANSYS FEM. The thickness of each wall is 4 ft – 11 in.

Wall A13001 is located at coordinate y = -49 ft – 8 $^{7}/_{16}$ in, and spans from x = -178 ft -11 $^{5}/_{8}$ in to x = -115 ft – 3 $^{5}/_{8}$ in. This wall is chosen for analysis to incorporate the effects of an East-West earthquake load for in-plane shear. Wall A13003 is located at coordinate x = -178 ft – 11 $^{5}/_{8}$ in, and spans from y = -49 ft – 8 $^{7}/_{16}$ in to y = 49 ft – 8 $^{7}/_{16}$ in. This wall is chosen for analysis to incorporate the effects of a North-South earthquake load for in-plane shear.

Section Location within SB4

The sections under investigation are the SB4 North wall (labeled as A33008) and SB4 East wall (labeled as A33003) below grade (El. -31 ft – 6 in to 0 ft – 0 in), which are shown in Figure 3E.1-65—Location of SB4 North and East Walls Below Grade. SB4 walls below grade span from global coordinate z = -31 ft – 6 in to z = 0 ft – 0 in (below grade portion only) in the ANSYS FEM. The thickness of each wall is 4 ft – 11 in.

Wall A33008 is located at coordinate y = 49 ft–8 $^{7}/_{16}$ in, and spans from x = 106 ft – 4 in to x = 178 ft – 11 $^{5}/_{8}$ in. This wall is chosen for analysis to incorporate the effects of an East-West earthquake load for in-plane shear. Wall A33003 is located at coordinate x = 178 ft – 11 $^{5}/_{8}$ in, and spans from y = -49 ft – 8 $^{7}/_{16}$ in to y = 49 ft – 8 $^{7}/_{16}$ in. This wall is chosen for analysis to incorporate the effects of a North-South earthquake load for in-plane shear.

SB4 walls are chosen as critical sections because they are adjacent to buildings that impact the soil loading on these walls.

The design of the SB walls below grade initiates with the computer model described in Section 3.8.4.4.2. The SB walls under investigation in the ANSYS FEM are constructed using shell (Shell43) elements. The typical element is approximately 5 ft - 0 in by 5 ft – 0 in.

Isometric views from the FEM for all walls under investigation are shown in Figure 3E.1-66—SB1 Wall A13001 Isometric View, Figure 3E.1-67—SB1 Wall A13003 Isometric Vew, Figure 3E.1-68—SB4 Wall A33008 Isometric View, and Figure 3E.1-69—SB4 Wall A33003 Isometric View.

Applicable Loadings, Analysis, and Design Methods

The methodology used for the structural design of this critical section is to determine the reinforcement configuration for the concrete sections of the walls below grade for SB1 and SB4 from El. -31 ft – 6 in to 0 ft – 0 in. A FEM is generated using ANSYS, as described in Section 3.8.4.4.2, and is used to determine forces and moments for the walls below grade by evaluating various loads, load combinations, and soil analysis cases. These forces and moments are analyzed using a design macro where they are compared with applicable codes, standards, and specifications for the Safeguard Building walls below grade as described in Section 3.8.4.2.

Loads applied to the Safeguard Building walls below grade are described in Section 3.8.4.3.1. Additional loads due to accidental torsion are analyzed separately from the ANSYS FEM and added to the in-plane shear loads.

All load combinations applied to the SB walls below grade are described in Section 3.8.4.3.2. This section is designed to accommodate all soil analysis cases shown in Table 3.7.1-6.

Results of Critical Section Design

The structural design for the critical sections addressed herein provides reinforcement to resist element forces and moments as described below for each of the sections considered.

Table 3E.1-34—Summary of Governing Design Data for SB External Walls Below Grade shows the governing forces and moments from the applied loads, where bold cells indicate design values, the sign convention is negative for compression and positive for tension, and the averaged numbers are indicated in italics.

In general, the load combination that includes: Dead (D) + Live (L) + Lateral Earth Pressure (H) + Hydrostatic Pressure (F) + Buoyancy Force (F_b) + Earthquake (E') loads controls the design of the SB walls below grade.

The SB walls below grade are designed for the resultant forces and moments determined based on the applicable range of loading combinations and soil conditions. It should be noted that the design maximum (or minimum, as appropriate) forces and moments may not occur at the same location and may not be from the same load combination/soil condition.

Table 3E.1-35—Reinforcement Design for SG Walls Below Grade (A13001, A13003, A33008, and A33003) summarizes the reinforcement provided to meet the area of steel required for the associated direction and forces and moments.

The typical reinforcing patterns for each wall described in Table 3E.1-35 are shown in Figure 3E.1-70—Cross Section of Walls A13001, A13003, A33008, and A33003 Showing Reinforcement.

Section thicknesses and reinforcing quantities may be optimized based on subsequent analysis results.

3E.1.9 Foundation of Nuclear Island Buildings and Base Slab of the RB Internal Structures

This critical section presents the structural design of the reinforced concrete NI foundation basemat and RB Internal Structures base slab. The structural components designed in this critical section are safety-related, Seismic Category I structures, as described in Sections 3.8.1, 3.8.3, and 3.8.5.

Description of the Critical Section and Computer Model

The NI foundation basemat transfers all of the loads from the buildings located on the NI Common Basemat to the supporting soil. Thus, the foundation basemat is a critical structural member of the NI. With reference to the finished grade level, the foundation basemat lies between elevation -41 ft – 4 $^{1}/_{16}$ in and -31 ft - 5 $^{15}/_{16}$ in except under the RCB where it is located between elevation -36 ft – 5 in and -25 ft – 7 $^{1}/_{16}$ in.

Figure 3E.1-71—Isometric FEM of NI Foundation Basemat, shows a schematic of the NI foundation basemat. At its largest plan dimension, the foundation basemat is 354 ft – 8 in by 357 ft – 11 in. The thickness of the foundation basemat ranges from 9 ft – 10 $^{1}/_{8}$ in to 13 ft – 1 $^{1}/_{2}$ in.

The design of the NI foundation basemat and the base slab for RB Internal Structures initiates with the computer model described in Sections 3.8.1.4.1 for the RCB, 3.8.1.4.1 for RB Internal Structures, and 3.8.5.4.2 for the NI foundation basemat.

The NI foundation basemat and base slab for RB Internal Structures are modeled using solid (Solid45) elements in the ANSYS FEM. In order to accurately model the interface between the RB Internal Structures base slab and the foundation basemat, a sub-model is developed for the analysis and design of the RB Internal Structures base slab. This sub-model is based on the ANSYS FEM used for all structures located on the NI Common Basemat, with appropriate boundary conditions imposed.

The base slab for RB Internal Structures provides support for structures and components that are internal to the RCB. The base slab rests on the foundation basemat of the RCB. The load imposed on the base slab is transferred to the foundation basemat, which in turn bears on the underlying soil.

The RB Internal Structures base slab is located between elevations -25 ft – 7 $^{1}/_{16}$ in and -20 ft – 2 $^{1}/_{8}$ in and elevations -25 ft – 7 $^{1}/_{16}$ in and -7 ft – 6 $^{1}/_{2}$ in. The base slab is contained in a circular form with a diameter of 154 ft – 6 in. Figure 3E.1-72—Elevation View of RB Internal Structure Base Slab shows a schematic of the RB Internal Structures base slab.

As shown in Figure 3E.1-72, the portion of the RB Internal Structures base slab between elevation -25 ft – 7 $^{1}/_{16}$ in and -7 ft – 6 $^{1}/_{2}$ in is 18 ft – $^{9}/_{16}$ in thick and occurs between radii 54 ft – 1 $^{5}/_{8}$ in and 76 ft – 9 $^{1}/_{4}$ in. Figure 3E.1-72 shows that this portion of the base slab slopes at an angle between radii 73 ft – 9 $^{3}/_{16}$ in and 76 ft – 9 $^{1}/_{4}$ in. This critical section considers the 18 ft – 0 $^{9}/_{16}$ in thick portion between radii 54 ft – 1 $^{5}/_{8}$ in and 68 ft – 8 in.

The 5 ft – 4 $^{15}/_{16}$ in thick portion of the RB Internal Structures base slab occurs between radii 0 ft – 0 in and 54 ft – 1 $^{5}/_{8}$ in, as shown in Figure 3E.1-72.

Applicable Loadings, Analysis, and Design Methods

The methodology used for the structural design of the critical section is to determine the reinforcement configuration for the concrete sections of the NI foundation basemat and the Internal Structures base slab.

Loads considered in the analysis of the global FEM of the NI Common Basemat Structures are described in Sections 3.8.1.3.1, 3.8.3.3.1, and Section 3.8.5.3, and are applicable to the RCB, RB Internal Structures, and the NI foundation basemat, respectively.

The applicable load combinations for the sections under investigation are applicable to the RCB, RB Internal Structures, and the NI foundation basemat, and are outlined in Sections 3.8.1.3.2, 3.8.3.3.2, and 3.8.5.3, respectively. All soil analysis cases described in Table 3.7.1-6 are considered for the design of this critical section.

A separate analysis was performed to estimate the effects of concrete cracked on thermal moments. Based on the results of this analysis, the thermal moments carried by the portions of the RCB were reduced.

Results of Critical Section Design

The structural design for the critical sections addressed herein provides reinforcement to resist element forces and moments as described below for each of the sections considered.

The governing load combinations and soil analysis cases for the structural sections with the corresponding forces and moments are reported in

Table 3E.1-36—Governing Design Data for the NI Foundation Basemat and RB Internal Structures Base Slab.

The reinforcement detail for this critical section is shown in Figure 3E.1-73—Reinforcement Pattern for NI Foundation Base Mat (Except Below RCB), Figure 3E.1-74—Reinforcement Pattern for RB Internal Structures Base Slab - Elevation -25'-7" to -20'-2", Figure 3E.1-75—Reinforcement Pattern for RB Internal Structures Base Slab - Elevation -25'-7" to -7'-6 1/2", and Figure 3E.1-76—Reinforcement Pattern for NI Foundation Base Mat below RCB, for the NI Foundation basemat, RB Internal Structures base slab between elevations -25 ft – 7 in and -20 ft – 2 in, and RB Internal Structures between elevations -25 ft – 7 in and -7 ft – 6 $^{1}/_{2}$ in. The required reinforcement is summarized for each design location in Table 3E.1-37—Reinforcement Summary for the NI Foundation Basemat and RB Internal Structures Base Slab.

Section thicknesses and reinforcing quantities may be optimized based on subsequent analysis results.

Table 3E.1-1—Independent Loads Considered in the FEM

D	Dead Loads
L	Live Loads
J	Post-tensioning Loads
H	Lateral Earth Pressure Loads
F	Hydrostatic Loads
F_b	Buoyancy Loads
E’	Seismic Loads
R_o	Piping Loads (normal operating conditions)
R_a	Piping Loads (accident conditions)
W	Wind Loads (severe environmental)
W_t	Wind Loads (extreme environmental)
P_t	Pressure Loads (test conditions)
P_a (only for containment wall)	Pressure Loads (accident conditions)
T_a (only for containment wall)	Temperature Loads (accidental conditions)
C	Combustible Gas

Table 3E.1-2—Independent Loads Not Considered in the FEM

G	Relief Valve Loads
R_r	Pipe Rupture Loads
F_a	Compartment Flood Loads
T_o	Temperature Loads (normal operating)
T_t	Temperature Loads (test conditions)
P_v	Containment Wall Pressure Variant Loads
P_a	Sub-compartment pressurization
CL	Construction Loads

Table 3E.1-3—Summary of Governing Design Data for the Wall to Foundation Connection
Sheet 1 of 2

Location	LC	AC	Condition	T_x (k/ft)	T_y (k/ft)	T_{xy} (k/ft)	M_x (k-ft/ft)	M_y (k-ft/ft)	M_{xy} (k-ft/ft)	N_x (k/ft)	N_y (k/ft)
Primary Gusset	D + L + J + G + P_a + T_a + E' + R_a + R_r	Fixed 5u	Membrane & Tangential	0 (315)	**-552**	-623	0	-1394	-1288	0	-169
		Fixed 4u-M		0 (315)	-575	**-647**	0	-111	-1011	0	72
		Fixed 4u-M		**370**	0 (25)	-408 (500)	-987	0	-366	-97	0
		Fixed 4u-M		**386**	0 (26)	-400 (500)	-973	0	352	97	0
	D + L + J + G + P_a + T_a + E' + R_a + R_r	5u	Membrane & Bending	**688**	0	113	-1362	0	-56	-23	0
		5u		604	0	100	**-1501**	0	456	19	0
	D + L + J + G + P_a + T_a + E' + R_a + R_r	-	Membrane & Radial	0	**-800**	*	0	*	*	0	*
		4u-M		0	-1359	-30	0	-783	0	0	**1358**

Table 3E.1-3—Summary of Governing Design Data for the Wall to Foundation Connection Sheet 2 of 2

Location	LC	AC	Condition	T_x (k/ft)	T_y (k/ft)	T_{xy} (k/ft)	M_x (k-ft/ft)	M_y (k-ft/ft)	M_{xy} (k-ft/ft)	N_x (k/ft)	N_y (k/ft)
Upper Gusset	$D + L + J + G + P_a + T_a + E' + R_a + R_r$	5u	Membrane & Tangential	**650**	0	37	-1040	0	384	53	0
		Fixed 4u-M		0	**219**	86	0	655	215	0	18
		Fixed 4u-M		300	0	**533**	-1049	0	333	90	0
	$D + L + J + G + P_a + T_a + E' + R_a + R_r$	Fixed 4u-M	Membrane & Radial	0	**219**	86	0	655	215	0	18
	$D + L + J + G + T_o + R_o + P_v + E'$	4u-M		0	-376	33	0	1301	-38	0	**-168**
Upper & Primary Gusset	$D + L + J + G + P_a + T_a + E' + R_a + R_r$	5u	Membrane & Radial	**688**	0	113	-1362	0	-56	-23	0
		2sn4u		-227	0	363	-2125	0	-332	**-451**	0
Primary Gusset	$D + F + L + R_a + E'$	4u-M	N/A	N/A	**0**	N/A	N/A	N/A	N/A	N/A	**1250**

*LC refers to the governing load combination; AC refers to the governing soil analysis case.

* - 800 k/ft corresponds to several load/soil analysis cases, but was chosen because it is a conservative value (least compression) for a series of shears.

In most cases the required reinforcing is based on an envelope of the forces and moments resulting from multiple load combinations/soil analysis cases given in the above table. In some cases, values indicated thusly: (###), the envelope is extended to include a larger range of associated values.

Table 3E.1-4—Summary of Typical Gusset Reinforcement

Location	Type	Direction	Thickness (T)	Required Area of Steel (in^2/ft) Axial & Bending (per face)	Required Area of Steel (in^2/ft) In-Plane Shear	Required Area of Steel (in^2/ft) Out-of-Plane Shear	Reinforcement Pattern
Primary Gusset	Flexural	Vertical	22 ft – 6 $^{11}/_{16}$ in	9.0	-	-	2 Layers #14 @ 6 in EF
	Flexural	Horizontal		9.0	-	-	2 Layers #14 @ 6 in EF
	Shear	Vertical		-	11.56	-	#11 @ 12 in
	Shear	Horizontal		-		17.31	#9 @ 12 in
	Stirrup	Horizontal		-	-	-	#5 @ 6 in
Upper (transition) Gusset	Flexural	Vertical	varies	Match wall reinf.	-	-	#14 @ 6 in EF
	Flexural	Horizontal		Match wall reinf.	-	-	#14 @ 6 in EF
	Shear	Vertical		-	12.22	-	5 - #11 @ 6 in (plus one additional bar)
	Shear	Horizontal		-	-	17.70	#9 @ 6 in
	Stirrup	Horizontal		-	-	-	#5 @ 6 in

Table 3E.1-5—Governing Design Data for the Equipment Hatch Area (Factored Loads)

Cut Section	LC	AC	T_{x_MAX} (k/ft)	T_{x_MIN} (k/ft)	T_{xy} (k/ft)	$M_x + M_{xy}$ (k-ft/ft)	N_x (k/ft)
H-Strip#9 V-Cut#8	$D+L+J+G+1.5P_a+T_a+R_a$	Fixed 5a	**1450**	-44	**117**	**869**	29
V-Strip#10 H-Cut#6	$D+L+J+G+P_a+T_a+E'+R_a+R_r$	Enveloped	**1**	-1146	**459**	**3539**	168
V-Strip#9 H-Cut#5	$D+L+J+G+P_a+T_a+E'+R_a+R_r$	Enveloped	**179**	-718	678	2082	**241**

*The controlling load components are highlighted in "bold."

*LC refers to the governing load combination; AC refers to the governing soil analysis case.

Table 3E.1-6—Governing Design Data for the Equipment Hatch Area (Service Loads)

Cut Section	LC	AC	T_{x_MAX} (k/ft)	T_{x_MIN} (k/ft)	T_{xy} (k/ft)	$M_x + M_{xy}$ (k-ft/ft)	N_x (k/ft)
H-Strip#9 V-Cut#11	$D+L+J+G+T_0+R_0+P_v$	Enveloped	**-1079**	-	**563**	**1599**	15
V-Strip#10 H-Cut#8	$D+L+J+G+T_0+R_0+P_v$	Enveloped	**-1258**	-	**563**	**1795**	112
V-Strip#9 H-Cut#5	$D+L+J+T_t+P_t$	Enveloped	**-372**	-	309	518	**180**

*The controlling load components are highlighted in "bold."

*LC refers to the governing load combination; AC refers to the governing soil analysis case.

Table 3E.1-7—Summary of Typical Reinforcement for the Equipment Hatch Area

Location	Type	Thickness (T)	Required Reinforcement, A_s (in²/ft) Axial+Flexural+ Tangential-Shear	Out-of-Plane Shear	Reinforcement Pattern
Along V-Strips 1 & 14	Hoop	4 ft-3 $^{3}/_{16}$ in	9.0 E.F. & 4.5 Middle		2 Layers #14 @ 6 in E.F & 1 Layer #14 @ 6 in middle
	Vertical		9.0 E.F. & 4.5 Middle		2 Layers #14 @ 6 in E.F & 1 Layer #14 @ 6 in middle
	Stirrup			0.5	1 #8 @ 16 in
Along V-Strips 2& 13	Hoop	6 ft-0 $^{1}/_{2}$ in	9.0 E.F. & 4.5 Middle		2 Layers #14 @ 6 in E.F & 1 Layer #14 @ 6 in middle
	Vertical		9.0 E.F. & 4.5 Middle		2 Layers #14 @ 6 in E.F & 1 Layer #14 @ 6 in middle
	Stirrup			0.3	1 #8 @ 16 in
Along V-Strips 3& 12	Hoop	6 ft-4 $^{13}/_{16}$ in	9.0 E.F. & 4.5 Middle		2 Layers #14 @ 6 in E.F & 1 Layer #14 @ 6 in middle
	Vertical		9.0 E.F. & 4.5 Middle		2 Layers #14 @ 6 in E.F & 1 Layer #14 @ 6 in middle
	Stirrup			0.3	1 #8 @ 16 in
Along V-Strips 4& 11	Hoop	7 ft-2 in	9.0 E.F. & 4.5 Middle		2 Layers #14 @ 6 in E.F & 1 Layer #14 @ 6 in middle
	Vertical		13.5 E.F. & 4.5 Middle		3 Layers #14 @6 in E.F.& 1 Layer #14 @6 in Middle
	Stirrup			0.3	1 #8 @ 16 in
From V-Strips 5 & 10	Hoop	7 ft-10 $^{1}/_{2}$ in	13.5 E.F. & 4.5 Middle		3 Layers #14 @6 in E.F.& 1 Layer #14 @6 in Middle
	Vertical		20.5 E.F. & 4.5 Middle		3 Layers #18 @ 8 in and 3-#9 Hoop bars E.F., & 1 Layer #14 @ 6 in Middle
	Stirrup			0.73	1 #8 @ 12 in
From V-Strips 6 to 9	Hoop	7 ft-10 $^{1}/_{2}$ in	13.5 E.F. & 4.5 Middle		3 Layers #14 @6 in E.F.& 1 Layer #14 @6 in Middle
	Vertical		13.5 E.F. & 4.5 Middle		3 Layers #14 @6 in E.F.& 1 Layer #14 @6 in Middle
	Stirrup			0.73	1 #8 @ 12 in

Table 3E.1-8—Accidental Torsion Loadings for the Typical Cylinder Wall and Buttress Section

Tangential Shear (k/ft)	Elevation (ft)
25	All

Table 3E.1-9—Reduction of Thermal Bending Moments Due to Cracked Concrete for the Typical Cylinder Wall and Buttress Section

Reduction of Thermal Bending Moment (k-ft / ft)	Applicable Section
400	Typical Wall
400	Typical Narrow Buttress
400	Typical Wide Buttress

Table 3E.1-10—Governing Design Data for Tangential Shear Design (Typical RCB Wall Section)

Location	T_{xy} (k/ft)	T_x (k/ft)	T_y (k/ft)	Comments
RCB Typical Wall	297	-87	-44	Controls for design of hoop reinforcing (A_{sh}).
	297	-87	-44	Controls for design of meridional reinforcing (A_{sm}).
	200	334	129	Controls for design of hoop reinforcing (A_{sh}), coincident with membrane tensions.
	200	334	129	Controls for design of meridional reinforcing (A_{sm}), coincident with membrane tensions.

Table 3E.1-11—Governing Design Data for Membrane and Bending Design (Typical RCB Wall Section)

Location	T_x or T_y (k/ft)	M_x or M_y (k-ft/ft)	Comments
RCB Typical Wall (Factored Loads)	-100	436	Controls for design of hoop reinforcing, coincident with membrane compression in the hoop direction.
	-100	452	Controls for design of meridional reinforcing, coincident with membrane compression in the meridional direction.
	334	435	Controls for design of hoop reinforcing, coincident with membrane tension in the hoop direction.
	129	538	Controls for design of meridional reinforcing, coincident with membrane tension in the meridional direction.
RCB Typical Wall (Service Loads)	-176	65	Controls for design of hoop reinforcing, coincident with membrane compression in the hoop direction.
	-223	74	Controls for design of meridional reinforcing, coincident with membrane compression in the meridional direction.
	n/a	n/a	There is no membrane tension in the hoop direction.
	n/a	n/a	There is no membrane tension in the meridional direction.

Table 3E.1-12—Governing Design Data for Radial Shear Design (Typical RCB Wall Section)

Location	N_x or N_y (k/ft)	T_x or T_y (k/ft)	Comments
RCB Typical Wall	6	334	Controls for design of radial shear reinforcing (A_v).

Table 3E.1-13—Reinforcing Summary (Typical RCB Wall Section)

Location	Type	Thickness	Required A_S (in^2 / foot)				Reinforcement Pattern
			Membrane and Bending[1]	Tangential Shear[1]	Total Area of Steel	Radial Shear	
RCB Typical Wall	Meridional (Vertical)	4 ft-3 $^{3}/_{16}$	Compression 8.39 Tension 10.80	Compression 5.11 Tension 2.70	13.50	-	Inside Layer #14 @ 6 in o.c. Middle Layer #14 @ 6 in o.c Outside Layer #14 @ 6 in o.c
	Hoop (Horizontal)		Compression 8.75 Tension 11.77	Compression 4.75 Tension 1.73	13.50	-	Inside Layer #14 @ 6 in o.c Middle Layer #14 @ 6 in o.c Outside Layer #14 @ 6 in o.c
	Stirrup		-	-	-	0.05	#3 @18 in o.c. vertical and horizontal

Note:

1. Two values of required tangential shear steel were determined. One value covered all situations of membrane compression, and the other covered all situations of membrane tension. This resulted in less required tangential shear reinforcing for situations involving membrane tension, since these situations coincided with smaller values of tangential shear. This was necessary to minimize the amount of reinforcing to be “discounted” when designing for combined membrane tension and bending.

Table 3E.1-14—Governing Design Data for Tangential Shear Design (Typical RCB Narrow Buttress Section)

Location	T_{xy} (k/ft)	T_x (k/ft)	T_y (k/ft)	Comments
RCB Typical Narrow Buttress	225	-481	25	Controls for design of hoop reinforcing (A_{sh}).
	225	-481	25	Controls for design of meridional reinforcing (A_{sm}).
	221	-481[1]	31	Controls for design of hoop reinforcing (A_{sh}), coincident with membrane tensions.
	221	-481[1]	31	Controls for design of meridional reinforcing (A_{sm}), coincident with membrane tensions.

Note:

1. There were no membrane tensions in the buttress in the hoop direction. Therefore, the least compressive membrane load was utilized.

Table 3E.1-15—Governing Design Data for Combined Membrane and Bending Design (Typical RCB Narrow Buttress Section)

Location	T_x or T_y (k/ft)	M_x or M_y (k-ft/ft)	Comments
RCB Typical Narrow Buttress (Factored Loads)	-107	426	Controls for design of hoop reinforcing, coincident with membrane compression in the hoop direction.
	-100	741	Controls for design of meridional reinforcing, coincident with membrane compression in the meridional direction.
	n/a	n/a	There is no membrane tension in the hoop direction.
	207	874	Controls for design of meridional reinforcing, coincident with membrane tension in the meridional direction.
RCB Typical Narrow Buttress (Service Loads)	-700	798	Controls for design of hoop reinforcing, coincident with membrane compression in the hoop direction.
	-400	223	Controls for design of meridional reinforcing, coincident with membrane compression in the meridional direction.
	n/a	n/a	There is no membrane tension in the hoop direction.
	n/a	n/a	There is no membrane tension in the meridional direction.

Table 3E.1-16—Governing Design Data for Radial Shear Design (Typical RCB Narrow Buttress Section)

Location	N_x or N_y (k/ft)	T_x or T_y (k/ft)	Comments
RCB Typical Narrow Buttress	109	-500	Controls for design of radial shear reinforcing (A_v).

Table 3E.1-17—Reinforcing Summary (Typical RCB Narrow Buttress Section)

Location	Type	Thickness	Required As (in²/ft) Membrane and Bending[1]	Tangential Shear[1]	Total Area of Steel	Radial Shear	Reinforcement Pattern
RCB Typical Narrow Buttress	Meridional (Vertical)	Varies Effective thickness is 6 ft-17/16 in	Compression 8.70 Tension 8.82	Compression 3.94 Tension 3.82	12.64	-	Inside Layer # 14 @ 6 in o.c.
							Middle Layer # 14 @ 6 in o.c.
							Outside Layer #14 (17 total) [2]
	Hoop (Horizontal)		Compression 9.43 Tension 9.49	Compression 1.65 Tension 1.59	11.08	-	Inside Layer # 14 @ 6 in o.c.
							Middle Layer # 14 @ 6 in o.c.
							Outside Layer # 11 @ 9 in o.c.
	Stirrup		-	-	-	0.08	# 4 @ 24 in o.c. Vertical and horizontal

Notes:

1. Two values of required tangential shear steel were determined. One value covered all situations of membrane compression, and the other covered all situations of membrane tension. This resulted in less required tangential shear reinforcing for situations involving membrane tension, since these situations coincided with smaller values of tangential shear. This was necessary to minimize the amount of reinforcing to be “discounted” when designing for combined membrane tension and bending.

2. Number of vertical bars across outside face of buttress.

Table 3E.1-18—Governing Design Data for Tangential Shear Design (Typical RCB Wide Buttress Section)

Location	T_{xy} (k/ft)	T_x (k/ft)	T_y (k/ft)	Comments
RCB Typical Wide Buttress	225	-554	75	Controls for design of hoop reinforcing (A_{sh}).
	225	-554	75	Controls for design of meridional reinforcing (A_{sm}).
	126	-149[1]	121	Controls for design of hoop reinforcing (A_{sh}), coincident with membrane tensions.
	126	-149[1]	121	Controls for design of meridional reinforcing (A_{sm}), coincident with membrane tensions.

Note:

1. There were no membrane tensions in the buttress in the hoop direction. Therefore, the least compressive membrane load was utilized.

Table 3E.1-19—Governing Design Data for Combined Membrane and Bending Design (Typical RCB Wide Buttress Section)

Location	T_x or T_y (k/ft)	M_x or M_y (k-ft/ft)	Comments
RCB Typical Wide Buttress (Factored Loads)	-149	13	Controls for design of hoop reinforcing, coincident with membrane compression in the hoop direction.
	-100	716	Controls for design of meridional reinforcing, coincident with membrane compression in the meridional direction.
	n/a	n/a	There is no membrane tension in the hoop direction.
	121	728	Controls for design of meridional reinforcing, coincident with membrane tension in the meridional direction.
RCB Typical Wide Buttress (Service Loads)	-744	328	Controls for design of hoop reinforcing, coincident with membrane compression in the hoop direction.
	-511	126	Controls for design of meridional reinforcing, coincident with membrane compression in the meridional direction.
	n/a	n/a	There is no membrane tension in the hoop direction.
	n/a	n/a	There is no membrane tension in the meridional direction.

Table 3E.1-20—Governing Design Data for Radial Shear Design (Typical RCB Wide Buttress Section)

Location	N_x or N_y (k/ft)	T_x or T_y (k/ft)	Comments
RCB Typical Wide Buttress	n/a	n/a	There is no radial shear reinforcing (A_v) required for this section.

Table 3E.1-21—Reinforcing Summary (Typical RCB Wide Buttress Section)

Location	Type	Thickness	Required As (in²/ft)				Reinforcement Pattern
			Membrane and Bending[1]	Tangential Shear[1]	Total Area of Steel	Radial Shear	
RCB Typical Wide Buttress	Meridional (Vertical)	Varies Effective Thickness is 6 ft-1 $^{7}/_{16}$ in	Compression 8.50 Tension 10.56	Compression 3.53 Tension 1.47	12.03		Inside Layer # 14 @ 6 in o.c.
							Middle Layer # 14 @ 6 in o.c.
							Outside Layer # 14 (23 total)[2]
	Hoop (Horizontal)		Compression 9.60 Tension 9.75	Compression 1.48 Tension 1.33	11.08	-	Inside Layer # 14 @ 6 in o.c.
							Middle Layer # 14 @ 6 in o.c.
							Outside Layer # 11 @ 9 in o.c.
	Stirrup		-	-	-	0.00	# 4 @ 24 in o.c. vertical and horizontal

Notes:

1. Two values of required tangential shear steel were determined. One value covered all situations of membrane compression, and the other covered all situations of membrane tension. This resulted in less required tangential shear reinforcing for situations involving membrane tension, since these situations coincided with smaller values of tangential shear. This was necessary to minimize the amount of reinforcing to be "discounted" when designing for combined membrane tension and bending.

2. Number of vertical bars across outside face of buttress.

Table 3E.1-22—Governing Design Cases for the SG and RCP Supports and Typical Cavity Wall
Sheet 1 of 2

Location	LC	AC	Controlling Direction	Mx+Mxy k-ft/ft	My+Mxy k-ft/ft	Tx k/ft	Ty k/ft	Txy k/ft	Nx k/ft	Ny k/ft
Floor Slab @ Elevation 4 ft - 11 $^{1}/_{16}$ in (Thickness 6 ft -6 $^{3}/_{4}$ in)	$D + F + L + T_a + R_a + F_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	3r3u-M	y	627	256	-669	1810	97	131	117
		3r3u-M	x	832	115	319	1	53	102	36
		5a-H	out-of-plane	1136	469	-155	179	51	220	336
Floor Slab @ Elevation 4 ft - 11 $^{1}/_{16}$ in (Thickness 3 ft -3 $^{3}/_{8}$ in)	$D + F + L + T_a + R_a + F_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	3r3u-M	y	35	24	-387	425	214	29	11
		5a-H	out-of-plane	76	170	-100	137	20	154	361
	$D + F + L + T_o + R_o + E'$	4u-M	x	60	58	176	-121	102	14	28
SG/RCP Wing Wall Bottom	$D + F + L + T_a + R_a + F_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	5u-H	x	1507	627	-87	-118	64	122	278
		4u-M	y and out-of-plane	1278	764	98	6	60	308	200
SG/RCP Wing Wall Top	$D + F + L + T_a + R_a + F_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	Fixed 4u-M	x	451	359	219	-48	231	90	91
		4u-M	y	455	542	111	74	67	128	136
		4u-M	out-of-plane	676	307	133	10	23	135	309
SG Separation Wall Bottom	$D + F + L + T_a + R_a + F_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	5u-H	x	430	83	189	-17	50	80	4
		Fixed 4u-M	y	49	19	636	136	189	8	6
		4u-M	out-of-plane	163	154	56	-6	31	104	9

Table 3E.1-22—Governing Design Cases for the SG and RCP Supports and Typical Cavity Wall
Sheet 2 of 2

Location	LC	AC	Controlling Direction	Mx+Mxy k-ft/ft	My+Mxy k-ft/ft	Tx k/ft	Ty k/ft	Txy k/ft	Nx k/ft	Ny k/ft
SG Separation Wall Top	$D + F + L + T_a + R_a + F_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	5u-H	x	950	483	-8	-50	53	148	147
		5u-H	y	678	611	-27	70	27	210	140
		5u-H	out-of-plane	951	484	51	53	57	148	147

*LC refers to the governing load combination; AC refers to the governing soil analysis case.

Table 3E.1-23—Summary of Reinforcement for SG and RCP Floor Slab

Location	Type	Section Thickness, T	Required A_s (in^2/ft)		Reinforcement Pattern
			Axial +Bending & In-Plane Shear Reinforcement (per face)	Out-of-plane shear (s=6 in)	
Floor Slab @ Elevation 4 ft - 11 $^1/_{16}$ in	Circumferential	6 ft -6 $^3/_4$ in	12.35		3 Layers # 14 @ 6 in EF
	Radial		5.28		2 layers # 11 @ 6 in EF
	Stirrups (max)			0.25	#4 @ 6 in EF
Floor Slab @ Elevation 4 ft - 11 $^1/_{16}$ in	Circumferential	3 ft - 3 $^3/_8$ in	4.85		1st Layer: #10 @ 6 in EF 2nd Layer: # 10 @6 in EF
	Radial		2.41		#10 @ 6 in EF
	Stirrups			0.39	#4 @ 6 in EF

Table 3E.1-24—Typical SG and RCP Cavity Wall Reinforcement
Sheet 1 of 2

Location	Type	Section Thickness, T	Required A_s (in²/ft)		Reinforcement Pattern
			Axial +Bending & In-Plane Shear Reinforcement (per face)	**Out-of-plane shear (s=6 in)**	
SG/RCP Wing Wall Bottom	Vertical	3 ft – 11 3/4 in	3.52		1st Layer: #10 @ 6 in EF 2nd Layer: # 10 @ 12 in EF
	Horizontal		6.35		1st Layer: #14 @ 6 in EF 2nd Layer: # 14 @12 in EF
	Stirrups (max)			0.53	#5 @ 6 in
SG/RCP Wing Wall Top	Vertical	3 ft - 3 3/8 in	4.50		1st Layer: #10 @ 6 in EF 2nd Layer: # 10 @ 6 in EF
	Horizontal		7.38		1st Layer: #14 @ 6 in EF 2nd Layer: # 11 @6 in EF
	Stirrups (max)			0.57	#5 @ 6 in
			Axial +Bending & In-Plane Shear Reinforcement (per face)	**Out-of-plane shear (s=12 in)**	
SG Separation Wall Bottom	Vertical	3 ft - 3 3/8 in	2.14		#10 @ 6 in EF
	Horizontal		2.93		#11 @ 6 in EF
	Stirrups (max)			0.15	#4 @6 in *
			*#4 @ 6 in controls as punching shear check		

Table 3E.1-24—Typical SG and RCP Cavity Wall Reinforcement
Sheet 2 of 2

Location	Type	Section Thickness, T	Required A_s (in^2/ft)		Reinforcement Pattern
			Axial +Bending & In-Plane Shear Reinforcement (per face)	Out-of-plane shear (s=6 in)	
SG Separation Wall Top	Vertical	3 ft - 3 $^3/_8$ in	3.95		1st Layer: #11 @ 6 in EF 2nd Layer: # 11 @12 in EF
	Horizontal		6.72		1st Layer: #14 @ 6 in EF 2nd Layer: # 14 @12 in EF
	Stirrups (max)			0.52	#5 @ 6 in

Table 3E.1-25—Summary of Governing Design Data

Location	LC	AC	$M_x + M_{xy}$ (k-ft/ft)	$M_y + M_{xy}$ (k-ft/ft)	T_x (k/ft)	T_y (k/ft)	T_{xy} (k/ft)	N_x (k/ft)	N_y (k/ft)
Floor Slab	$D + F + L + T_a + R_a + F_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	4u-M	108	75	76	21	**63**	53	65
		5a-H	**331**	135	**55**	-6	1	97	114
		Fixed 2sn4u-M	58	79	-10	2	6	**110**	91
			123	73	-5	18	9	103	**108**
	$D + F + L + T_o + R_o + E'$	4u-M	31	31	-58	-44	**77**	38	36
		2sn4u-M	64	**211**	5	**52**	13	63	45
Wall Section	$D + F + L + T_a + R_a + F_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	Fixed 4u-M	**18**	**17**	**-47**	**-50**	**148**	3	3
			26	**74**	10	**92**	84	9	15
			33	39	-18	-52	-27	9	**45**
		1u-S	**55**	79	**38**	-17	18	7	22

*LC refers to the governing load combination; AC refers to the governing soil analysis case.

Table 3E.1-26—Summary of Typical PZR Cubical Reinforcement

Location	Section Thickness, t	Type	Minimum Required As (in^2/ft)		Reinforcement Pattern
			Total Area	Out-of-Plane	
Floor Slab	2 ft - 9 $^{7}/_{16}$ in	Longitudinal	3.12	-	#11 @ 6 in
		Transverse	2.10	-	#11 @ 6 in
		Stirrup	-	0.56	#5 @ 6 in
Wall Section	2 ft - 7 $^{11}/_{16}$ in	Vertical	2.18	-	#11 @ 6 in
		Horizontal	1.33	-	#11 @ 6 in
		Stirrup	-	0.13	#4 @ 12 in
Floor Slab Under Support	2 ft - 7 ½ in	Parallel	6.24	-	Two layers of #11 @ 6 in
		Perpendicular	4.70	-	One layer of #11 @ 6 in 2 #8 @ each side
		Stirrup	-	0.56	#5 @ 6 in

Table 3E.1-27—Summary of Governing Design Data for the Operating Floor Area

Location	LC	AC	T_x (k/ft)	T_y (k/ft)	T_{xy} (k/ft)	M_x (k-ft/ft)	M_y (k-ft/ft)	M_{xy} (k-ft/ft)	N_x (k/ft)	N_y (k/ft)
RM15	D + F + L + Ta + Ra + Fa + Pa + Rrr + Rrj + Rrm + E'	4u-M	62	140	36	-14	-3	3	8	4
RM22		5u-H	417	-1	60	24	-1	8	-2	2
RM22		4u-M	-38	368	-37	18	17	-21	-5	6
RM16-1		4u-M	143	-725	-113	-9	42	1	-1	-2
RM16-1		4u-M	-131	329	8	-19	-57	33	3	-2
RM16-1		4u-M	15	405	-70	46	47	10	10	-2
RM16-2		4u-M	196	161	-272	-55	-31	6	15	-4
RM16-3		4u-M	93	202	167	-66	-153	-48	18	29
RM16-3		4u-M	281	209	215	11	24	20	5	-1
RM18		4u-M	210	-28	3	-7	27	-9	-28	18
RM18		Fixed 4u-M	-72	160	14	1	17	13	11	15

*LC refers to the governing load combination; AC refers to the governing soil analysis case.

Table 3E.1-28—Summary of Typical Reinforcement for the Operating Floor Area

Location (Sub-Floor #)	Type	Thickness (T)	Required A_s (in^2/ft) Axial + Flexural + In-Plane-Shear (per face)	Required A_s (in^2/ft) Out-of-Plane Shear	Reinforcement Pattern
Slab (RM15)	Radial	2 ft-7 ½ in	0.81		1-#9 @ 12 in T&B
	Tangential		1.66		1-#9 @6 in T&B
	Stirrup			(Not Required)	
Slab (RM22)	Radial	2 ft-7 ½ in	4.82		2-#11 @6 in T&B
	Tangential		4.13		1st Layer 1-#11 @6 in & 2nd Layer 1-#11 @12 in T&B
	Stirrup			0.60	1 #5 @ 6 in
Slab (RM16-1)	Radial	3 ft-$3^3/_8$ in	2.53		1-#11 @6 in T&B
	Tangential		3.67		1st Layer 1-#11 @6 in & 2nd Layer 1-#11 @12 in T&B
	Stirrup			0.49	1 #5 @ 6 in
Slab (RM16-2)	E-W	3 ft-$3^3/_8$ in	5.40		2-#11 @6 in T&B
	N-S		4.68		1st Layer 1-#11 @6 in & 2nd Layer 1-#11 @12 in T&B
	Stirrup			(Not Required)	
Slab (RM16-3)	E-W	4 ft-$3^3/_{16}$ in	5.27		2-#11 @6 in T&B
	N-S		4.49		1st Layer 1-#11 @6 in & 2nd Layer 1-#11 @12 in T&B
	Stirrup			0.39	1 #5 @ 6 in
Slab (RM18)	E-W	2 ft-7 ½ in	1.89		1-#9 @6 in T&B
	N-S		1.96		1-#9 @6 in T&B
	Stirrup			(Not Required)	

Table 3E.1-29—Controlling Nodal Forces and Moments for FB Roof

Location	LC	AC	Mx +Mxy (k-ft/ft)	My+Mxy (k-ft/ft)	Tx (k/ft)	Ty (k/ft)	Txy (k/ft)	Nx (k/ft)	Ny (k/ft)
FB Roof	D + F + L + H + To + Ro + E’	4u-M	414	257	**-20**	22	294	**85**	8
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E’	2sn4u-M	101	184	-67	**59**	137	85	**40**
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E’	2sn4u-M	70	**123**	7	**68**	336	31	5
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E’	2sn4u-M	**80**	**137**	**21**	**38**	380	16	17
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E’	2sn4u-M	**354**	240	**-18**	21	298	73	7

*LC refers to the governing load combination; AC refers to the governing soil analysis case.

Table 3E.1-30—Controlling Nodal Forces and Moments for SB 2 and 3 Roof

Location	LC	AC	Mx +Mxy (k-ft/ft)	My+Mxy (k-ft/ft)	Tx (k/ft)	Ty (k/ft)	Txy (k/ft)	Nx (k/ft)	Ny (k/ft)
SB 2 and 3 Roof	D + F + L + H + To + Ro + E'	3r3u-M	244	183	**4**	-227	59	**97**	26
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E'	5u-H	264	91	158	**-146**	45	65	**102**
	D + F + L + H + To + Ro + E'	3r3u-M	**781**	496	**111**	-177	58	103	48
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E'	2sn4u-M	89	**146**	-421	**240**	211	19	32
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E'	2sn4u-M	177	**140**	-432	**231**	178	25	39
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E'	5u-H	**251**	79	**232**	-219	88	40	40

*LC refers to the governing load combination; AC refers to the governing soil analysis case.

Table 3E.1-31—Controlling Nodal Forces and Moments for RSB Wall below FB Roof and SB 2 and 3 Roof

Location	LC	AC	Mx +Mxy (k-ft/ft)	My+Mxy (k-ft/ft)	Tx (k/ft)	Ty (k/ft)	Txy (k/ft)	Nx (k/ft)	Ny (k/ft)
SB 2 and 3 Wall Below Roof	D + F + L + H + To + Ro + E’	4u-M	69	73	**-113**	-96	99	**27**	9
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E’	2sn4u-M	40	198	-274	**97**	77	3	**47**
	D + F + L + H + To + Ro + E’	4u-M	**171**	18	**25**	-223	205	29	1
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E’	Fixed 4u-M	79	54	-125	**-52**	283	5	5
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E’	Fixed 4u-M	**55**	47	**141**	-5	159	7	4
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E’	Fixed 4u-M	70	**56**	-126	**-52**	285	4	5

*LC refers to the governing load combination; AC refers to the governing soil analysis case.

Table 3E.1-32—Controlling Nodal Forces and Moments for RSB Wall above FB Roof and SB 2 and 3 Roof

Location	LC	AC	Mx +Mxy (k-ft/ft)	My+Mxy (k-ft/ft)	Tx (k/ft)	Ty (k/ft)	Txy (k/ft)	Nx (k/ft)	Ny (k/ft)
SB 2 and 3 Wall Above Roof	1.4(D +F) + 1.7(L + H + R_o)	1u-S	782	409	**-260**	-308	51	**104**	18
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E'	2sn4u-M	534	425	-421	**117**	161	51	**14**
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E'	4u-M	150	**102**	-222	**88**	311	10	1
	D + F + L + H + Ta + Ra + Pa + Rrr + Rrj + Rrm + E'	Fixed 4u-M	**136**	81	**93**	-76	140	14	1
	D + F + L + H + To + Ro + E'	4u-M	423	**371**	-399	**35**	162	42	10

*LC refers to the governing load combination; AC refers to the governing soil analysis case.

Table 3E.1-33—Specified Reinforcement Pattern for RSB Wall to Roof Connection

Location	Type	Thickness (T)	Required Area of steel (in^2/ft)		Reinforcement Pattern
			Total Area of Steel (per face) (axial, bending, in-plane)	Out-of-Plane Shear	
Fuel Roof	Radial	5 ft – 10 $^7/_8$ in	4.43	-	2 Layers #10 @ 6 in EF
	Circumferential		4.06	-	2 Layers #10 @ 6 in EF
	Stirrup		-	0.00	#5 @ 6 in
SB 2 and 3 Roof	Radial	5 ft – 10 $^7/_8$ in	4.79	-	2 Layers #10 @ 6 in EF
	Circumferential		3.70	-	2 Layers #10 @ 6 in EF
	Stirrup		-	0.00	#5 @ 6 in
SB Wall Below Roof	Vertical	4 ft – 3 $^3/_{16}$ in	2.68	-	#11 @ 6 in EF
	Circumferential		2.79	-	#11 @ 6 in EF
	Stirrup		-	0.00	#5 @ 6 in
SB Wall Above Roof	Vertical	5 ft – 10 $^7/_8$ in	4.07	-	2 Layers #10 @ 6 in EF
	Circumferential		2.71	-	2 Layers #10 @ 6 in EF
	Stirrup		-	0.00	#5 @ 6 in

Table 3E.1-34—Summary of Governing Design Data for SB External Walls Below Grade
Sheet 1 of 4

Location	Element	LC	AC	T_x (k/ft)	T_y (k/ft)	T_{xy} (k/ft)	M_{xu} (k-ft/ft)	M_{yu} (k-ft/ft)	N_x (k/ft)	N_y (k/ft)
In-Plane Shear										
A13001	393183	$D + F + L + H + T_a + R_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	5u	**-125**	-240	**281**	69	11	16	3
A13003	394270		3r3u	**-48**	-446	**228**	3	10	5	5
A33008	426416		2sn4u	**-63**	-251	**293**	22	42	14	27
A33003	426271	$D + F + L + H + T_o + R_o + E'$	3r3u	**83**	-521	**253**	0	10	7	4
Axial/Bending										
A13001	393192	$D + F + L + H + T_a + R_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	5u	**-440**	20	298	155	53	89	48
	393192		5u	-419	-219	291	**217**	241	87	19
	393190		3r3u	**153**	-168	49	14	36	25	22
	393189		3r3u	35	-160	63	**65**	55	13	8
	393228		2sn4u	14	**-572**	48	43	176	5	39
	393184		5u	-404	-138	501	216	**292**	78	109
	393228		Fixed4u-M	4	**323**	80	6	8	4	8
	393228		5u	14	28	23	14	**78**	4	26

Table 3E.1-34—Summary of Governing Design Data for SB External Walls Below Grade
Sheet 2 of 4

Location	Element	LC	AC	T_x (k/ft)	T_y (k/ft)	T_{xy} (k/ft)	M_{xu} (k-ft/ft)	M_{yu} (k-ft/ft)	N_x (k/ft)	N_y (k/ft)
A13003	393288	D + F + L + H + T_o + R_o + E'	2u-S	**-333**	-716	298	16	52	8	22
	394321	D + F + L + H + T_a + R_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'	Fixed5a	-53	-118	89	**114**	27	20	9
	394269		3r3u	**262**	-68	131	12	25	6	10
	393292		2u-S	81	-232	126	**54**	64	12	7
	393288	D + F + L + H + T_o + R_o + E'	4u-M	-232	**-974**	223	17	47	7	18
	393241	1.4(D + F) + 1.7(L + H + R_o)	1u	-61	-403	26	40	**196**	2	57
	393289	D + F + L + H + T_o + R_o + E'	Fixed4u-M	43	**371**	131	6	25	5	16
	393289	D + F + L + H + T_a + R_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'	Fixed4u-M	-16	3	84	18	**90**	5	36
A33008	425155	D + F + L + H + T_o + R_o + E'	5u	**-433**	40	210	252	114	152	32
	425153	D + F + L + H + T_a + R_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'	3r3u	-347	-347	455	**324**	464	132	133
	425156		2sn4u	**233**	-127	308	49	146	49	32
	425153		4u-M	22	87	228	**86**	125	41	41
	425197		Fixed4u-M	5	**-471**	94	31	60	1	15
	425153		3r3u	-347	-347	455	324	**464**	132	133
	425197		Fixed4u-M	-21	**223**	91	9	25	1	11
	425153		4u-M	36	67	206	70	**127**	33	41

Table 3E.1-34—Summary of Governing Design Data for SB External Walls Below Grade
Sheet 3 of 4

Location	Element	LC	AC	T_x (k/ft)	T_y (k/ft)	T_{xy} (k/ft)	M_{xu} (k-ft/ft)	M_{yu} (k-ft/ft)	N_x (k/ft)	N_y (k/ft)
A33003	426305	$D + F + L + H + T_a + R_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	4u-M	**-244**	-234	175	10	14	1	0
	426300		Fixed4u-M	-7	-28	73	**64**	25	26	1
	426270	$D + F + L + H + T_o + R_o + E'$	3r3u	**394**	16	167	23	56	5	21
	426300	$D + F + L + H + T_a + R_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	Fixed5u	16	-33	51	**66**	13	26	0
	426306		2sn4u	-33	**-1020**	126	14	68	0	2
	425273	$1.4(D + F) + 1.7(L + H + R_o)$	1u	-20	-439	54	34	**185**	1	45
	426306	$D + F + L + H + T_a + R_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	Fixed4u-M	17	**255**	105	12	38	0	28
	426306		5u	4	64	37	22	**103**	2	54

Table 3E.1-34—Summary of Governing Design Data for SB External Walls Below Grade Sheet 4 of 4

Location	Element	LC	AC	T_x (k/ft)	T_y (k/ft)	T_{xy} (k/ft)	M_{xu} (k-ft/ft)	M_{yu} (k-ft/ft)	N_x (k/ft)	N_y (k/ft)
Out-of-Plane Shear										
A13001	393190	$D + F + L + H + T_a + R_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	5u	-266	-399	424	40	249	35	98
	393192		5u	-440	20	298	155	53	40	48
A13003	393292		5u	128	290	33	31	25	22	29
	393295		2sn4u	-57	-464	51	24	33	47	6
A33008	425166	$D + F + L + H + T_o + R_o + E'$	5u	-211	-335	303	71	238	68	103
	425155		5u	-414	-176	210	292	268	89	38
A33003	426296	$D + F + L + H + T_a + R_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	Fixed4u-M	43	108	54	18	64	7	59
	426270		3r3u	393	16	169	23	55	5	20

Table 3E.1-35—Reinforcement Design for SG Walls Below Grade (A13001, A13003, A33008, and A33003)

Location	Type	Thickness, T	Required A_s (in^2/ft)				Reinforcement Pattern
			Axial and Bending (per face)	In-Plane Shear (per face)	Total Area of Steel (per face)	Out-of-Plane Shear	
Wall A13001	Vertical	4 ft-11 in	4.21	5.08/2 = 2.54	6.75	-	3 layers #14 @ 12 in
	Horizontal		4.21	4.25/2 = 2.13	6.34	-	3 layers #14 @ 12 in
	Stirrup		-	-	-	0.12	#5 @ 24 in
Wall A13003	Vertical	4 ft-11 in	4.86	3.77/2 = 1.89	6.75	-	3 layers #14 @ 12 in
	Horizontal		4.86	3.27/2 = 1.64	6.50	-	3 layers #14 @ 12 in
	Stirrup		-	-	-	0.12	#5 @ 24 in
Wall A33008	Vertical	4 ft-11 in	4.05	5.39/2 = 2.70	6.75	-	3 layers #14 @ 12 in
	Horizontal		4.05	4.48/2 = 2.24	6.29	-	3 layers #14 @ 12 in
	Stirrup		-	-	-	0.12	#5 @ 24 in
Wall A33003	Vertical	4 ft-11 in	4.34	4.82/2 = 2.41	6.75	-	3 layers #14 @ 12 in
	Horizontal		4.34	4.06/2 = 2.03	6.37	-	3 layers #14 @ 12 in
	Stirrup		-	-	-	0.12	#5 @ 24 in

Table 3E.1-36—Governing Design Data for the NI Foundation Basemat and RB Internal Structures Base Slab Sheet 1 of 2

Location	LC	AC	T_x (k/ft)	T_y (k/ft)	T_{xy} (k/ft)	M_x (k-ft/ft)	M_y (k-ft/ft)	M_{xy} (k-ft/ft)	N_x (k/ft)	N_y (k/ft)
Y - Radial Direction										
SB 2 and 3	$D + F + L + H + T_a + R_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	4u-M	0	554	18	0	1275	43	0	73
SB 1		2sn4u	0	394	5	0	1068	38	0	22
SB 4		3r3u	0	444	-223	0	-225	419	0	31
FB		2sn4u	0	-195	395	0	-593	768	0	134
RCB (Radial)	$D + L + J + G + P_a + T_a + E' + R_a + R_r$	2u	0	1380	70	0	-1520	-5	0	240
RBIS (Transverse) El. -25 ft - 7 in & -20 ft - 2 in	D + F + L + Ta + Ra + Fa + Pa + Rrr + Rrj + Rrm + E'	1u	0	-841	33	0	-2725	-11	0	26
RBIS El. -25 ft - 7 in & 7 ft - 6 1/2 in		4u	0	1233	0	0	-872	-993	0	77
X - Transverse Direction										
SB 2 and 3	$D + F + L + H + T_a + R_a + P_a + R_{rr} + R_{rj} + R_{rm} + E'$	4u	308	0	171	721	0	283	-36	0
SB 1		2sn4u	563	0	46	1344	0	74	-69	0
SB 4		2u	135	0	-245	444	0	319	-49	0
FB		2sn4u	55	0	354	26	0	79	358	0
RCB (Transverse)	$D + L + J + G + P_a + T_a + E' + R_a + R_r$	1u	318	0	-566	-439	0	586	-509	0

Table 3E.1-36—Governing Design Data for the NI Foundation Basemat and RB Internal Structures Base Slab
Sheet 2 of 2

Location	LC	AC	T_x (k/ft)	T_y (k/ft)	T_{xy} (k/ft)	M_x (k-ft/ft)	M_y (k-ft/ft)	M_{xy} (k-ft/ft)	N_x (k/ft)	N_y (k/ft)
RBIS (Radial) El. -25 ft - 7 in & -20 ft - 2 in	D + F + L + Ta + Ra + Fa + Pa + Rrr + Rrj + Rrm + E'	2sn4u	-1002	0	124	-2714	0	-165	-25	0
RBIS El. -25 ft - 7 in & 7 ft - 6 1/2 in		4u	1233	0	0	-872	0	-993	77	0

*LC refers to the governing load combination; AC refers to the governing soil analysis case.

Table 3E.1-37—Reinforcement Summary for the NI Foundation Basemat and RB Internal Structures Base Slab
Sheet 1 of 2

Location	Type	Thickness (in.)	Required A_s (in^2/ft)			Reinforcement Pattern
			Combined Bending Moment + Axial Load	In-Plane Shear	Out-of-Plane Shear	
SB 2 and 3 Basemat	Vertical	118.1	4.5	0.76	0.14	2 Layers #18 @ 12 in EF
	Horizontal		8.0	0.0	0.70	2 Layers #18 @ 12 in EF
	Stirrup		-		0.79	#8 @ 12 in EF
SB 1 Basemat	Vertical	118.1	8.0	0.0	0.42	2 Layers #18 @ 12 in EF
	Horizontal		6.75	0.0	0.26	2 Layers #18 @ 12 in EF
	Stirrup		-		0.79	#8 @ 12 in EF
SB 4 Basemat	Vertical	118.1	4.5	1.79	0.66	2 Layers #18 @ 12 in EF
	Horizontal		6.0	2.16	0.12	2 Layers #18 @ 12 in EF
	Stirrup		-		0.79	#8 @ 12 in EF
FB Basemat	Vertical	118.1	2.0	2.96	0.81	2 Layers #18 @ 12 in EF
	Horizontal		4.5	3.34	0.582	2 Layers #18 @ 12 in EF
	Stirrup		-		0.79	#8 @ 12 in EF
RCB Basemat	Radial	130	16.5	0.06	0.64	4 Layers #18 @ 12 in EF
	Transverse		6.24	7.94	0.84	4 Layers #18 @ 12 in EF
	Stirrup		-		0.79	#8 @ 12 in EF
RB Internal Structures Base Slab (El. -25 ft-7 in to -20 ft-2 in)	Vertical	65	4.0	0.52	0.46	3 Layers #14 @ 12 in EF
	Horizontal		6.75	0.00	1.33	3 Layers #14 @ 12 in EF
	Stirrup		-		1.76	#6 @ 6 in EF (U-Shaped)

Table 3E.1-37—Reinforcement Summary for the NI Foundation Basemat and RB Internal Structures Base Slab
Sheet 2 of 2

Location	Type	Thickness (in.)	Required A_s (in^2/ft): Combined Bending Moment + Axial Load	Required A_s (in^2/ft): In-Plane Shear	Required A_s (in^2/ft): Out-of-Plane Shear	Reinforcement Pattern
RB Internal Structures Base Slab (El. -25 ft-7 in to -7 ft-6 ½ in)	Vertical	216	14.75	0.0	0.19	3 Layers #18 @ 12 in EF + Additional one layer of #18 @ 18 in EF
	Horizontal		14.75	0.0	0.19	3 Layers #18 @ 12 in EF + Additional one layer of #18 @ 18 in EF
	Stirrup		-		0.20	#4 @ 12 in EF

Figure 3E.1-1—ANSYS Analysis Results for Nuclear Island Elements

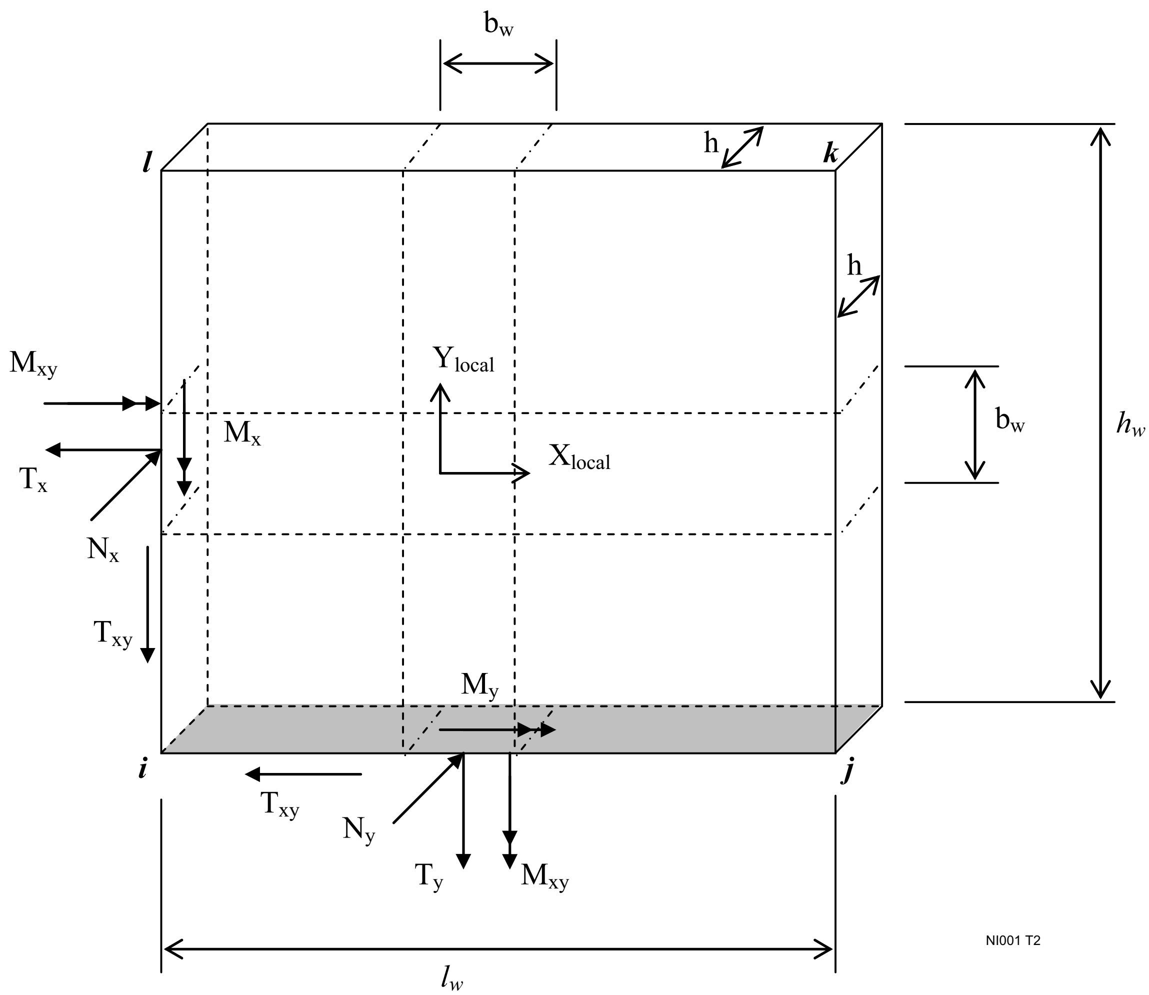


Figure 3E.1-2—Gusset Section of RCB

Figure 3E.1-3—Cross-Section of Gusset

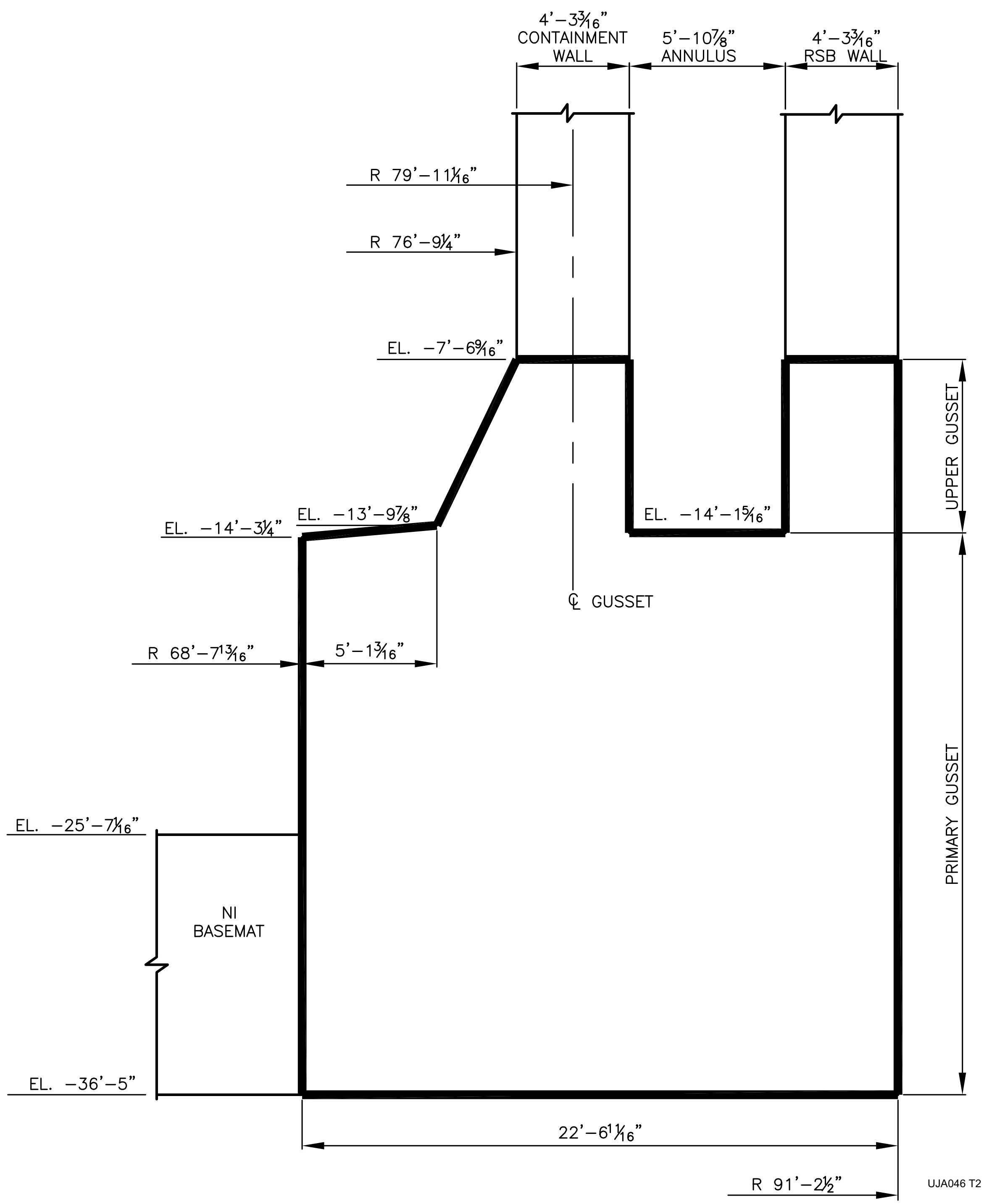


Figure 3E.1-4—180° FEM Gusset Segment of Containment Foundation

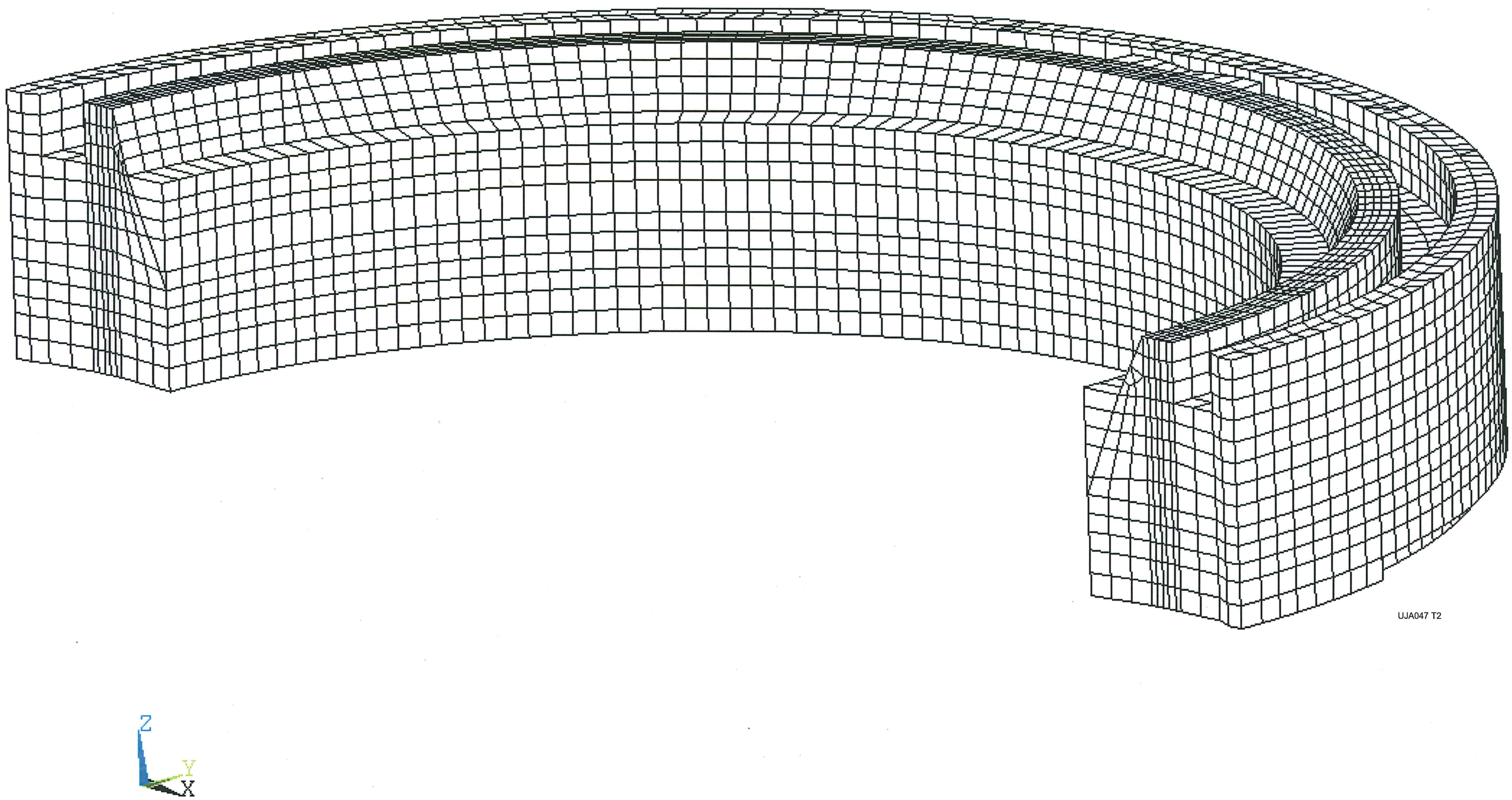


Figure 3E.1-5—Gusset Section - Typical Reinforcement

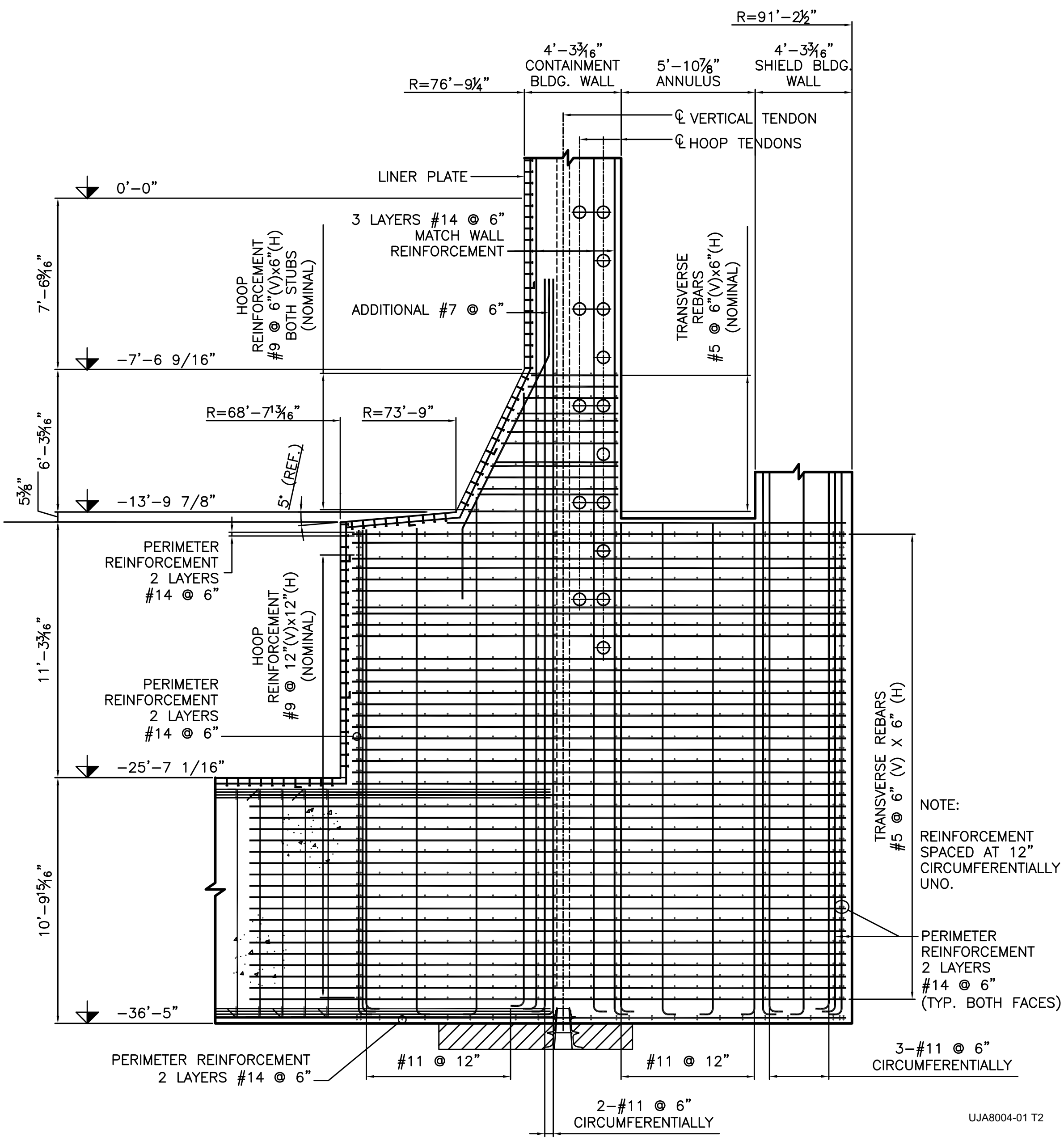


Figure 3E.1-6—Plan View of Equipment Hatch Area

Figure 3E.1-7—FEM of Equipment Hatch Area - Outer View

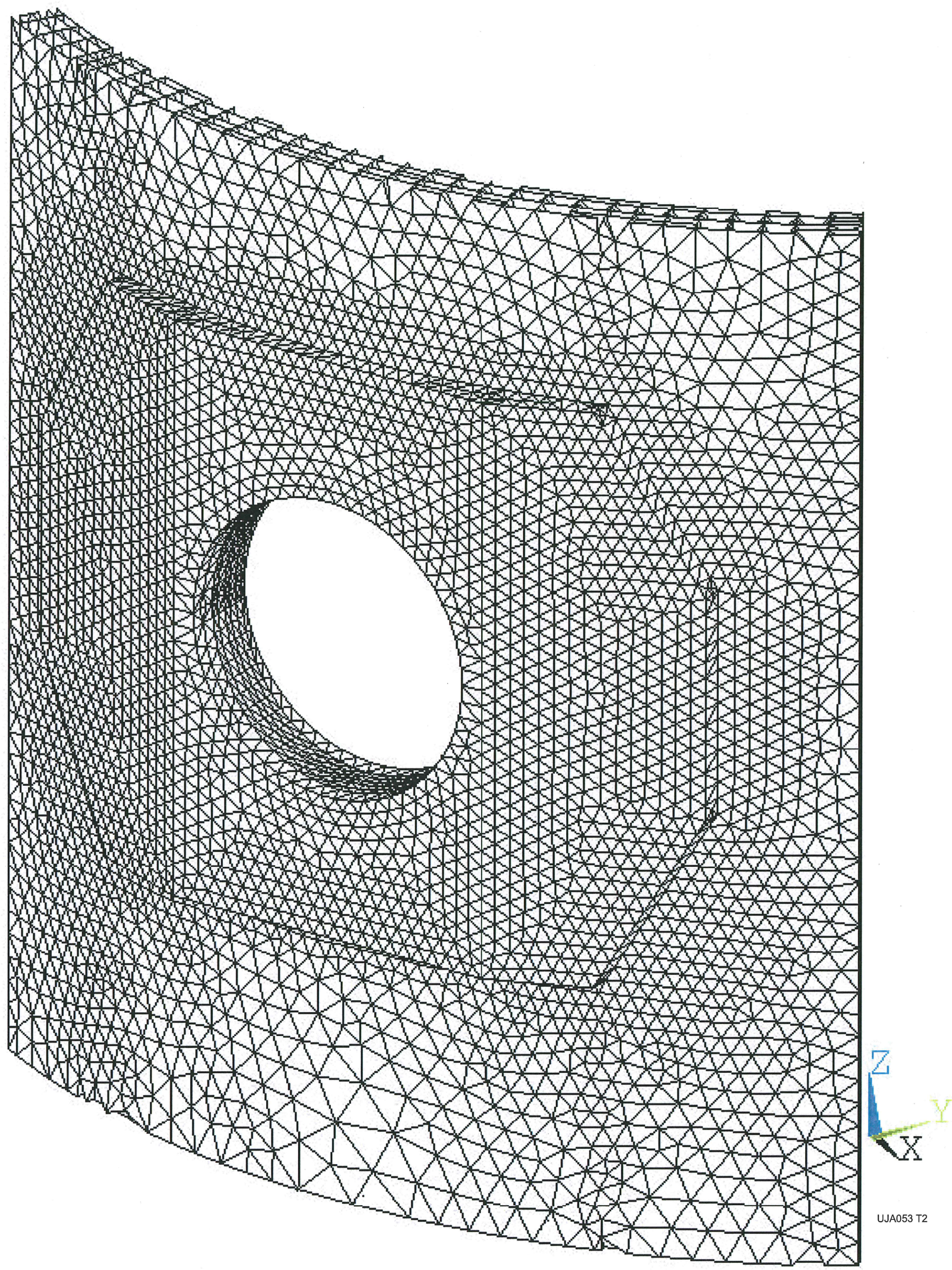


Figure 3E.1-8—FEM of Equipment Hatch Area - Inner View

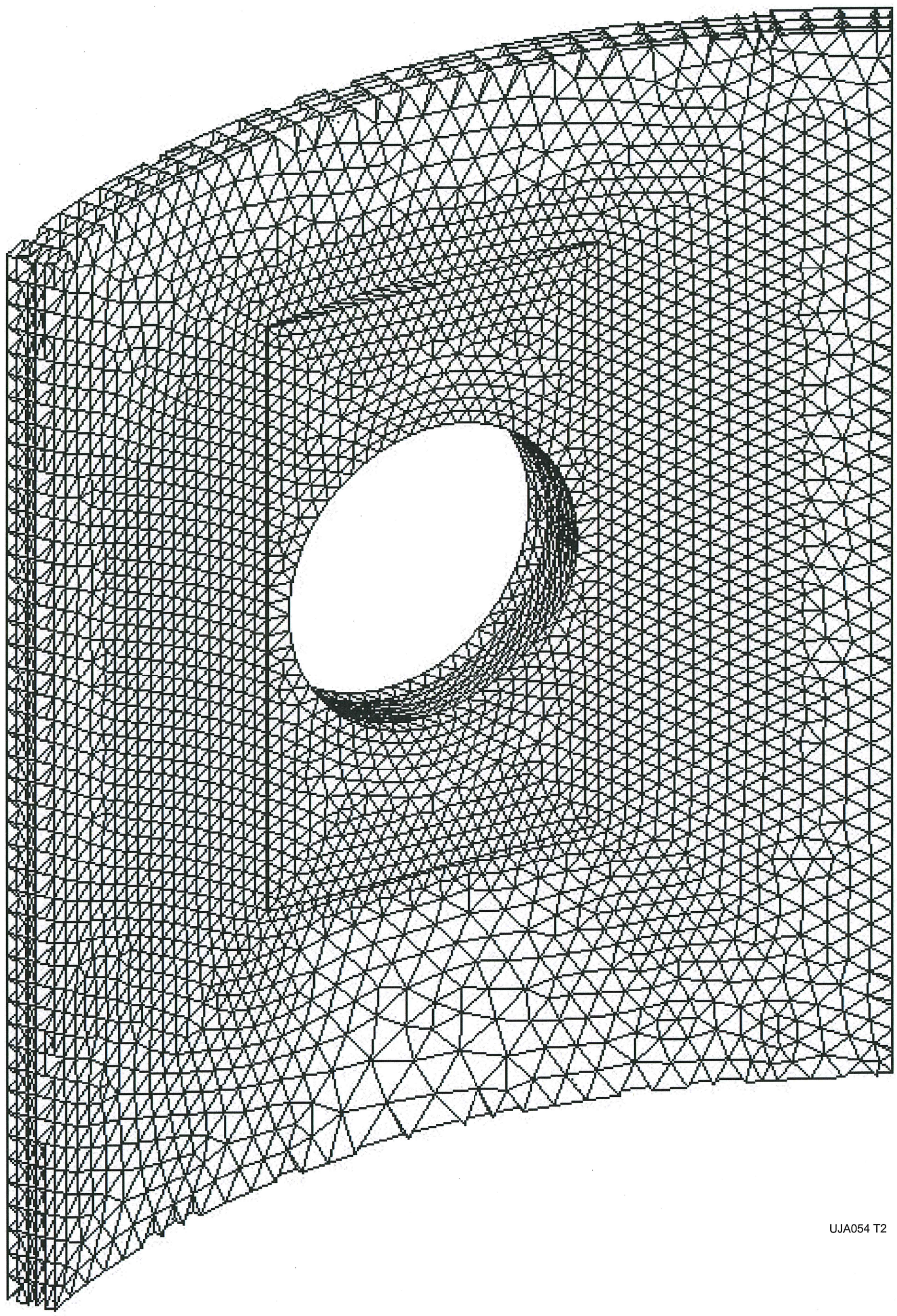


Figure 3E.1-9—Cross-Section of Equipment Hatch Area

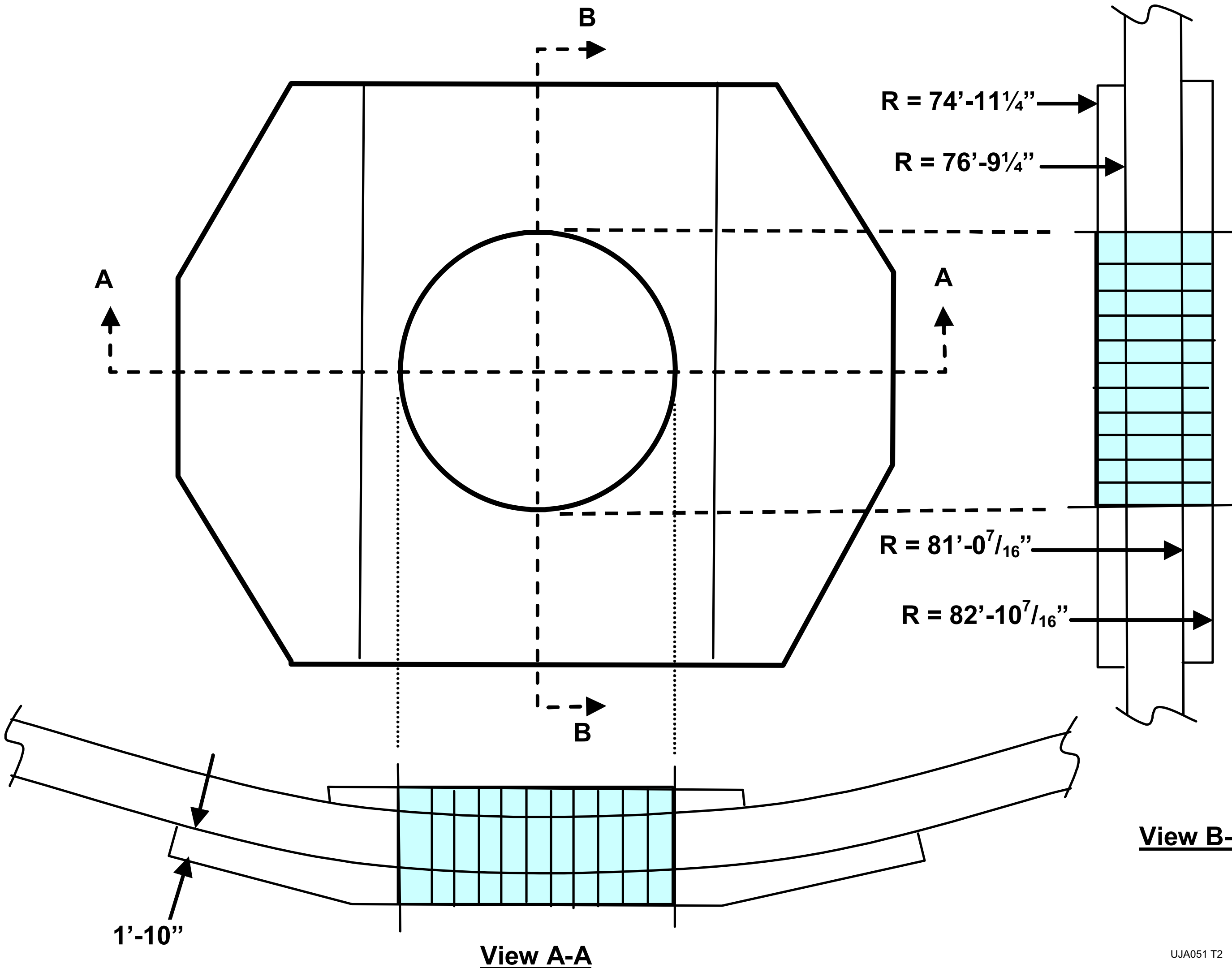


Figure 3E.1-10—Elevation View of Equipment Hatch Area Showing Cuts

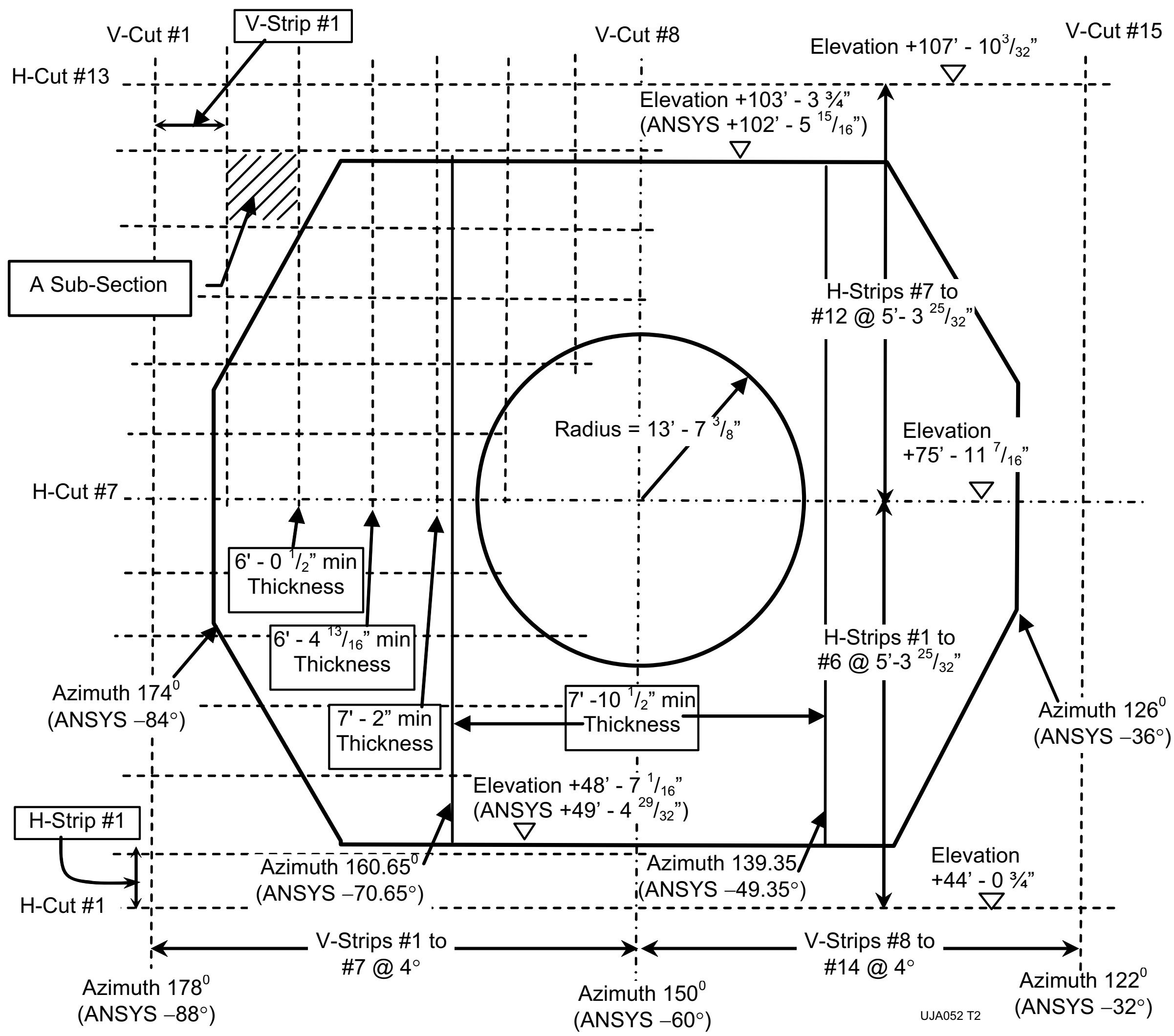


Figure 3E.1-11—Sections 1-1 and 2-2 of the Equipment Hatch Area

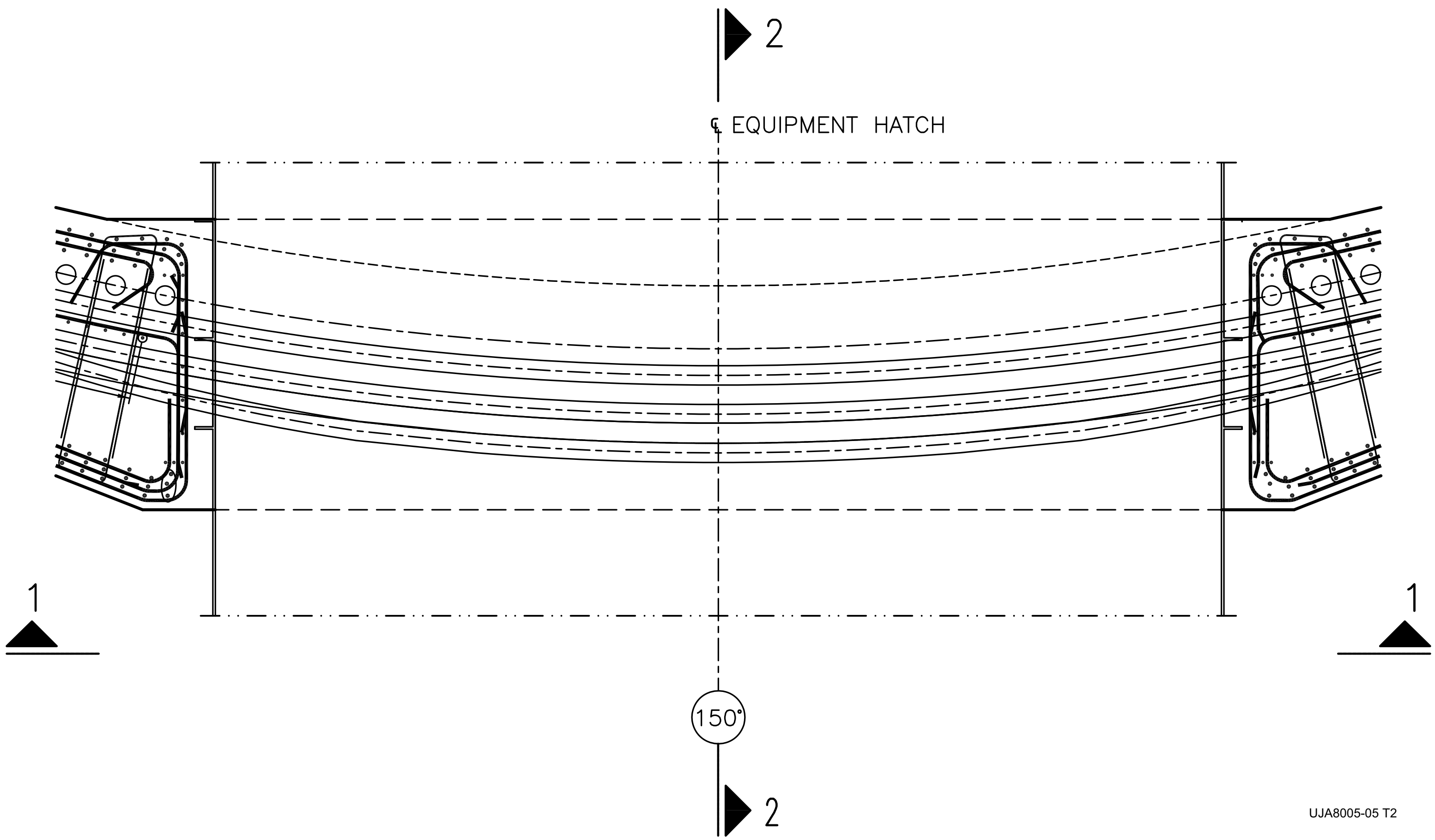


Figure 3E.1-12—Reinforcement Pattern for Section 1-1 of the Equipment Hatch Area

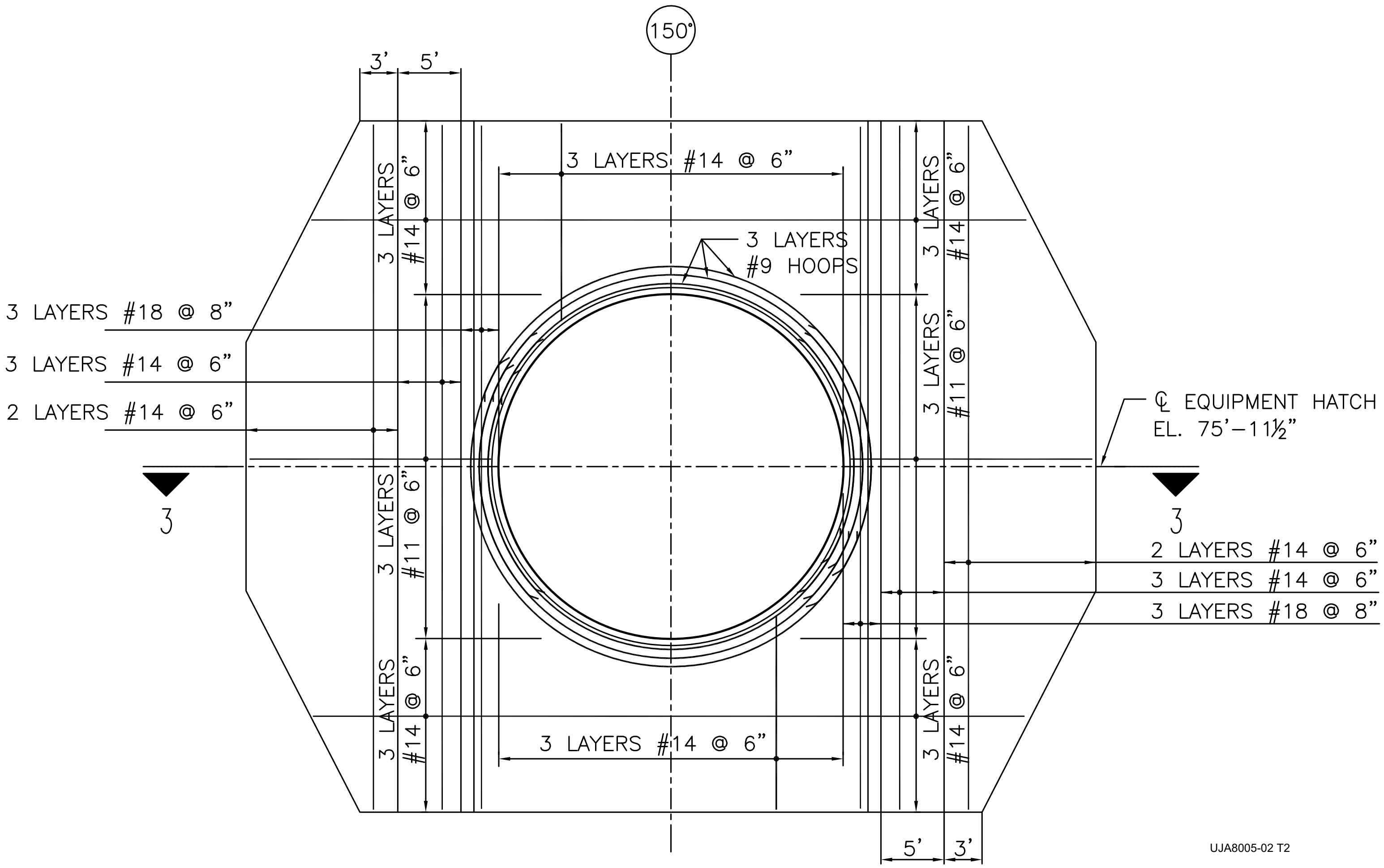
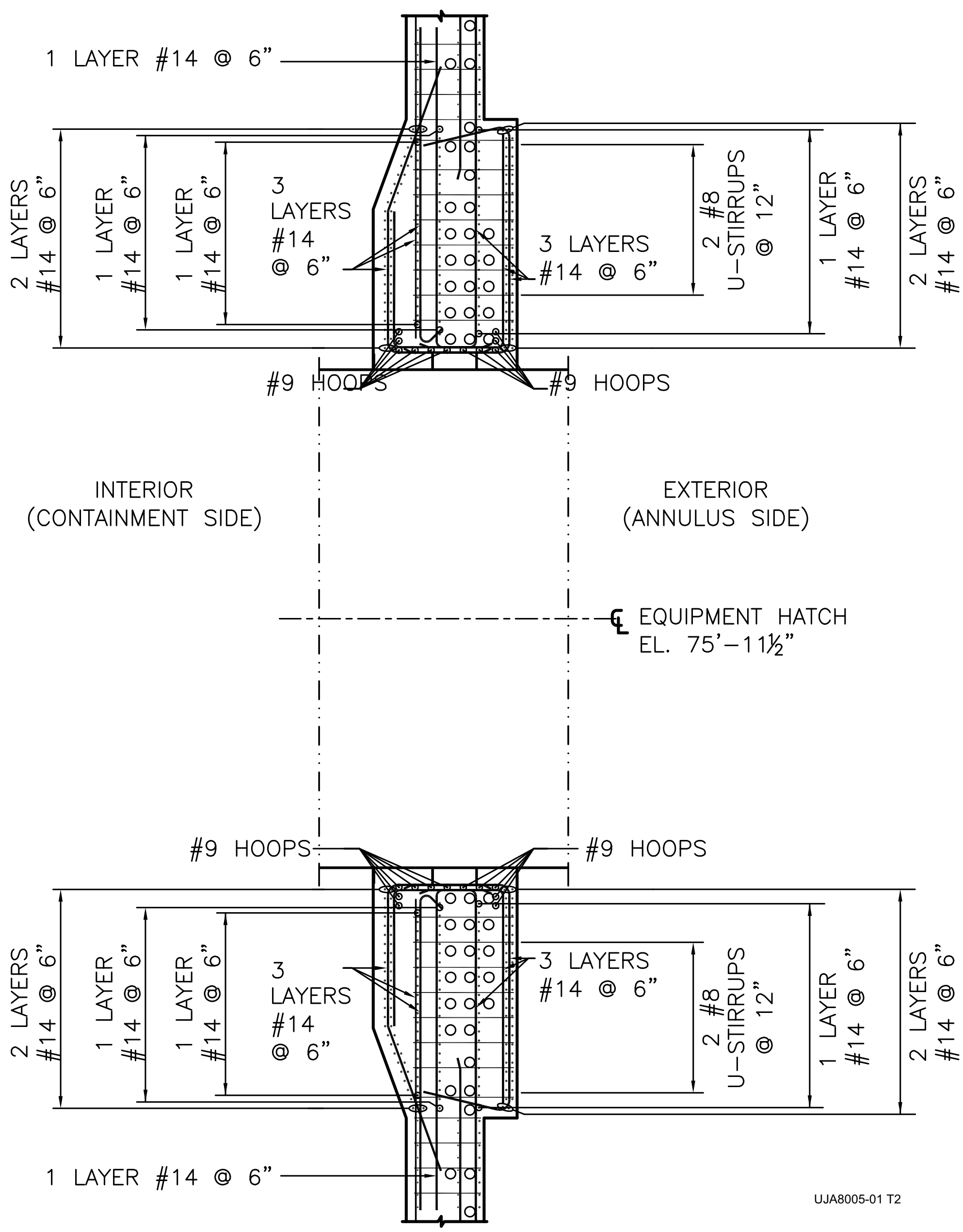


Figure 3E.1-13—Reinforcement Pattern for Section 2-2 of the Equipment Hatch Area



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