Serial No. NA3-15-032
Docket No. 52-017

ENCLOSURE 6

GEH Technical Report

WG3-U97-DRD-S-0001 Revision 0

Fuel Building Structural Design Report

REVISION STATUS SHEET

Document Title: Fuel Building Structural Design Report

Revision #: 0 **Type:** Engineering Report – Design

Safety Related Classification Code: N/A **MPL No.:** U97-5010

"|" Vertical Sidebar Denotes Change

Rev #	DOORS BL	Change Number	MM/DD/YYYY	Preparing Organization	Issue / Release Status	Verification Status
0	N/A	ECO-0015278	11/10/2015	GEH	Issued for Use-Design	Verified

MADE BY	APPROVALS	AUTH. DATE
Gary Ehlert GEH	Tanya B. Kirby GEH	11/10/2015

Public Information Notice

This is a public version of WG3-U97-ERD-S-0001, Rev 0, from which the security-related information has been removed. Portions of the document that have been removed are indicated by white space within single brackets as shown here { }. The footer of each page where security-related information is withheld carries the notation "{{{Security-Related Information - Withheld Under 10 CFR 2.390}}}."

REVISION CHART (CONT)

Rev #	DOORS BL	Change Number	MM/DD/YYYY	Preparing Organization	Issue / Release Status	Verification Status

RECORD OF REVISION

Rev #	Description
0	Initial issue

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. SCOPE

This report describes the section design calculation results of the Fuel Building (FB) for North Anna Unit 3 (NA3) site-specific seismic load demands that exceed the seismic loads used for the standard design of the FB. The scope of the evaluation is the analysis and stress checks of the structure for site-specific seismic loads in combination with other design loads in critical seismic load combinations. The analysis is performed using the same NASTRAN models used for the standard design of the FB, which are further described in Section 6.2.2.1 of Reference 2.1.2-p. The design loads applied to the models are the same as those considered in the standard design, except for the Safe Shutdown Earthquake (SSE) loads that are obtained from Reference 2.1.2-o. The NA3 site-specific SSE loads are combined with non-seismic standard plant loads following the same standard design analysis methodology and acceptance criteria.

The FB is integrated with the Reactor Building (RB), including the Reinforced Concrete Containment Vessel (RCCV), sharing a large common foundation mat. In the structural design of the FB, RB, and RCCV, stresses are evaluated using one Finite Element (FE) analysis model (RB/FB global model), which is shown in Figure 1-1. As described later in Chapter 6, the details of the FE analysis methods, such as analysis model and load application methods, are included in the Reactor Building Structural Design Report, Reference 2.1.2-p). Therefore, this report describes mainly the results of FE analyses and section design calculations of the FB.

2. APPLICABLE DOCUMENTS

2.1 Supporting and Supplemental Documents

The following documents form a part of this documents:

2.1.1 Supporting Documents

Supporting documents are those documents that complete the requirements of this document and are referred to herein.

	Designation
a. 105E4059, Fuel Building Concrete Drawings, Revision 3	U97-2010
b. eDRF Section 0000-0102-0965, "Deliverable to Structural Group for Steady State Heat Transfer and Stress Analysis", Revision 0	

2.1.2 Supplemental Documents

Supplemental documents are those documents that are to be used in conjunction with this document.

Designation

a. SR3-1-A11-TRD-5201, Standard Review Plans and Regulatory Guides Design Specification, Revision 4 A11-5201

b. 105E3908, "ESBWR Nuclear Island General Arrangement Drawing", Revision 5

c. 26A6642AL, "ESBWR Design Control Document Tier 2 Chapter 3 Appendices 3A – 3F", Revision 10

d. 26A6642AN, "ESBWR Design Control Document Tier 2 Chapter 3 Appendices 3G – 3L", Revision 10

e. DE-ES-0083, "Seismic Load Data for North Anna 3 from HGNE Analysis", Revision 0

f. 26A6650, "ESBWR RCCV Structural Design Report", Revision 5

g. 26A6651, "ESBWR Reactor Building Structural Design Report", Revision 5

h. 26A6655, "ESBWR Fuel Building Structural Design Report", Revision 5

i. 26A6605, "Design Specification for Concrete Containment", Revision 4

j. 26A6606, "Design Specification for Reactor Building", Revision 2

k. WG3-U71-ERD-S-0001, "North Anna 3 Reactor/Fuel Building Complex Seismic Analysis Report", Revision 3

l. WG3-U71-ERD-S-0003, "North Anna 3 Reactor/Fuel Building Complex Stability Analysis Report", Revision 1

m. SER-DMN-011, "Benchmarking of SASSI2010 MSM Results from NA3 Site-Specific SSI Analysis", Revision 1

n. TODI WG3-A25-TDI-S-0004, "North Anna 3 RB/FB, CB & FWSC SSI Analyses EPRI 2013 GMPE Based Inputs", Revision 0

o. SER-DMN-019 "RB/FB Seismic Analyses Bounding Results and In-Structure Response Spectra" , Revision 0

p. WG3-U71-ERD-S-0004, "North Anna 3 Reactor Building Structural Design Report", Revision 0

q. WG3-T11-DRD-S-0001, "North Anna 3 RCCV Structural Design Report", Revision 0

r. SR3-1-A11-TRD-5202, Industry Codes and Standards Design Specification, Revision 0 A11-5202

s. 26A6558, General Civil Design Criteria, Revision 4 A40-4010

t. 26A6649, Reactor/Fuel Building Complex Heat Transfer Analysis Report, Revision 3 U71-5060

u. 26A6608, Design Specification for Fuel Building, Revision 2 U97-4010

2.2 Industry Codes and Standards

The following industry codes and standards shall form a part of this document to the extent specified herein. Unless otherwise specified, the applicable revision of the industry codes and standards as indicated in the Industry Codes and Standards Design Specification (Reference 2.1.2-r) shall be used.

a. ACI 349-01: "Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-01) and Commentary (ACI 349R-01)"

b. ASME-2004: Boiler and Pressure Vessel Code, Section III, Rules for Construction of Nuclear Power Plant Components, Division 2, Subsection CC, "Code for Concrete Reactor Vessels and Containments"

c. AISC N690-1994: "Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities," with the Supplements No.1 (2002) and No.2 (2004)

d. ASCE 7-02: "Minimum Design Loads for Buildings and Other Structures"

e. ASCE 4-98: "Seismic Analysis of Safety-Related Nuclear Structures"

2.3 Regulation and Regulatory Requirements

The following regulations and regulatory requirements shall form a part of this document to the extent specified herein. Unless otherwise specified, the applicable revision of the Standard Review Plans (SRP) and Regulatory Guides (RG) as indicated in the Standard Review Plans and Regulatory Guides Design Specification (Reference 2.1.2-a) shall be used.

a. NUREG-0800, "USNRC Standard Review Plan for Review of Safety Analysis Reports for Nuclear Power Plants-Light Water Reactor Edition" Revision 4

2.4 References

a. A Review of Procedures for the Analysis and Design of Concrete Structures to Resist Missile Impact Effects, R.P. Kennedy, Holmes and Narver, Inc. (Nuclear Engineering and Design article Vol. 37 1976, pages 183-203)

b. Topical Report, Design of Structures for Missile Impact, Bechtel Power Corp., BC-TOP-9A Revision 2, September 1974

3. STRUCTURAL DESCRIPTION AND GEOMETRY

3.1 Structural Geometry and Dimensions

The FB is integrated with the RB, sharing a common wall between the RB and the FB and a large common foundation mat. The FB houses the spent fuel pool (SFP) facilities and their supporting system, and HVAC equipment. The FB is a Seismic Category I structure except for the penthouse that houses HVAC equipment. The penthouse is a Seismic Category II structure, and the design of the penthouse is not included in this report.

The FB is a rigid box shape building, and its key dimensions are summarized in Table 3.1-1. Table 3.1-1 includes the key dimensions of the RB for reference. Floor plans and sections of the FB and RB are shown in Figures 3.1-1 through 3.1-7.

The NA3 site-specific seismic demands for sliding stability can be solved without shear key as shown in the NA3 RB/FB Stability Analysis Report, Reference 2.1.2-l. Therefore, shear key design is not contained in this report. The same shear keys as described in Reference 2.1.2-g are provided under the basemat for NA3.

3.2 Key Structural Elements and Descriptions

The FB is a reinforced concrete shear wall structure consisting of walls and slabs and is supported by a foundation mat. Concrete framing is composite with concrete slab and used to support the slabs for vertical loads. As for the floor slab at EL 22,500, it is supported by steel girders.

The FB is a shear wall structure designed to accommodate all seismic loads with its walls and the connected floors. Therefore, frame members such as beams or columns are designed to accommodate deformations of the walls in case of earthquake conditions.

The SFP is composed with thick walls and bottom slab to satisfy the requirements of radiation shielding and to bear pressure loads of the contained water. The bottom slab of the SFP is a part of the FB basemat. The thickness of the basemat is increased to 5.5 m, whereas it is 4.0 m in other regions. The steel liner plates are installed at the inside surfaces of the SFP to prevent leakage, but the design of the steel liners is out of scope of this report.

3.3 Floor Layout and Elevations

Floor layouts and sections of the FB are shown in Figures 3.1-1 through 3.1-7. The FB is a four-story (excluding the penthouse) building with rectangular shape floor plans. The FB structure is partially embedded with the top of basemat 16.0 meters below the finished ground level grade.

3.4 Conditions of Vicinity and Support

In the ESBWR NA3 site-specific design, the buildings including the RB are designed under the condition that they are supported by the foundation soil that has the following properties corresponding to the Soft Site conditions described in WG3-U71-ERD-S-0004 " North Anna 3 Reactor Building Structural Design Report", Reference 2.1.2-p. The soft site conditions are conservative for NA3 rock site because softer soils lead to larger structural deformations.

- Shear wave velocity: 300 m/s
- Unit weight: 0.0196 MN/m^3 (2.00 t/m^3)

- Shear modulus: 180 MN/m^2 (1.835×10^4 t/m^2)
- Poisson's Ratio: 0.478

3.5 Special Structural Features

The FB has the following structural feature.

- Steel girders supporting the slabs at EL 22,500 are connected with pinned joints at their both ends.

4. STRUCTURAL MATERIAL REQUIREMENTS

4.1 Concrete

The specified compressive strengths, f_c', of the concrete at 28 days, or earlier, are as follows.

- basemat: 27.6 MPa (4,000 psi)
- others: 34.5 MPa (5,000 psi)

4.2 Reinforcement

Reinforcing steel is deformed billet steel conforming to ASTM A-615 grade 60. Minimum yield strength, Fy, is 413.6 MPa (60,000 psi).

4.3 Structural Steel

4.3.1 Carbon Steel Plate and Shapes

Structural steel and fasteners of the FB conform to the following:

- Structural Steel: A572 Gr.50 (for girders)
- High strength bolts: ASTM A325 or A490
- Anchor bolts (rods): ASTM A36 or A307
- Steel floor decking: ASTM A446 with minimum fy = 228 MPa (33 ksi)
- Studs: ASTM A 108
- Pipe material: ASTMA-333 Gr. 1 or 6, and A312 tp 304L or 316L
- Forgings: ASTM A 350 Gr. LF1 or LF2, and A182 Type F304L/316L

4.3.2 Stainless Steel Plate

N/A.

4.3.3 Steel Decking

Steel floor and roof decks conform to ASTM A446, Grade A, galvanized.

5. STRUCTURAL LOADS

The structural loads considered in the design are described in detail in the Reactor Building Structural Design Report, Reference 2.1.2-p. They are summarized below.

5.1 Live Loads and Dead Loads

5.1.1 Dead Loads

Dead loads under normal operation condition are considered in the design. The following loads are included in the dead loads.

- Structural weight:
- Equipment weights: Refer to Table 5.1.1-1.
- Weight of miscellaneous structures, piping, and commodities: Refer to Table 5.1.1-2.
- Pool water hydrostatic loads
  Hydrostatic pressure loads due to the SPF pool water of 14.35 m deep is considered in the design.

5.1.2 Live Loads

The following live loads are considered.

- Floor live loads: Refer to Table 5.1.2-1. Floor live loads for roofs are enveloping snow load.
- Snow loads: Refer to Figure 5.1.2-1.
- Static soil pressure: Refer to Table 5.1.2-2

The at-rest lateral pressures are for generic sites considered in the standard design and they are larger than the NA3 site-specific static lateral pressures and conservatively used for NA3.

5.2 Transient Loads

5.2.1 Pressure Loads

Pressure loads includes the following loads.

- Containment pressure loads
- High Energy Line Break (HELB) loads

These loads are not applied to the FB structures directly. However, because the FB is integrated with the RB and RCCV, the loads applied to the RCCV are transferred to the FB through the RB floor slabs. Therefore, the containment pressure load at the following event is considered in the FB design among the pressure loads considered in the RCCV and RB design.

1. Normal operation
2. LOCA – 5 seconds after Design Basis Accident (DBA)
3. LOCA – 6 minutes after DBA
4. LOCA – 10 hours after DBA
5. LOCA – 72 hours after DBA

Details of pressure loads are described in the RCCV Structural Design Report, Reference 2.1.2-q and the Reactor Building Structural Design Report, Reference 2.1.2-p.

5.2.2 Thermal Loads

Thermal loads during normal operation, LOCA and DBA in the spent fuel pool due to loss of Fuel and Auxiliary Pools Cooling System (FAPCS) cooling function are considered. Both of summer and winter conditions are included in each phenomenon.

Table 5.2.2-1 and 5.2.2-4 show the temperature conditions during normal operation and DBA in the FB, respectively. LOCA thermal loads at the following event are considered in the FB design with the same reason as pressure loads.

1. Normal operation, Summer and Winter
2. LOCA – 5 seconds after DBA, Summer and Winter
3. LOCA – 6 minutes after DBA, Summer and Winter
4. LOCA – 10 hours after DBA, Summer and Winter
5. LOCA – 72 hours after DBA, summer and winter

The thermal loads in the spent fuel pool are considered for the following cases in combination with No.1 and No.5 of the above RCCV conditions.

1. Normal operation
2. DBA – 72hours after DBA due to loss of Fuel and Auxiliary Pools Cooling System (FAPCS) cooling function

Tables 5.2.2-2 and 5.2.2-3 based on Reference 2.1.2-t show the average temperature, Td, and the surface temperature difference, Tg, at the normal operation in the FB regions that are shown in Figures 5.2.2-1 through 5.2.2-8. The thermal loads at the 72 hours after DBA in the spent fuel pool are shown in Tables 5.2.2-5 and 5.2.2-6.

The stress-free design temperature used in the stress analyses is 15.5 °C.

5.2.3 Hydrodynamic Loads

Hydrodynamic loads are not applied to the FB structures directly. However, because the FB is integrated with the RB and RCCV, the loads applied to the RCCV are transferred to the FB through the RB floor slabs. Therefore, the following hydrodynamic loads are considered in the FB design among the hydrodynamic loads considered in the RCCV and RB design.

1. Safety-Relief Valve (SRV) Loads
2. Chugging (CH) Load
3. Condensation Oscillation (CO) Load
4. Pool Swell

Details of hydrodynamic loads are described in the RCCV Structural Design Report, Reference 2.1.2-q and the Reactor Building Structural Design Report, Reference 2.1.2-p.

5.2.4 RPV Reactions due to Hydrodynamic Loads

RPV reactions due to hydrodynamic loads considered for the FB design are described in the Reactor Building Structural Design Report, Reference 2.1.2-p.

5.3 Environmental Loads

5.3.1 Wind Loads

Design conditions for calculating the basic wind load are as follows.

Basic wind speed (50 year recurrence interval), m/s (mph)	62.6 (140)
Importance Factors (Safety-related structures)	1.15
Exposure Category	Exposure D

Wind load values at each floor level are shown in Table 5.3.1-1. The evaluation of design wind loads is described in Reference 2.1.2-g.

5.3.2 Tornado Loads

Design conditions for calculating the tornado wind load are as follows.

Maximum Tornado wind speed, m/s (mi/hr)	147.5 (330)
Maximum Rotational Speed, m/s (mi/hr)	116.2 (260)
Maximum Translational Speed, m/s (mi/hr)	31.3 (70)
Radius, m (ft)	45.7 (150)
Maximum Pressure Drop, kPa (psi)	16.6 (2.4)

Maximum Rate of Pressure Drop, kPa/s (psi/s)	11.7 (1.7)

Tornado load values at each floor level are shown in Table 5.3.2-1. The evaluation of design tornado loads is described in Reference 2.1.2-g.

5.3.3 Seismic Loads

The seismic loads considered in the FB design are those generated by the site-specific Safe Shutdown Earthquake (SSE).

The design seismic loads are determined from the site-specific soil-structure interaction (SSI) analysis results, which are described in the site-specific seismic analysis of the Reactor/Fuel Building Complex (Reference 2.1.2-k). Four components - two horizontal, one vertical, and one torsional - of the seismic loads are evaluated following the methodology used for the standard design of the FB in Reference 2.1.2-h. The out-of-plane loads due to horizontal SSE acceleration are considered as one of the horizontal components at walls, whose out-of-plane natural frequency is less than 50 Hz.

The design loads applied to the FB are shown in the following tables. Node numbers in the tables are described in Figure 5.3.3-1.

- Horizontal seismic loads and torsion: Table 5.3.3-1.
- Vertical seismic loads: Tables 5.3.3-2 and 5.3.3-3
- Out-of-plane accelerations at walls: Table 5.3.3-6

The equivalent out-of-plane acceleration loads on slabs and walls are based on Tables 4.5-1 and 4.5-2 of Reference 2.1.2-o. The details of calculation of the equivalent out-of-plane acceleration loads on slabs and walls are shown in Appendix D of Reference 2.1.2-k.

The following loads are also regarded as seismic loads, which are described in the Reactor Building Structural Design Report (Reference 2.1.2-p), and are considered in the FB design:

- Soil pressure due to an earthquake: Refer to Table 5.3.3-4.
- Sloshing loads in pools
  Hydrodynamic loads in the SFP due to SSE are shown in Table 5.3.3-5.

6. STRUCTURAL ANALYSIS AND DESIGN

6.1 General Description

The structural analysis and design of the FB are performed according to the following procedure.

1. Prepare a finite element (FE) model for stress analyses considering structural characteristics and materials.
   As stated in Section 3.1, the RB including RCCV and the FB are integrated into one

building in the ESBWR plant. Therefore, the FE model includes the RCCV, RB, and FB (RB/FB global FE model).

2. Perform stress analyses for the design loads described in Chapter 5, and calculate the section forces.
3. Select the basic and critical load combinations as the selected design load combinations for the FB design.
4. Combine the section forces according to the selected design load combinations mentioned in Step 3 above, which are described later in Section 6.3.
5. Perform structural design calculations using the section forces for the selected design load combinations.

The design/evaluation is essentially performed using ASME, Section III, Division 2. The details of the design/evaluations and the exceptions to the use of ASME, Section III, Division 2 are described in Section 6.4.1.1.

The design of steel structures in the FB is performed in accordance with AISC N690-1994.

6.2 Stress Analysis

An outline of the RB/FB global FE model analysis is summarized below since it is described in detail in the Reactor Building Structural Design Report, Reference 2.1.2-p.

6.2.1 Analysis Program

The computer program used for the stress analysis calculations is NASTRAN Version 2013.0.0. It is a general-purpose stress analysis program, which is technically based on the finite element method. Analysis calculations are executed on Red Hat Enterprise Linux Server release 5.7 OS.

6.2.2 Analysis Model

Figure 1-1 shows the global FE model, which consists of SHELL elements for plane members such as the basemat, the RCCV, walls, and slabs and BAR elements for linear members such as beams and columns.

Table 6.2.2-1 shows the material constants for the concrete and steel used in the analysis.

The Young's modulus for concrete used in the thermal load analysis is reduced depending on the average temperature of each element, as described in Note 2 of Table 6.2.2-1. Young's modulus for the RCCV steel liners is set to a small value, 1/10000 of the normal value, in analysis calculations for non-thermal loads so that they do not bear any stresses.

6.2.3 Method of Applying Loads

Refer to the Reactor Building Structural Design Report, Reference 2.1.2-p.

6.2.4 Analysis Results

Tables 6.2.4-1 through 6.2.4-5 show the element forces and moments of the selected elements. The locations of the selected elements are illustrated in Figures 6.2.4-1 through 6.2.4-5. The elements for tabulation are selected, in principle, from the center and both ends of wall and slab, where it is reasonably expected that the critical stresses appear based on engineering experience and judgment. Element forces and moments listed in the tables are defined with relation to the element coordinate system shown in Figure 6.2.4-6.

6.3 Load Combinations

6.3.1 Code Requirements

Reinforced concrete structures

The load combinations and associated load factors and acceptance criteria for reinforced concrete structures outside the containment are summarized in Table 6.3.1-1, which is in compliance with ACI 349-01 and SRP 3.8.4.

For the design of any structures which are integrated with the RCCV structures, the load combinations and associated load factors and acceptance criteria for the RCCV design are also considered. Therefore, Table 6.3.1-3, which is the load combination table for the RCCV design, is considered to the FB structures in addition to Table 6.3.1-1. Table 6.3.1-3 complies with ASME-2004.

Steel structures

The load combinations and associated load factors and acceptance criteria for steel structures outside the containment are summarized in Table 6.3.1-2, which is in compliance with AISC N690-1994 Code and SRP 3.8.4.

6.3.2 Selection of Design Load Combinations

Reinforced concrete structures

The following load combinations given in Tables 6.3.1-1 and 6.3.1-3 need not be considered, because of the reasons described for each of the load combinations in common with the RB.

No.	Reason
FB-C5	Stresses in the basemat and pool due to wind loads W are negligibly small, and the combination FB-C3 covers these combinations.
FB-C6 FB-C8	These combinations are almost identical to CV-5, CV-7, respectively.
FB-C9	This combination is almost identical to CV-11.
CV-2	Stresses in the basemat and pool due to wind loads W are negligibly small, and the combination CV-3 covers CV-2.

CV-4, 6	Stresses in the basemat and pool due to wind loads W or tornado loads Wt are negligibly small, and these combinations are not critical for their design.
CV-5	This combination is covered by CV-11.
CV-8, 9	These combinations are covered by CV-7.
CV-10	Stresses in the basemat and pool due to wind loads W are negligibly small, and the combination CV-7 covers CV-10.

Finally, the following load combinations are selected for reinforced concrete structures.

- FB-C1, FB-C2, FB-C3, FB-C4, FB-C7, CV-1, CV-3, CV-7, CV-11

Detailed design load combinations are determined in terms of load patterns for the selected load combinations. Load patterns include time of year for temperature loads, time after an accident for LOCA pressure/temperature loads, and load application patterns for hydrodynamic loads. The determined detail design combinations are shown in Table 6.3.2-1. The acceptance criteria for the selected combinations are also included in the tables. In addition, the load combinations selected as critical combinations in Appendix 3G of the ESBWR Design Control Document (DCD) are identified in the table.

Steel structures

Among the load combinations listed in Table 6.3.1-2, the following combination is negligible.

No.	Reason
FB-S1	This combination is covered by FB-S3.
FB-S2	This combination is covered by FB-S4.

The detail design combinations for the steel structures are shown in Table 6.3.2-2 together with acceptance criteria.

Some remarks concerning the determination of the detailed load combinations are mentioned below.

- Two kinds of temperature loads, summer and winter, are considered. Because of the uncertainties in the temperature loads, two combinations which are almost same but different in including the temperature load or not are always considered in the detailed load combinations.
- Seismic loads include the following.
  - Sloshing load of the spent fuel pool water
  - Dynamic increment of soil pressure

- Dynamic load, i.e. seismic loads and hydrodynamic loads are combined according to the SRSS method, as specified in Section 6.3.2 of RCCV Structural Design Report, Reference 2.1.2-p.
- For the tornado loads, the following combinations are considered in accordance with SRP 3.3.2.

  $W_t = W_w$

  $W_t = W_p$

  $W_t = W_w + 0.5W_p$

  where,

  W_w: Tornado wind load

  W_p: Tornado differential pressure load

6.3.3 Result of Load Combination

Tables 6.3.3-1 through 6.3.3-3 show the resultant combined forces and moments for the selected elements shown in Figures 6.2.4-1 through 6.2.4-5, which are calculated for several typical design load combinations selected from the combinations in Table 6.3.2-1.

Section forces due to the following loads are shown independently in the tables.

- OTHR: Loads other than temperature and seismic loads
- TEMP: Temperature loads
- SEIS: Seismic loads
- HYDR: Hydrodynamic loads

Element forces and moments listed in the tables are defined with relation to the element coordinate system shown in Figure 6.2.4-6.

6.4 Section Design Principles

6.4.1 Section Design of Reinforced Concrete Structures

The design/evaluation is essentially performed using ASME, Section III, Division 2. The details of the design/evaluations and the exceptions to the use of ASME, Section III, Division 2 are described in the following Sections. The design flow chart is shown in Figure 6.4.1-1.

6.4.1.1 Walls and Slabs

Section design calculations for reinforced concrete walls and slabs are carried out for the following section forces and it is confirmed that the results satisfy code requirements.

- Flexure and Membrane Forces

- Membrane Axial Forces
- Transverse Shear
- In-plane Shear Force

The evaluation method for each of the section forces is described in the following subsections.

6.4.1.1.1 Section Design for Flexure and Membrane Forces

Stress conditions of the FB structure sections are actually very complicated since the various forces, such as axial forces, in-plane shear, bending moments, and torsional moments, are applied simultaneously. It is difficult to estimate the section strength of the section under such a complicated stress condition by the equations which are normally used in the design calculation.

Therefore, stress calculations for flexure and membrane forces are performed by a computer program SSDP-2D. The program has the following characteristics.

- It calculates concrete and rebar stresses under two dimensional equilibrium conditions for six components of the section forces in a shell element – two axial forces, two bending moments, in-plane shear, and torsional moment.
- It takes concrete cracks into account in the stress calculation. Cracked concrete is assumed not to bear tensile forces.
- It assumes concrete and rebars to be perfectly elastic.
- It considers the reduction of thermal stresses due to the decreased stiffness of a cracked concrete section.
- Transverse shear is generated in an element but is not considered in the equilibrium conditions. Stresses of shear ties are not calculated with SSDP-2D. The design method for transverse shear is described in Section 6.4.1.1.3.

In calculations with SSDP-2D, section forces including in-plane shear force, axial forces and bending moments are considered simultaneously. In SSDP-2D, the compressive stress distribution of concrete is based on the linear distribution which is proportional to the strain distribution at the section. Moment capacity based on this condition is more conservative than the moment capacity specified in ACI 349-01which is based on the stress block for the compressive stress distribution of concrete. Therefore, the wall design with SSDP-2D is considered to be more conservative than the design specified in ACI 349-01. This is further demonstrated in Appendices B and C for separate ACI 349-01 check for in-plane shear and axial compression, respectively.

As for the thermal effects, section forces due to thermal loads, which are evaluated by NASTRAN analyses using uncracked concrete stiffness, are reduced considering the depth and direction of cracking in calculations with SSDP-2D. The cracked section properties are used in the calculation only for the cracked sections. Furthermore, compatibility between strain distribution in a section and internal forces including reduced thermal stress is examined under an assumed crack condition in calculations with SSDP-2D. The calculations are continued until the compatibility of strain and internal forces are satisfied. During the iterative calculations, redistribution of internal forces and strains are considered adequately.

Table 6.4.1.1-1 shows the material properties used for the stress calculation. Allowable stresses specified in CC-3420 of ASME-2004 are used in the design, since they are not defined in ACI 349-01. Tables 6.4.1.1-2 and 6.4.1.1-3 show the allowable stresses of concrete and rebar.

As specified in the Design Specification for Fuel Building (Reference 2.1.2-u), strengths of concrete and rebars are reduced taking effects of elevated temperatures into consideration.

Reduction of concrete strength due to high temperature, which is based on averaged temperature, Td, obtained from the heat transfer analysis, is determined based upon the average value of the following upper bound and lower bound equations.

- Lower bound reduction factor
  - $\phi = 1.0 - 0.0030\ (T-21.1)$ 21.1°C (70°F) $\leq T \leq$ 121.1°C (250°F)
  - $\phi = 0.70 - 0.00083\ (T-121.1)$ 121.1°C (250°F) $\leq T$
- Upper bound reduction factor
  - $\phi = 1.0$ $T \leq$ 260.0°C (500°F)
  - $\phi = 1.0 - 0.00081\ (T-260.0)$ 260.0°C (500°F) $\leq T$

Reduction of reinforcing steel strength is based upon the following equation.

- Reduction Factor
  - $\phi = 1.0 - 0.000873\ (T-21.1)$ 21.1°C (70°F) $\leq T \leq$ 204.4°C (400°F)

Allowable stresses listed in Tables 6.4.1.1-2 and 6.4.1.1-3 are reduced using these factors in calculations for load combinations including thermal loads.

6.4.1.1.2 Section Design for Membrane Compressive Forces

ASME-2004 specifies the allowable concrete stresses for membrane forces. It is necessary to confirm that the compressive stresses of the concrete due to membrane forces do not exceed the allowable stresses specified in CC-3420 of ASME-2004. Examinations for membrane compressive forces are also performed in the FB design in addition to examinations for flexure and membrane forces.

The principal membrane compressive stress σ_c, which is calculated by the following equation, is used for the evaluation.

$$\sigma_c = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau^2{}_{xy}}$$ (- for compression, + for tension)

$$\sigma_x = \frac{N_x}{h}$$

$$\sigma_y = \frac{N_y}{h}$$

$$\tau_{xy} = \frac{N_{xy}}{h}$$

where N_x: x-direction axial force per unit length (Tension is positive.)

N_y: y-direction axial force per unit length (Tension is positive.)

N_{xy}: in-plane shear force per unit length

h: element thickness

Table 6.4.1.1-4 shows the allowable membrane compressive stress of concrete. Reductions due to elevated temperatures described in Subsection 6.4.1.1.1 are applicable to these allowables.

6.4.1.1.3 Section Design for Transverse Shear

Section design calculations for transverse shear are performed according to ACI 349-01, Chapter 11. It requires that the shear force at a section and section strength satisfy the following equation.

$$V_u \le \phi(V_c + V_s)$$

where V_u: factored shear force at section per unit length

V_c: nominal shear strength provided by concrete per unit length

V_s: nominal shear strength provided by shear reinforcement per unit length

ϕ: strength reduction factor (=0.85)

The nominal shear strength provided by concrete, V_c, is calculated in accordance with Section 11.3.2 of ACI 349-01. The calculation method is shown in Figure 6.4.1.1-1. The nominal shear strength provided by shear reinforcement, V_s, is calculated by the following equation.

$$V_s = \rho_v f_y d, \quad V_s \le 8\sqrt{f_c'}d$$ (in English units)

where ρ_v: shear reinforcement ratio

f_y: specified yield strength of rebar

d: distance from extreme compression fiber to centroid of tension reinforcement

f_c': specified compressive strength of concrete

The transverse shear stress is evaluated in the direction of the maximum shear force, and the section forces for evaluation are calculated by the following equations.

$$V_u = \sqrt{Q_x^2 + Q_y^2}$$
$$M_u = M_x \sin^2\theta + M_y \cos^2\theta + 2M_{xy} \sin\theta \cos\theta$$
$$N_u = N_x \sin^2\theta + N_y \cos^2\theta + 2N_{xy} \sin\theta \cos\theta$$
$$\theta = \tan^{-1}(Q_x / Q_y)$$

In NASTRAN analyses, the transverse shear forces, i.e., Q_x and Q_y, are calculated independently in X and Y directions, respectively. The resultant transverse shear forces, i.e. the maximum transverse shear force (V_u), is calculated with SRSS method in order to consider transverse shear forces in two directions simultaneously. The value, θ means the direction of the maximum shear force. The values N_u and M_u are also evaluated in the direction of the maximum shear force.

6.4.1.2 Columns and Girders

Structural design of reinforced concrete columns and girders is performed according to the following principles.

- Section design is performed by confirming strength ratios are less than 1.0 for each component of section forces, i.e., axial force, bending moment and shear force. Strength ratios are calculated by dividing section forces by corresponding section strengths including strength reduction factors defined in ACI 349-01.
- Rebar arrangements are determined based on the results of section design calculations and according to structural specifications on rebar arrangements described in ACI 349-01.
- Section forces due to thermal loads are reduced considering concrete cracking.
- Section forces are evaluated at both ends of bar elements, which are used to model frame members in the FE stress analyses.
- Columns are designed in two principal directions. Bending moments and shear forces are assumed to act in each independent direction. Effects of the bi-axial bending are neglected in the design because the effects are required to be considered only for slender columns in the ACI code.

- Girders with slabs are designed only in the out-of-plane direction with regard to the slabs, since in-plane deformations are restricted. For the in-plane direction (weak-axis direction), skin rebars are arranged according to ACI standards, but section strengths are, in principle, not examined.

6.4.1.2.1 Strength Reduction Factor

Strength reduction factor ϕ is defined in ACI 349-01 as follows.

- Axial force with bending moment:

$$
{}_p\phi = \begin{cases} 0.90 & \left({}_p\phi \cdot P_n \leq 0\right) \\ 0.70 + 0.20\left(1 + \dfrac{{}_p\phi \cdot P_n}{P_m}\right) & \left(0 < {}_p\phi \cdot P_n < 0.1 f_c' A_g\right) \\ 0.70 & \left({}_p\phi \cdot P_n \geq 0.1 f_c' A_g\right) \end{cases}
$$

$$
P_m = \begin{cases} 0.1 f_c' A_g & \left(f_y \leq 60{,}000\,psi \text{ and } (h - d' - d_s)/h \geq 0.70\right) \\ \min\left(0.1 f_c' A_g, \quad {}_p\phi \cdot P_b\right) & \text{(others)} \end{cases}
$$

where:

P_n : nominal strength for axial force at given eccentricity

P_b: nominal axial load strength at balanced strain conditions

f'_c : specified compressive strength of concrete

A_g : gross area of section

f_y : specified yield strength of reinforcement

h : overall thickness of member

d' : distance from extreme compression fiber to centroid of compression reinforcement

d_s: distance from extreme tension fiber to centroid of tension reinforcement

- Shear force

${}_v\phi = 0.85$

6.4.1.2.2 Section Design for Axial Forces and Bending Moments

Section strengths for axial forces and bending moments are calculated based on the following assumptions, which conform to ACI 349-01, and on equilibrium conditions of section forces and conformity conditions of strains.

- Tensile strength and stiffness of concrete are ignored.

- Stress-strain relationship of concrete is perfectly elasto-plastic, in which design compressive strength is $0.85 f'_c$ (See Figure 6.4.1.2-1).
- Section forces due to thermal loads are reduced considering concrete cracks. The reduction method is in accordance with SSDP-2D, which is described in the Subsection 6.4.1.1.1.
- Design section strengths are obtained from section strengths and strength reduction factor ${}_p\phi$. Strength ratios are calculated, as illustrated in Figure 6.4.1.2-2, by dividing design section forces by design section strengths. Section design for axial force and bending moment is completed by confirming that strength ratios are less than 1.0 as follows.

  $P_u / {}_p\phi P_n < 1.0$ and $M_u / {}_p\phi M_n < 1.0$

6.4.1.2.3 Section Design for Shear Forces

It is confirmed that the following equation is satisfied in the section design for shear forces.

$$V_u \le {}_v\phi (V_c + V_s)$$

where

V_u : factored shear force at section

V_c : nominal shear strength provided by concrete

V_s : nominal shear strength provided by shear reinforcement

${}_v\phi$: strength reduction factor (=0.85)

Nominal shear strength provided by concrete, V_c, is evaluated as follows.

$N_u > 0$ (compression)

$$V_c = \min(V_{c1}, V_{c2})$$

$$V_{c1} = \left(1.9\sqrt{f_c'} + 2500\rho_w \frac{V_u \cdot d}{M_m}\right) b_w d$$

$$V_{c2} = 3.5\sqrt{f_c'} \cdot b_w d \sqrt{1 + \frac{N_u}{500 A_g}}$$

$$M_m = M_u - N_u \frac{(4h - d)}{8}$$

$$\text{if } M_m < 0,\ V_c = V_{c2}$$

$N_u < 0$ (tension)

$$V_c = 2\left(1 + \frac{N_u}{500A_g}\right)\sqrt{f_c'} \cdot b_w d$$

where:

V_c : nominal shear strength provided by concrete

f'_c : specified compressive strength of concrete

M_u : factored moment at section

N_u : factored axial load normal to cross section occurring simultaneously with V_u

V_u : factored shear force at section

ρ_w : ratio of shear reinforcement

b_w : width of section

d : distance from extreme compression fiber to centroid of longitudinal tension rebar

h : overall thickness of member

A_g : gross area of section

Nominal shear strength provided by shear reinforcement, V_s, is evaluated as follows.

$$V_s = \rho_w \cdot {}_r f_y \cdot b_w \cdot d \text{ and } V_s \leq 8\sqrt{f_c'} \cdot b_w \cdot d$$

where:

V_s : nominal shear strength provided by shear reinforcement

ρ_w : ratio of shear reinforcement

${}_r f_y$: specified yield strength of shear reinforcement

b_w : width of section

d : distance from extreme compression fiber to centroid of longitudinal tension rebar

f'_c : specified compressive strength of concrete

6.4.2 Section Design of Steel Structures

Section design of steel member is performed according to AISC N690-94. Steel members are examined by the evaluation method described in the following subsections.

The design flow of steel structures is almost same as the flow of reinforced concrete structures which is shown in Figure 6.4.1-1. However, reductions of thermal stresses are not considered for the steel design.

6.4.2.1 Section Design for Axial Compression and Bending

Steel members subjected to both axial compression and bending stresses shall be proportioned to satisfy the following requirements:

$$\frac{f_a}{F_a}+\frac{C_{mx}f_{bx}}{\left(1-\frac{f_a}{F'_{ex}}\right)F_{bx}}+\frac{C_{my}f_{by}}{\left(1-\frac{f_a}{F'_{ey}}\right)F_{by}}\le 1.0 \qquad (6.4.2\text{-}1)$$

$$\frac{f_a}{0.60F_y}+\frac{f_{bx}}{F_{bx}}+\frac{f_{by}}{F_{by}}\le 1.0 \qquad (6.4.2\text{-}2)$$

When $f_a/F_a \le 0.15$, Equation (6.4.2-3) is permitted in lieu of Equation (6.4.2-1) and (6.4.2-2):

$$\frac{f_a}{F_a}+\frac{f_{bx}}{F_{bx}}+\frac{f_{by}}{F_{by}}\le 1.0 \qquad (6.4.2\text{-}3)$$

In Equations (6.4.2-1), (6.4.2-2) and (6.4.2-3), the subscripts x and y, combined with subscripts b, m and e, indicate the axis of bending about which a particular stress or design property applies, and

F_a = Axial compressive stress that would be permitted if axial force alone existed, ksi

F_b = Compressive bending stress that would be permitted if bending moment alone existed, ksi

$$F'_e=\frac{12\pi^2E}{23(Kl_b/r_b)^2}$$

= Euler stress divided by a factor of safety, ksi (In the expression for F'_e, l_b is the actual unbraced length in the plane of bending and r_b is the corresponding radius of gyration. K is the effective length factor in the plane of bending.)

f_a = Computed axial stress, ksi

f_b = Computed compressive bending stress at the point under consideration, ksi

C_m = Coefficient whose value shall be taken as follows:

a. For compression members in frames subject to joint translation (sidesway), $C_m = 0.85$.

b. For rotationally restrained compression members in frames braced against joint translation and not subject to transverse loading between their supports in the plane of bending,

$C_m = 0.6 - 0.4\ (M_1/M_2)$.

where M_1/M_2 is the ratio of the smaller to larger moments at the ends of that portion of the member unbraced in the plane of bending under consideration. M_1/M_2 is positive when the member is bent in reverse curvature, negative when bent in single curvature.

c. For compression members in frames braced against joint translation in the plane of loading and subjected to transverse loading between their supports, the value of C_m may be determined by an analysis. However, in lieu of such analysis, the following values are permitted:

i. For members whose ends are restrained against rotation in the plane of bending .... $C_m = 0.85$

ii. For members whose ends are unrestrained against rotation in the plane of bending .... $C_m = 1.0$

6.4.2.2 Section Design for Axial Tension and Bending

Steel members subjected to both axial tension and bending stresses shall be proportioned at all points along their length to satisfy the following requirement:

$$\frac{f_a}{F_t}+\frac{f_{bx}}{F_{bx}}+\frac{f_{by}}{F_{by}}\leq 1.0 \qquad (6.4.2\text{-}4)$$

where f_b is the computed bending tensile stress, f_a is the computed axial tensile stress, F_b is the allowable bending stress and F_t is the governing allowable tensile stress.

6.4.2.3 Section Design for Transverse Shear

Steel members subjected to transverse shear stress shall be proportioned to satisfy the following requirement:

$$\frac{f_v}{F_v}\leq 1.0 \qquad (6.4.2\text{-}5)$$

where f_v is the computed shear stress and F_v is the governing allowable shear stress.

6.4.2.4 Allowable Stresses

6.4.2.4.1 Allowable Axial Tensile Stress

On the gross section of axially loaded tension members, the allowable stress is:

$$F_t = 0.60F_y \qquad (6.4.2\text{-}6)$$

where F_y is the specified minimum yield stress of the type of steel being used, ksi.

6.4.2.4.2 Allowable Axial Compressive Stress

On the gross section of axially loaded compression members, when *Kl/r*, the largest effective slenderness ratio of any unbraced segment is less than C_c, the allowable stress is:

$$F_a = \frac{\left[1 - \frac{(Kl/r)^2}{2C_c^2}\right]F_y}{\frac{5}{3} + \frac{3(Kl/r)}{8C_c} - \frac{(Kl/r)^3}{8C_c^3}} \qquad (6.4.2\text{-}7)$$

where

$$C_c = \sqrt{\frac{2\pi^2 E}{F_y}}$$

E = Modulus of elasticity of steel, ksi

On the gross section of axially loaded compression members, when *Kl/r* exceeds C_c, the allowable stress is:

$$F_a = \frac{12\pi^2 E}{23(Kl/r)^2} \qquad (6.4.2\text{-}8)$$

6.4.2.4.3 Allowable Bending Stress of W-shaped Members (Strong Axis Bending)

The allowable stress for the strong axis bending of W-shaped members is given according to the procedure shown in Figure 6.4.2-1.

6.4.2.4.4 Allowable Bending Stress of W-shaped Members (Weak Axis Bending)

The allowable stress for the weak axis bending of W-shaped members is given according to the procedure shown in Figure 6.4.2-2.

6.4.2.4.5 Allowable Bending Stress of Box Members

The allowable bending stress of box members is given according to the procedure.shown in Figure Figure 6.4.2-3.

6.4.2.4.6 Allowable Shear Stress

For $h/t_w \le 380/\sqrt{F_y}$, on the overall depth times the web thickness, the allowable shear stress is:

$$F_v = 0.40F_y \qquad (6.4.2\text{-}9)$$

For $h/t_w > 380/\sqrt{F_y}$, the allowable shear stress on the clear distance between flanges times the web thickness is:

$$F_v = \frac{F_y}{2.89}(C_v) \le 0.40F_y \qquad (6.4.2\text{-}10)$$

where

$$C_v = \frac{45000k_v}{F_y(h/t_w)^2} \text{ when } C_v \text{ is less than 0.8}$$

$$= \frac{190}{h/t_w}\sqrt{\frac{k_v}{F_y}} \text{ when } C_v \text{ is more than 0.8}$$

$$k_v = 4.00 + \frac{5.34}{(a/h)^2} \text{ when } a/h \text{ is less than 1.0}$$

$$= 5.34 + \frac{4.00}{(a/h)^2} \text{ when } a/h \text{ is more than 1.0}$$

t_w = thickness of web, in.
a = clear distance between transverse stiffeners, in.
h = clear distance between flanges at the section under investigation, in.

7. SUMMARY OF RESULTS

7.1 Required Section

Figures 7.1-1 through 7.1-4 shows typical sections of the FB concrete structures.

The steel members, i.e., steel girders at EL 22,500, are shown in Figure 7.1-5.

7.2 Provided Section

The sections of the FB structures that have been provided are identical to the required sections described in Section 7.1.

7.3 Tabulation of Allowable Stresses versus Calculated Stresses

7.3.1 Reinforced Concrete Structure

7.3.1.1 Walls and Slabs

7.3.1.1.1 Calculations for Flexure and Membrane Forces

The stresses of the concrete and reinforcing steel are calculated for flexure and membrane forces. The calculations are performed for the selected design load combinations shown in Table 6.3.2-1, and it is confirmed that all values are less than their allowable stresses, except for the exterior wall at EL 4,650 to EL 6,600 with 3% exceedance. This exceedance is evaluated based on the moment capacity according to ASME-2004, conservatively. As shown in Figure 7.3.1.1-1, it is confirmed that the load demands are within the moment capacity of wall according to the specifications of ACI 349-01.

The calculation results for the selected elements shown in Figures 6.2.4-1 through 6.2.4-5 are given in this report. The thicknesses and the rebar arrangements of selected element are shown in Table 7.3.1.1.1-1. The arrangements of reinforcements and shear ties at the exterior wall on columns FA and FF at EL 4,650 to EL 6,600 are updated from standard design as shown in red in Table 7.3.1.1.1-1.

Calculated stresses and allowable stresses are compared in Tables 7.3.1.1.1-2 through 7.3.1.1.1-4 for several load combinations.

Table 7.3.1.1.1-5 shows a summary of the maximum stress ratios, which are ratios of the maximum stresses to the allowable stresses.

For shear walls and Spent Fuel Pool walls, the maximum stress of vertical rebar is found to be 257.3 MPa (37.30 ksi) at Section 2 due to the load combination FB-9 against the allowable stress of 372.2 MPa (53.97 ksi) as shown in Table 7.3.1.1.1-4. The maximum stress of horizontal rebar is found to be 333.3 MPa (48.33 ksi) at Section 2 for the combination FB-9 against the allowable stress of 372.2 MPa (53.97 ksi) as shown in Table 7.3.1.1.1-4. The maximum concrete stress is found to be -22.1 MPa (-3.20 ksi), which occurs at Section 3 due to load combination FB-9 against the allowable stress of -29.3 MPa (-4.25 ksi), as shown in Table 7.3.1.1.1-4.

For floor slabs, the maximum rebar stress of 133.5 MPa (19.36 ksi) is found due to the load combination FB-9 against the allowable stress of 372.2 MPa (53.97 ksi) as shown in Table 7.3.1.1.1-4. The maximum concrete stress is found to be -8.7 MPa (-1.26 ksi) due to load combination FB-9 against the allowable stress of -29.3 MPa (-4.25 ksi), as shown in Table 7.3.1.1.1-4.

For foundation mat, the maximum rebar stress is found to be 111.5 MPa (16.17 ksi) due to the load combination FB-9 against the allowable stress of 367.2 MPa (53.24 ksi) as shown in Table 7.3.1.1.1-4. The maximum concrete stress is found to be -7.0 MPa (-1.02 ksi) due to load combination FB-9 against the allowable stress of -22.9 MPa (-3.32 ksi), as shown in Table 7.3.1.1.1-4.

7.3.1.1.2 Calculations for Membrane Compressive Forces

The compressive stress of concrete is calculated for membrane forces. The calculations are performed for the selected design load combinations shown in Table 6.3.2-1, and it is confirmed that the values are less than the allowable stress.

Table 7.3.1.1.2-1 gives a summary of the maximum compressive stresses for selected elements shown in Figures 6.2.4-1 through 6.2.4-5.

For shear walls and Spent Fuel Pool walls, the maximum compressive stress of -9.094 MPa (-1.319 ksi) is found at Section 1 against the allowable stress of -25.9 MPa (-3.756 ksi) as shown in Table 7.3.1.1.2-1.

For floor slabs, the maximum compressive stress of -3.689 MPa (-0.535 ksi) is found against the allowable stress of -25.9 MPa (-3.756 ksi) as shown in Table 7.3.1.1.2-1.

For foundation mat, the maximum compressive stress of -2.576 MPa (-0.374 ksi) is found against the allowable stress of -16.6 MPa (-2.407 ksi) as shown in Table 7.3.1.1.2-1.

7.3.1.1.3 Calculations for Transverse Shear

The transverse shear strength is calculated and compared with shear forces generated by design loads. The calculations are performed for the selected design load combinations shown in Table 6.3.2-1, and it is confirmed section forces are less than the shear strength of sections.

Table 7.3.1.1.3-1 gives a summary of the examinations for selected elements shown in Figures 6.2.4-1 through 6.2.4-5. Table 7.3.1.1.3-2 shows the calculation results for the load combinations selected for the DCD that are indicated in Table 6.3.2-1.

For shear walls and Spent Fuel Pool walls, the maximum transverse shear force is found to be 4.04 MN/m (23.1kips/in) against the shear strength of 11.08 MN/m (63.25 kips/in) at Section 1, Exterior Wall and Pool Wall as shown in Table 7.3.1.1.3-2.

For floor slabs, the maximum transverse shear force is found to be 0.97 MN/m (5.54 kips/in) against the shear strength of 4.35 MN/m (24.8 kips/in) as shown in Table 7.3.1.1.3-2.

For foundation mat, the maximum transverse shear force is found to be 5.35 MN/m (30.54 kips/in) against the shear strength of 16.05 MN/m (91.62 kips/in) as shown in Table 7.3.1.1.3-2.

7.3.1.2 Columns and Beams

Design section strengths for axial forces, bending moments, and shear forces are calculated, and compared with section forces and moments generated by design loads. The calculations are performed for the selected design load combinations shown in Table 6.3.2-1, and it is confirmed that all design section forces and moments are less than design section strengths.

The calculation results for the selected elements shown in Figure 7.3.1.2-1 are given in this report.

Tables 7.3.1.2-1 and 7.3.1.2-2 give a summary of the maximum strength ratios, which are defined in Subsection 6.4.1.2.

7.3.2 Steel Structure

The stresses of the steel members are combined in accordance with Table 6.3.2-2, and it is confirmed that all values are less than the allowable stresses.

Table 7.3.2-1 lists the calculation results of the selected sections included in Figure 7.3.1.2-1. The stress ratios of the design stresses against their allowable stresses shown in the tables are the maximum ratios among all the load combinations.

8. CONCLUSIONS

The site-specific stress check calculations for the FB structure are performed to evaluate the structural integrity of the FB at the NA3 site per the specifications of ACI 349-01, ASME-2004, and AISC N690-1994, following the same methodology as that used for the standard design. The stress checks are based on the results of the RB/FB global model analyses for the site-specific seismic loads combined together with the non-seismic load results according to site-specific seismic load combinations. The conclusions from the site-specific stress checks are summarized as follows:

- Reinforced concrete walls and slabs
  - The stresses of the concrete and rebar are less than the allowable stresses specified in the code, except for the exterior wall at EL 4,650 to EL 6,600 with 3% exceedance. This exceedance is evaluated based on the moment capacity according to ASME-2004, conservatively. As shown in Figure 7.3.1.1-1, it is confirmed that the load demands are within the moment capacity of wall according to the specifications of ACI 349-01. The arrangements of reinforcement at the exterior wall at EL 4,650 to EL 6,600 are updated from the standard design as shown in red in Table 7.3.1.1.1-1.
  - The sections have enough strength to bear transverse shear forces generated by design loads. The arrangements of shear ties at the exterior wall at EL 4,650 to EL 6,600 are updated from the standard design as shown in red in Table 7.3.1.1.1-1.
- Reinforced concrete columns and girders
  - The sections have enough strength to bear axial forces, bending moments, and shear forces generated by design loads.
- Steel structures

- The stresses of steel members are less than the allowable stresses specified in the code.

The comparison between NA3 and the standard design is shown in Appendix A.

In addition, the following structural evaluations are performed for the FB separately:

- The stability of the RB/FB at the NA3 site is demonstrated to resist the dynamic load demand without the shear keys that are part of the standard design of the RB/FB, as described in the "Reactor/Fuel Building Complex Stability Analysis Report," Reference 2.1.2-l.
- Tornado missile impact assessment is shown in Reference 2.1.2-g.

Therefore, it can be concluded that the FB structure is adequately designed to resist the NA3 site-specific SSE loads in combination with non-seismic standard plant loads.

Table 3.1-1 Key Dimensions of RB and FB

Building	Dimension		Notes
Reactor Building	Story	six stories (above grade) three stories (below grade)	The design plant grade is 16.15 m from the top of basemat
	Plan	49.0 m × 49.0 m (below EL 34.0 m) 49.0 m x 39.0 m (above EL 34.0 m)	
	Height	64.2 m	From the top of the basemat
Fuel Building	Story	one story (above grade) three stories (below grade)	(excluding the penthouse) The design plant grade is 16.15 m from the top of basemat
	Plan	21.0 m × 49.0 m	
	Height	34.0 m	From the top of the basemat (excluding the penthouse)
Common	Thickness of Basemat	4.0 m	The thickness is increased to 5.1 m inside of the RPV Pedestal and 5.5 m at the bottom of the Spent Fuel Pool.

Table 5.1.1-1 Dead Loads of Equipment in FB

Elevation (m)	Item No.*	Description	Weight unit (kN)	qt.	margin	Sum up (kN)	Area Load (kN/m²)
-11.50	F-1	Skimmer Tank	353	1	0.2	424	
	F-2	Spent Fuel Racks	16,239	1	0.2	19487	
	F-3	Spent Fuel Cask					120
	F-4	Fuel and Auxiliary Pools Cooling Backwash Tank Room	353	1	0.2	424	
	F-5	Fuel and Auxiliary Pools Cooling Heat Exchange Room	236	1	0.2	284	
	F-6	Sump Room	95	1	0.2	114	
	F-7	Fuel and Auxiliary Pools Cooling Transfer Pump Room	17	2	0.2	41	
	F-8	Fuel and Auxiliary Pools Cooling Pump Room	112	1	0.2	134	
-6.40	F-11	Fuel and Auxiliary Pools Cooling Filter/Demineralizer Vault	142	2	0.2	341	
	F-12	FAPC Holding Pump Room	37	1	0.2	45	
	F-13	Control Rod Drive Maintenance Area	49	1	0.2	59	
	F-14	Control Rod Drive Maintenance Control Panel Room	38	1	0.2	46	
	F-15	Control Rod Drive Motor Test Room	98	1	0.2	118	
-1.00	F-21	New Fuel Prep Machine Pit	12	1	0.2	15	
4.65	CR-1	Fuel Handling Machine	343	1	0.2	412	
13.57	CR-2	Fuel Building Crane	1079	1	0.2	1295	
	CR-3	Lifted Load	1750	1	-	1750	
22.50	F-61a	HVAC Penthouse	112	2	0.2	269	
	F-61b	HVAC Penthouse	112	2	0.2	269	
	F-61c	HVAC Penthouse	174	2	0.2	416	
	F-61d	HVAC Penthouse	322	2	0.2	772	
	F-61e	HVAC Penthouse	292	2	0.2	701	

General Note: The values shown in this table are based on the following Design Specifications.
26A6605 Design Specification for Concrete Containment, Rev. 3
26A6606 Design Specification for Reactor Building, Rev. 2
26A6608 Design Specification for Fuel Building, Rev. 1

Note *: Refer to Figures 5.1.1-1 through 5.1.1-9 of Reference 2.1.2-p.

Table 5.1.1-2 Miscellaneous Structures, Piping, and Commodities on the Slabs

Elevation (m)	Piping Area Load (kN/m^2)	Note
27.50	0.0	FB roof slab of penthouse
22.50	2.4	
4.65	2.4	
-1.00	2.4	
-6.40	2.4	
-11.50	2.4	

Table 5.1.2-1 Floor Live Loads

Elevation (m)	Area Load (kN/m^2)	Remarks
27.50	2.9	FB roof slab of penthouse
22.50	2.9	
4.65	4.8	
-1.00	4.8	
-6.40	4.8	
-11.50	4.8	

Table 5.1.2-2 Design Lateral Soil Pressure at-Rest

Elevation (m)	Soil Pressure (kN/m^2)			Note
	RB on R1 column-row Wall	FB on FA column-row Wall	Other Walls	
4.65	11.0	175.4	11.0	Design plant grade
4.04	21.9	186.3	21.9	Water level
-1.00	127.7	292.1	127.7	
-4.20	194.9	359.3	194.9	Bottom level of basemat of TB
-4.20	457.9			
-6.40	504.1	405.5	241.0	
-11.50	611.1	512.5	348.1	
-15.50	695.1	596.5	432.0	Bottom level of basemat

Table 5.2.2-1 Steady State Temperature Conditions

Region	Temperature (°C)		Note
	Summer	Winter	
Rooms	40.0	10.0	
Spent Fuel Pool	48.9	48.9	
Air	46.1	-40.0	
Ground	15.5	15.5	

Table 5.2.2-2 Thermal Loads for Shell Elements Normal Operation: Summer

Location	Index	Boundary*		Thickness	Td	Tg	note
		1	2	(mm)	(°C)	(°C)	
Basemat	BM1	RM	GR	4000	27.07	23.15	General
	BM6	FP	GR	5500	32.20	33.40	below Spent Fuel Pool
	BM7	FP	GR	4000	32.20	33.40	Skimmer Surge Tank
Spent Fuel Pool Wall	FP7	FP	RM	1500	45.05	7.70	
	FP8	FP	RM	1900	44.94	7.92	
	FP9	FP	RM	1750	44.97	7.85	around Skimmer Surge Tank
	FP10	FP	RM	2000	44.91	-7.96	
	FP11	FP	FP	1900	48.90	0.00	
	FP12	FP	FP	1750	48.90	0.00	between Skimmer Surge Tanks
Outer Wall	BW1	RM	GR	2000	26.47	21.94	below Grade General
	BW5	FP	GR	2000	32.19	33.39	below Grade Spent Fuel Pool
	BW6	FP	GR	3600	32.20	33.39	
	GW9	RM	AT	1000	43.49	-4.77	EL 27000 to Room
Inner Wall	IW1	RM	RM		40.00	0.00	General
Slab	SL1	RM	RM		40.00	0.00	General
	SL8	RM	AT	700	43.63	-4.36	FB Roof at EL 22500

*: RM: Room FP: Spent Fuel Pool
GR: Ground AT: Outside Air

Table 5.2.2-3 Thermal Loads for Shell Elements Normal Operation: Winter

Location	Index	Boundary*		Thickness	Td	Tg	note
		1	2	(mm)	(°C)	(°C)	
Basemat	BM1	RM	GR	4000	12.90	-5.20	General
	BM6	FP	GR	5500	32.20	33.40	below Spent Fuel Pool
	BM7	FP	GR	4000	32.20	33.40	Skimmer Surge Tank
Spent Fuel Pool Wall	FP7	FP	RM	1500	32.07	33.63	
	FP8	FP	RM	1900	31.58	34.62	
	FP9	FP	RM	1750	31.74	34.30	around Skimmer Surge Tank
	FP10	FP	RM	2000	31.48	-34.82	
	FP11	FP	FP	1900	48.90	0.00	
	FP12	FP	FP	1750	48.90	0.00	between Skimmer Surge Tanks
Outer Wall	BW1	RM	GR	2000	13.04	-4.93	below Grade General
	BW5	FP	GR	2000	32.19	33.39	below Grade Spent Fuel Pool
	BW6	FP	GR	3600	32.20	33.39	
	GW9	RM	AT	1000	-18.80	39.27	EL 27000 to Room
Inner Wall	IW1	RM	RM		10.00	0.00	General
Slab	SL1	RM	RM		10.00	0.00	General
	SL8	RM	AT	700	-19.97	35.96	FB Roof at EL 22500

*: RM: Room FP: Spent Fuel Pool
GR: Ground AT: Outside Air

Table 5.2.2-4 Design Basis Accident Temperatures in Spent Fuel Pool

Time		Temperature
(hr.)	(sec)	(°C)
0.00	0	48.9
0.06	200	49.2
0.28	1000	50.5
0.50	1800	51.8
1.00	3600	54.7
5.00	18000	77.7
8.86	31900	100.0
10.00	36000	100.0
20.00	72000	100.0
72.00	259200	100.0

Note: DBA for the spent fuel pool is due to loss of Fuel and Auxiliary Pools Cooling System (FAPCS) cooling function.

The temperature after 8.86hrs. correspond to the spent fuel pool temperature at 100 °C (212 °F), which is slightly less than the 104 °C (219 °F) water boiling temperature. The slight 4% increase in the spent fuel pool temperature is negligible to the design of the spent fuel pool structure. This is because there are sufficient stress margins in accordance with Tables 7.3.1.1.1-5, 7.3.1.1.2-1, and 7.3.1.1.3-1, even if the total combined stresses were increased by 4%, which would be very conservative since stresses other than thermal in the load combination do not increase.

Table 5.2.2-5 Thermal Loads for Shell Elements around Spent Fuel Pool: 72 hr. after DBA: Summer

Location	Index	Boundary*		Thickness	Td	Tg	note
		1	2	(mm)	(°C)	(°C)	
Basemat	BM6	FP	GR	5500	36.74	56.83	below Spent Fuel Pool
	BM7	FP	GR	4000	38.45	63.68	Skimmer Surge Tank
Spent Fuel Pool Wall	FP7	FP	RM	1500	61.65	57.12	
	FP8	FP	RM	1900	58.10	54.97	
	FP9	FP	RM	1750	59.26	56.04	around Skimmer Surge Tank
	FP10	FP	RM	2000	57.42	-54.16	
	FP11	FP	FP	1900	75.29	0.00	
	FP12	FP	FP	1750	77.51	0.00	between Skimmer Surge Tanks
Outer Wall	BW5	FP	GR	2000	44.70	79.61	below Grade Spent Fuel Pool
	BW6	FP	GR	3600	39.14	66.16	

*: RM: Room FP: Spent Fuel Pool
GR: Ground AT: Outside Air

Table 5.2.2-6 Thermal Loads for Shell Elements around Spent Fuel Pool: 72 hr. after DBA: Winter

Location	Index	Boundary*		Thickness	Td	Tg	note
		1	2	(mm)	(°C)	(°C)	
Basemat	BM6	FP	GR	5500	36.74	56.83	below Spent Fuel Pool
	BM7	FP	GR	4000	38.45	63.68	Skimmer Surge Tank
Spent Fuel Pool Wall	FP7	FP	RM	1500	48.67	83.06	
	FP8	FP	RM	1900	44.74	81.67	
	FP9	FP	RM	1750	46.02	82.49	around Skimmer Surge Tank
	FP10	FP	RM	2000	43.99	-81.01	
	FP11	FP	FP	1900	75.29	0.00	
	FP12	FP	FP	1750	77.51	0.00	between Skimmer Surge Tanks
Outer Wall	BW5	FP	GR	2000	44.70	79.61	below Grade Spent Fuel Pool
	BW6	FP	GR	3600	39.14	66.16	

*: RM: Room FP: Spent Fuel Pool
GR: Ground AT: Outside Air

Table 5.3.1-1 Design Wind Pressure Loads by Floor Level

Height (m)		Design Wind Load (kN/m²)			
EL	Z	Windward Wall	Leeward Wall	Side Wall	Roof
52.40	47.75	3.13	-2.20	-2.82	-3.87
34.00	29.35	2.93	-2.20	-2.82	-3.87
27.00	22.35	2.82	-2.20	-2.82	
17.50	12.85	2.62	-2.20	-2.82	
13.57	8.92	2.50	-2.20	-2.82	
9.22	4.57	2.30	-2.20	-2.82	
9.06	4.41	2.30	-2.20	-2.82	
4.65	0.00	2.30	-2.20	-2.82	

	zg	700	ft
	α	11.5	
Importance factor	I	1.15	
Basic wind speed	V	62.59	m/s
Wind directionality factor	Kd	0.85	

Coef.	Wall			Roof
	Windward	Leeward	Side	
G	0.85			
Cp	0.8	-0.5	-0.7	-1.04
GCpi	-0.18	0.18	0.18	0.18

Table 5.3.2-1 Design Pressure of Tornado Wind Load

Wind Direction	Building	p (kN/m²)			
		Wall			Roof
		Windward	Leeward	Side	
All	RB/FB	5.6	-3.5	-4.9	-7.3
Differential		16.5	16.5	16.5	16.5

Table 5.3.3-1 Design Seismic Loads for Horizontal SSE (RB and FB Walls)

Elev. (m)	Elem No.	Node No.	Shear X-Dir. (MN)	Shear Y-Dir. (MN)	Moment X-Dir. (MN-m)	Moment Y-Dir. (MN-m)	Calculated Torsion (MN-m)	Accidental Torsion (MN-m)	Design Torsion (MN-m)
52.40*	1110	110			2724	2143			
			192.2	140.0	5838	4488	1284	471	1755
34.00	1109	109			8196	5821			
			173.2	113.9	8719	6389	1938	424	2362
27.00	1108	108			9400	7162			
			396.0	259.4	9599	7958	2799	1321	4120
22.50	1107	107			11216	8328			
			436.4	291.8	11424	9227	4678	1486	6164
17.50	1106	106			12105	9408			
			438.4	343.5	12349	10195	4023	1535	5557
13.57	1105	105			12839	10255			
			450.7	363.7	13651	11216	4211	1578	5788
9.06	1104	104			13904	11338			
			454.6	383.4	15231	12506	4694	1591	6285
4.65	1103	103			9392	6302			
			454.7	360.1	10952	7759	5248	1591	6839
-1.00	1102	102			6545	4819			
			240.0	226.6	7303	5358	2718	840	3558
-6.40	1101	101			4748	3351			
-11.50		2	237.7	200.4	5053	3356	2079	832	2910

Note: RB/FB Seismic Analyses Bounding Results and In-Structure Response Spectra. (Table 4.1-1 of Reference 2.1.2-o)

The node numbers in this table are described in Figure 5.3.3-1.

* The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.

Table 5.3.3-2 Maximum Vertical Accelerations (RB and FB Walls and Floor Slab)

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
52.4*	110	RBFB	1.56
34.00	109	RBFB	1.20
27.00	108	RBFB	1.02
22.50	107	RBFB	0.92
17.50	106	RBFB	0.80
13.57	105	RBFB	0.72
9.06	104	RBFB	0.62
4.65	103	RBFB	0.56
-1.00	102	RBFB	0.57
-6.40	101	RBFB	0.52
-11.50	2	RBFB	0.51
-15.50	1	RBFB	0.52

Note: RB/FB Seismic Analyses Bounding Results and In-Structure Response Spectra. (Table 4.2-1 of Reference 2.1.2-o)
The node numbers in this table are described in Figure 5.3.3-1.
* The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.

Table 5.3.3-3 Enveloping Maximum Vertical Acceleration: RBFB Flexible Slab Oscillators

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
52.4*	9101	Oscillator	0.33
	9102	Oscillator	1.33
	9103	Oscillator	6.27
	9104	Oscillator	2.62
	9105	Oscillator	2.42
	9106	Oscillator	3.74
	9107	Oscillator	3.22
	9108	Oscillator	2.50
	9109	Oscillator	1.53
34.00	9091	Oscillator	1.61
	9092	Oscillator	1.61
	9093	Oscillator	1.12
27.00	9081	Oscillator	1.64
	9082	Oscillator	1.52
	9083	Oscillator	1.30
	9084	Oscillator	1.67
	9085	Oscillator	1.46
	9086	Oscillator	1.12
	9087	Oscillator	1.03
22.50	9071	Oscillator	1.15
	9072	Oscillator	1.79
	9073	Oscillator	4.47
	9074	Oscillator	1.67
	9075	Oscillator	1.51
	9076	Oscillator	1.65
17.50	9061	Oscillator	3.65
	9062	Oscillator	2.62
	9063	Oscillator	1.17
	9064	Oscillator	2.56
	9065	Oscillator	1.28
	99064	Oscillator	0.99
	9066	Oscillator	1.09
	9067	Oscillator	0.91

Note: Bounding Equivalent Out-of-plane Acceleration Loads on Slabs are shown in RB/FB Seismic Analyses Bounding Results and In-Structure Response Spectra. (Table 4.2-1 of Reference 2.1.2-o)
* The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.

Table 5.3.3-3 Enveloping Maximum Vertical Acceleration: RBFB Flexible Slab Oscillators (Continued)

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
13.57	9051	Oscillator	1.11
	9052	Oscillator	1.25
	9053	Oscillator	0.99
	9054	Oscillator	0.83
9.06	9041	Oscillator	1.02
	9042	Oscillator	1.26
	9043	Oscillator	0.93
	9044	Oscillator	0.80
4.65	9031	Oscillator	1.62
	9032	Oscillator	0.89
	9033	Oscillator	1.12
	9034	Oscillator	1.81
	9035	Oscillator	1.09
	9036	Oscillator	0.94
	9037	Oscillator	0.82
-1.00	9021	Oscillator	0.97
	9022	Oscillator	2.07
	9023	Oscillator	0.98
	9024	Oscillator	1.12
	9025	Oscillator	1.21
	9026	Oscillator	1.63
	9027	Oscillator	0.93
	9028	Oscillator	0.96
	9029	Oscillator	1.30
	9030	Oscillator	0.87
-6.40	9011	Oscillator	0.84
	9012	Oscillator	1.17
	9013	Oscillator	1.52
	9014	Oscillator	1.19
	9015	Oscillator	1.03

Note: Bounding Equivalent Out-of-plane Acceleration Loads on Slabs are shown in RB/FB Seismic Analyses Bounding Results and In-Structure Response Spectra. (Table 4.2-1 of Reference 2.1.2-o)

Table 5.3.3-4 Soil Pressure Due to an Earthquake

Elevation (m)	Soil Pressure (MPa) F3 Wall	Soil Pressure (MPa) FA and FF Wall	Note
4.65			Grade
	0.56	0.45	
-1.00			
	0.28	0.29	
-6.40			
	0.24	0.22	
-11.50			
	0.94	0.76	
-15.50			

Table 5.3.3-5 Sloshing Loads in the Spent Fuel Pool

NS Motion				EW Motion				Vertical Motion		
Wall		Floor		Wall		Floor		Wall		Floor
Depth d/H	Pressure (kN/m^2)	Distance x/(L/2)	Pressure (kN/m^2)	Depth d/H	Pressure (kN/m^2)	Distance x/(L/2)	Pressure (kN/m^2)	Depth d/H	Pressure (kN/m^2)	Pressure (kN/m^2)
0.0	12.3	0.0	0.0	0.0	11.8	0.0	0.0	0.0	0.0	98.5 for all floor area
0.2	23.6	0.2	7.4	0.2	24.2	0.2	8.5	0.2	19.7	
0.4	37.8	0.4	15.2	0.4	40.0	0.4	17.5	0.4	39.4	
0.6	44.6	0.6	23.7	0.6	49.4	0.6	27.4	0.6	59.1	
0.8	45.2	0.8	33.6	0.8	52.2	0.8	38.7	0.8	78.8	
1.0	45.2	1.0	45.2	1.0	52.2	1.0	52.2	1.0	98.5	

Note 1: "d" is a depth from the top of water. "H" is water height of the pool (14.35 m).

2: "x" is a distance from the center of the pool. "L" is width of the pool.

3: Floor pressure due to vertical motion is reference only. It is already included in vertical seismic loads for the floor.

Table 5.3.3-6 Enveloping Maximum Horizontal Acceleration: RBFB Wall Out-of-plane Oscillators

Elev. (m)	Node No.	Stick Model	Max. Horizontal Acceleration (g)	Portion
42.00 (X-dir)	99981	Oscillator	2.71	R1 and R7 walls
	99982	Oscillator	1.54	
	99986	Oscillator	0.89	
42.00 (Y-dir)	99983	Oscillator	1.86	RB and RF walls
	99984	Oscillator	1.02	
	99985	Oscillator	1.00	
	99987	Oscillator	0.59	
30.50 (X-dir)	99991	Oscillator	0.58	R1 and R7 walls
30.50 (Y-dir)	99992	Oscillator	0.56	RB and RF walls
13.57 (X-dir)	99971	Oscillator	2.11	F3 walls
	99972	Oscillator	2.29	
	99973	Oscillator	1.88	
	99974	Oscillator	1.13	
	99977	Oscillator	0.89	
13.57 (Y-dir)	99975	Oscillator	2.16	FA and FF walls
	99976	Oscillator	0.93	
	99978	Oscillator	0.97	

Note: Bounding Equivalent Out-of-plane Acceleration Loads on Walls are shown in RB/FB Seismic Analyses Bounding Results and In-Structure Response Spectra. (Table 4.5-2 of Reference 2.1.2-o)

Table 6.2.2-1 Material Constants Used in Stress Analysis

		Temperature (°C)	Reinforced Concrete: Basemat f'c=4000psi 27.6MPa	Reinforced Concrete: Others f'c=5000psi 34.5MPa	Steel: Carbon Steel Liner	Steel: Stainless Steel Liner	Steel: Structural Steel	Note
Young's Modulus (MPa)	Thermal Loads[*2]	<21	2.49E+04	2.78E+04	2.00E+05			Concrete: See Notes 1 & 2.
		93	1.81E+04	2.03E+04				
		204	1.62E+04	1.81E+04				
	Other Loads[*1]		2.49E+04	2.78E+04	2.00E+01		2.00E+05	
Poisson's Ratio			0.17		0.3			
Thermal Expansion (m/m°C)			9.90E-06		1.17E-05	1.52E-05	1.17E-05	
Weight Density (MN/m^3)			0.0235		0.0770			

Note *1: Young's modulus of concrete is calculated in accordance with ACI 349-01, Section 8.5.1. $Ec = 57{,}000\sqrt{f_c'}$

*2: Reduction factors of Young's modulus for concrete are determined based upon the average values of the following upper bound and lower bound equations. (See table and figure below.)

Lower bound:

$$\phi = 1.0 - 0.0038(T-70) \qquad 70^\circ F \le T \le 200^\circ F$$

$$= 0.50 - 0.0005(T-200) \qquad 200^\circ F \le T$$

Upper bound:

$$\phi = 1.0 - 0.00031(T-70) \qquad 70^\circ F \le T \le 400^\circ F$$

$$= 0.90 - 0.00084(T-400) \qquad 400^\circ F \le T$$

Table 6.2.4-1 Results of NASTRAN Analysis, Dead Load

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	-0.483	-1.787	-0.532	-0.161	-1.151	-0.028	-0.097	-0.367
	60219	0.334	-1.569	-0.302	-0.653	-0.827	-0.170	0.032	0.289
	70201	0.298	-0.173	0.000	0.499	-0.014	0.116	-0.273	0.073
	70204	0.425	-1.009	0.028	-0.227	-0.053	0.122	-0.003	-0.358
	110718	0.325	-1.358	-0.067	-0.050	0.085	0.008	0.036	0.190
2 Exterior Wall @ EL4.65 ~6.60m	62011	0.088	-1.040	0.070	0.043	0.145	0.010	0.010	0.056
	62019	0.125	-0.628	-0.192	-0.032	0.047	-0.031	-0.001	0.021
	72001	0.110	-0.170	0.106	0.106	0.020	-0.006	-0.015	-0.005
	72004	0.146	-0.452	0.196	-0.038	0.004	0.001	-0.016	0.014
3 Exterior Wall @ EL22.50 ~24.60m	64011	0.093	-0.287	-0.091	-0.110	-0.533	-0.004	-0.005	0.075
	64019	-0.109	-0.369	-0.067	-0.061	-0.371	0.053	0.063	0.063
	74001	-0.016	-0.049	0.093	0.049	-0.045	-0.046	-0.020	-0.029
	74004	-0.054	-0.212	0.089	-0.078	-0.336	-0.061	0.019	-0.069
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	0.603	-1.255	-0.494	-1.105	-0.819	-0.250	-0.006	-0.070
	70801	0.676	-0.155	0.010	1.075	0.074	-0.015	-0.548	0.031
	70804	0.581	-0.753	0.130	-0.561	-0.466	0.064	-0.097	0.045
	110748	0.225	-1.010	-0.442	-0.184	-0.081	-0.008	0.073	-0.025
5 Basemat	90306	-1.088	-0.435	0.523	0.940	-0.124	0.178	-0.539	1.189
	90310	-0.133	-0.122	-0.042	-0.153	-0.153	-0.696	0.169	-0.067
	90410	-0.454	-0.926	0.533	-0.714	0.165	1.501	1.398	-0.065
5 Basemat @ Spent Fuel Pool	90486	0.294	0.018	0.092	3.622	2.380	0.281	-0.180	0.125
	90490	0.429	0.186	0.284	1.433	1.263	0.508	1.201	0.262
	90526	0.518	0.486	0.013	1.991	2.124	0.124	-0.229	-0.799
6 Slab EL4.65m	93306	0.191	0.019	0.024	0.048	-0.004	0.005	0.031	-0.099
	93310	0.039	0.054	0.232	0.032	0.008	0.034	-0.024	0.006
	93410	0.313	0.318	-0.450	0.012	0.013	-0.069	0.002	-0.010

Table 6.2.4-2 Results of NASTRAN Analysis, Temperature Load (LOCA after 72 hours: Winter)

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	-0.932	0.104	-0.283	1.040	0.845	0.081	-0.279	-0.151
	60219	1.775	-2.822	0.999	-12.784	-17.538	-0.622	0.026	-2.138
	70201	2.001	2.952	-0.673	-4.155	-4.561	0.310	-0.183	0.610
	70204	1.559	1.017	-0.470	-3.984	-4.709	0.285	0.069	0.073
	110718	-2.155	-3.145	-1.392	-1.934	-2.203	0.009	0.190	-0.234
2 Exterior Wall @ EL4.65 ~6.60m	62011	5.880	1.937	0.541	-1.090	-1.228	0.001	-0.030	-0.062
	62019	7.722	0.133	-2.024	-1.201	-1.492	-0.050	0.033	-0.106
	72001	4.333	-1.692	2.655	-0.388	-0.891	0.038	-0.739	0.255
	72004	7.043	0.683	2.803	-1.318	-1.608	0.083	-0.056	0.166
3 Exterior Wall @ EL22.50 ~24.60m	64011	4.710	0.187	0.313	-0.963	-0.391	-0.017	-0.003	-0.083
	64019	5.505	1.413	1.655	-1.023	-0.448	0.026	-0.009	-0.051
	74001	2.905	-0.810	-3.488	-0.742	-0.459	0.125	-0.302	0.092
	74004	4.031	0.191	-3.611	-0.936	-0.298	-0.021	0.021	0.087
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	-2.067	-3.594	-0.353	-10.280	-9.932	-1.102	-0.058	-1.158
	70801	0.377	3.314	-0.183	-3.883	-4.019	0.017	-0.013	-0.017
	70804	-0.589	0.585	0.363	-3.927	-4.089	0.317	-0.051	0.144
	110748	-0.434	-2.821	-1.077	-1.340	-1.771	-0.097	0.369	-0.150
5 Basemat	90306	-0.842	-0.093	0.302	1.812	0.786	0.047	-0.013	0.259
	90310	0.134	0.271	0.321	1.221	1.339	0.612	0.152	-0.060
	90410	-0.192	-0.439	0.257	0.435	1.801	0.052	-0.016	-0.216
5 Basemat @ Spent Fuel Pool	90486	-3.327	-2.050	0.616	-18.282	-19.282	2.304	-0.005	0.385
	90490	-2.565	2.723	0.532	-22.985	-22.408	0.850	2.142	1.611
	90526	2.586	0.040	0.156	-19.469	-6.941	0.735	-0.998	1.464
6 Slab EL4.65m	93306	-0.789	-0.028	-1.656	-0.051	0.035	-0.014	0.080	-0.030
	93310	-2.219	-2.170	-3.223	-0.752	-0.783	-0.242	0.267	0.288
	93410	-0.686	-2.429	-0.064	-0.055	-0.015	0.020	-0.106	-0.032

Table 6.2.4-3 Results of NASTRAN Analysis, Seismic Load (Horizontal: North to South Direction)

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	-2.527	-0.242	0.003	0.047	0.600	-0.044	0.182	0.250
	60219	-3.014	-0.410	-0.969	1.178	1.359	0.655	-0.168	0.104
	70201	0.104	-0.513	-2.050	-0.332	-0.161	-0.003	-0.008	-0.040
	70204	0.894	-0.953	-3.264	-0.222	-0.234	-0.136	0.010	0.024
	110718	0.541	0.223	0.570	0.024	0.004	-0.044	0.041	-0.064
2 Exterior Wall @ EL4.65 ~6.60m	62011	0.623	-0.113	-0.372	0.013	0.227	0.003	-0.029	0.022
	62019	0.413	-0.851	-1.324	0.066	0.226	0.003	0.012	0.031
	72001	-0.541	-1.875	-3.594	-0.164	-0.068	0.013	0.015	0.044
	72004	-0.759	-1.467	-4.289	-0.040	-0.030	-0.001	0.024	0.004
3 Exterior Wall @ EL22.50 ~24.60m	64011	2.978	-0.129	-0.106	-0.055	-0.191	0.022	0.012	0.035
	64019	2.526	0.030	-0.323	-0.057	-0.149	-0.058	-0.032	0.031
	74001	0.086	-0.118	-1.096	0.044	0.049	-0.051	0.031	-0.014
	74004	-1.294	-0.175	-1.774	0.030	0.027	-0.030	0.013	0.011
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	-1.022	0.127	-1.375	1.221	0.842	0.921	0.121	0.038
	70801	-0.358	-0.817	-3.068	-0.657	-0.131	0.005	0.054	0.014
	70804	-0.103	-0.726	-3.437	-0.274	-0.078	-0.167	0.069	0.007
	110748	0.267	0.681	0.555	0.189	0.101	-0.145	-0.026	-0.036
5 Basemat	90306	1.633	-0.406	2.341	0.219	-0.150	2.426	-1.962	0.880
	90310	0.445	-0.957	0.030	0.506	-0.204	-0.171	-0.708	1.380
	90410	0.195	-4.795	-0.653	1.554	0.524	0.164	0.151	-0.109
5 Basemat @ Spent Fuel Pool	90486	0.407	-1.009	-1.091	2.026	1.996	-1.743	-0.995	-0.035
	90490	-0.049	-5.644	0.507	2.336	2.835	-0.175	0.538	-0.900
	90526	2.798	-0.137	-3.221	0.443	0.361	-3.693	-1.172	-0.748
6 Slab EL4.65m	93306	1.355	0.182	-0.860	0.288	-0.056	0.008	-0.077	-0.073
	93310	0.483	0.194	0.424	0.404	-0.225	0.053	-0.306	0.355
	93410	-0.409	0.459	1.304	0.362	0.100	0.081	-0.200	-0.005

Table 6.2.4-4 Results of NASTRAN Analysis, Seismic Load (Horizontal: East to West Direction)

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	0.127	0.100	1.432	-0.003	0.182	0.017	0.004	0.053
	60219	-0.749	-0.811	0.748	0.095	-0.120	0.002	0.003	-0.021
	70201	-0.041	-0.396	-0.366	-0.035	-0.084	0.006	-0.007	0.029
	70204	-0.066	-1.134	-1.147	-0.038	-0.137	0.027	0.007	0.050
	110718	0.154	-0.450	0.179	-0.057	-0.133	-0.006	0.011	-0.070
2 Exterior Wall @ EL4.65 ~6.60m	62011	-0.188	0.141	2.379	-0.025	-0.022	0.000	0.009	-0.009
	62019	-0.067	-1.025	1.859	0.004	0.007	0.001	-0.001	0.001
	72001	-0.092	-2.116	-0.080	-0.005	0.032	-0.001	0.033	-0.020
	72004	-0.211	-1.815	-0.919	0.026	0.082	0.012	0.006	-0.011
3 Exterior Wall @ EL22.50 ~24.60m	64011	-0.040	0.012	1.635	0.000	0.005	-0.001	0.001	-0.001
	64019	0.503	-0.082	1.246	0.000	-0.011	0.006	0.001	0.003
	74001	0.176	-0.213	-0.277	0.054	0.003	0.004	-0.038	-0.022
	74004	0.865	-0.137	-0.920	-0.003	-0.035	-0.001	-0.002	-0.008
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	-0.330	-0.421	0.955	0.078	-0.002	-0.011	0.002	-0.010
	70801	-0.029	-0.942	-0.470	0.031	0.055	0.009	0.010	0.045
	70804	-0.138	-0.873	-1.039	0.005	0.078	0.019	0.005	0.031
	110748	0.152	-0.207	0.175	0.065	0.006	-0.029	-0.014	-0.032
5 Basemat	90306	1.386	0.424	-1.243	-0.964	-0.175	-0.848	1.116	-1.018
	90310	0.146	0.278	-0.141	-0.069	-0.051	0.230	-0.169	-0.269
	90410	0.038	0.191	-1.179	0.159	0.269	-1.639	-0.055	1.018
5 Basemat @ Spent Fuel Pool	90486	-0.256	-0.281	-0.615	2.848	2.976	0.734	-0.251	0.291
	90490	-0.129	-1.702	-0.739	0.644	1.838	-0.546	0.905	0.419
	90526	-0.573	-0.169	-1.355	2.088	0.837	-0.745	-0.977	-1.038
6 Slab EL4.65m	93306	-0.987	-0.072	0.755	-0.210	-0.092	-0.005	-0.050	0.040
	93310	-0.191	-0.199	0.082	-0.011	-0.082	-0.026	-0.067	-0.004
	93410	0.009	-0.598	0.036	-0.030	0.020	-0.015	0.054	0.020

Table 6.2.4-5 Results of NASTRAN Analysis, Seismic Load (Vertical: Upward Direction)

Location	Element ID	Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 Exterior Wall	60011	-0.394	-1.290	-0.294	-0.134	-0.824	-0.025	-0.052	-0.250
and Pool Wall	60219	-0.106	-1.323	-0.197	-0.253	-0.663	-0.117	0.020	-0.118
@ EL-11.50	70201	0.031	-0.236	0.012	0.103	-0.108	0.000	-0.076	0.057
~-10.50m	70204	0.089	-0.958	-0.058	-0.078	-0.237	0.031	-0.008	0.062
	110718	0.169	-0.999	-0.239	0.000	0.035	0.008	-0.001	0.004
2 Exterior Wall	62011	0.069	-0.913	0.081	0.046	0.204	0.011	0.008	0.068
@ EL4.65	62019	0.057	-0.638	-0.092	-0.006	0.097	-0.035	0.001	0.033
~6.60m	72001	0.038	-0.262	-0.010	0.045	0.006	0.001	-0.001	0.004
	72004	0.025	-0.510	0.010	0.004	0.023	0.012	-0.004	-0.004
3 Exterior Wall	64011	0.075	-0.351	-0.041	-0.146	-0.706	-0.004	-0.004	0.097
@ EL22.50	64019	-0.055	-0.438	-0.042	-0.084	-0.497	0.064	0.079	0.080
~24.60m	74001	-0.011	-0.045	0.075	0.066	-0.058	-0.060	-0.029	-0.039
	74004	-0.063	-0.265	0.023	-0.103	-0.442	-0.078	0.023	-0.089
4 Spent Fuel	60819	0.091	-1.085	-0.333	-0.280	-0.075	-0.164	-0.005	-0.055
Pool Wall	70801	0.090	-0.331	-0.055	0.194	0.026	-0.027	-0.048	-0.005
@ EL-5.10	70804	0.114	-0.703	-0.012	-0.023	-0.011	0.018	-0.020	0.027
~-3.30m	110748	0.106	-0.671	-0.295	-0.025	0.003	0.003	0.003	0.010
5 Basemat	90306	-0.712	-0.334	0.447	0.682	-0.086	0.181	-0.461	0.901
	90310	-0.084	-0.104	-0.026	-0.102	-0.113	-0.505	0.098	-0.027
	90410	-0.309	-0.785	0.302	-0.474	0.139	1.025	1.008	0.036
5 Basemat	90486	-0.081	-0.369	-0.055	2.628	1.776	0.248	-0.136	0.099
@ Spent	90490	-0.119	-0.339	0.155	-0.009	0.762	0.334	1.083	0.177
Fuel Pool	90526	-0.003	-0.102	-0.124	1.279	0.419	0.034	-0.234	-0.829
6 Slab EL4.65m	93306	0.165	-0.003	0.027	0.048	0.051	0.009	0.026	-0.126
	93310	0.034	0.044	0.206	0.046	0.020	0.041	-0.025	0.006
	93410	0.237	0.287	-0.238	0.075	0.018	-0.068	-0.046	-0.016

Table 6.3.1-1 Load Combinations and Acceptance Criteria for Safety-related Reinforced Concrete Structures

Category	Combination*2 No.	Load *1*7													Acceptance Criteria *5
		D	F	L*6	H	Pa*3	To	Ta*3	E'	W	Wt	Ro	Ra	Y*4	
Normal	FB-C1	1.4	1.4	1.7	1.7							1.7			U
	FB-C2	1.05	1.05	1.3	1.3		1.3					1.3			U
Severe Environmental	FB-C3	1.4	1.4	1.7	1.7					1.7		1.7			U
	FB-C4	1.05	1.05	1.3	1.3		1.3			1.3		1.3			U
	FB-C5	1.2	1.2							1.7					U
Extreme Environmental	FB-C6	1.0	1.0	1.0	1.0		1.0		1.0			1.0			U
	FB-C7	1.0	1.0	1.0	1.0		1.0				1.0	1.0			U
Abnormal	FB-C8	1.0	1.0	1.0	1.0	1.5		1.0					1.0		U
Abnormal/Extreme Environmental	FB-C9	1.0	1.0	1.0	1.0	1.0		1.0	1.0				1.0	1.0	U

Note :

*1: D = Dead loads
F = Hydrostatic pressure loads
L = Live loads (For the roof, Roof Live loads or Snow loads or Rain loads each acting independently.)
H = Lateral soil pressure loads
Pa = Pressure loads during LOCA
To = Thermal loads during the normal operation
Ta = Thermal loads during LOCA
E' = Seismic loads (SSE)
W = Wind loads (basic wind)
Wt = Wind loads (tornado wind)
Ro = Pipe reaction loads during the normal operation
Ra = Pipe reaction loads during LOCA
Y = High energy pipe rupture

*2: For any load combination, where any load reduces the effects of other loads, the corresponding coefficient for that load shall be taken as 0.9 if it can be demonstrated that the load is always present or occur simultaneously with the other loads. Otherwise, the coefficient for that load shall be taken as zero.

*3: Because Pa and Ta are time-dependent loads, their effects are superimposed accordingly.

*4: Y includes Yj, Ym and Yr. The maximum value of Y including an appropriate Dynamic Load Factor (DLF) shall be used, unless an appropriate time history analysis is performed to justify otherwise.

*5: U = Section strength required to resist design loads based on the strength design method per ACI 349-01and in SRP 3.8.4 Section II.3.

*6: Check L using LL Building, LL Roof (Lr), LL Roof Snow (S), or LL Roof Rain (R) as defined in Section 6.2. These are independent load cases that are checked independently using the Load Factors for the appropriate categories.

*7: The effect of SRV and LOCA dynamic loads originating inside the containment shall be considered as applicable.

Table 6.3.1-2 Load Combinations and Acceptance Criteria for Safety-Related Steel Structures

Category	Combination No.	Load*1											Acceptance Criteria *3
		D	L	Pa	To	Ta	E'	W	Wt	Ro	Ra	Y*2	
Normal	FB-S1	1.0	1.0										S
	FB-S2	1.0	1.0		1.0					1.0			S (a)
Severe Environmental	FB-S3	1.0	1.0					1.0					S
	FB-S4	1.0	1.0		1.0			1.0		1.0			S (a)
Extreme Environmental	FB-S5	1.0	1.0		1.0		1.0			1.0			1.6S (b)(c)
	FB-S6	1.0	1.0		1.0				1.0	1.0			1.6S (b)(c)
Abnormal	FB-S7	1.0	1.0	1.0		1.0					1.0		1.6S (b)(c)
Abnormal/Extreme Environmental	FB-S8	1.0	1.0	1.0		1.0	1.0				1.0	1.0	1.7S (b)(c)

Note :

*1 : D = Dead loads

L = Live loads (For the roof, Roof Live loads or Snow loads or Rain loads each acting independently.)

Pa = Pressure loads during LOCA

To = Temperature loads during the normal operation

Ta = Temperature loads during LOCA

E' = Seismic loads (SSE)

W = Wind loads (basic wind)

Wt = Wind loads (tornado wind)

Ro = Pipe reaction loads during the normal operation

Ra = Pipe reaction loads during LOCA

Y = High energy pipe rupture

*2: Y includes Y_j, Y_m and Y_r. The maximum values of Y including an appropriate Dynamic Load Factor (DLF) shall be used, unless an appropriate time history analysis is performed to justify otherwise.

*3: Allowable elastic working stress (S) is the allowable stress limit specified in Part 1 of AISC N-690-1994-s2 (2004).

(a) For primary plus secondary stress, the allowable limits are increased by a factor of 1.5.

(b) Stress limit coefficient in shear shall not exceed 1.4 in members and bolts.

(c) Stress limit coefficient where axial compression exceeds 20% of nominal allowable, shall be 1.5 for load combination 5, 6, 7, and be 1.6 for load combination 8.

Table 6.3.1-3 Load Combinations, Load Factors and Acceptance Criteria for Reinforced Concrete Containment

Description	No.[*2]	Load Conditions[*1]																Acceptance Criteria[*6]
		D	L	Pt	Po	Pa[*3]	Tt	To	Ta[*3]	E'[*7]	W	W'	Ro	Ra	Y[*4]	SRV[*7]	LOCA[*5*7]	
Service Test	CV-1	1.0	1.0	1.0			1.0											S
Construction	CV-2	1.0	1.0					1.0			1.0							S
Normal	CV-3	1.0	1.0		1.0			1.0					1.0			1.0		S
Factored Severe Environmental	CV-4	1.0	1.3		1.0			1.0			1.5		1.0			1.3		U
Extreme Environmental	CV-5	1.0	1.0		1.0			1.0		1.0			1.0			1.0		U
	CV-6	1.0	1.0		1.0			1.0				1.0	1.0			1.0		U
Abnormal	CV-7	1.0	1.0			1.5			1.0					1.0		1.25	Note[*5]	U
	CV-8	1.0	1.0			1.0			1.0					1.25		1.0	Note[*5]	U
	CV-9	1.0	1.0			1.25			1.0					1.0		1.25	Note[*5]	U
Abnormal/Severe Environmental	CV-10	1.0	1.0			1.25			1.0		1.25			1.0		1.0	Note[*5]	U
Abnormal/Extreme Environmental	CV-11	1.0	1.0			1.0			1.0	1.0				1.0	1.0	1.0	Note[*5]	U

Notes:

*1: The loads are described in Section 6. The allowable stresses of concrete and reinforcing steel shall be in accordance with ASME Code Section III, Division 2, Subsection CC-3400 (except for tangential shear stress carried by orthogonal reinforcement which shall be limited to 4.41 MPa (639 psi) for factored load combinations). Inclined reinforcement shall not be used to resist tangential shear.

*2: For any load combination, if the effect of any load component (other than D) reduces the combined load, then the load component is deleted from the load combination.

*3: Because Pa, Ta, SRV and LOCA are time-dependent loads, their effects are superimposed accordingly.

*4: Y includes Yj, Ym and Yr.

*5: LOCA loads, CO, CHUG and PS are time-dependant loads for which DLF may be used. The sequence of occurrence is shown in Figure 5.2.3-2. The load factor for LOCA loads shall be the same as the corresponding pressure load Pa. LOCA loads shall include hydrostatic pressure (with a load factor of 1.0) due to containment flooding.

*6: S = Allowable Stress as in ASME Section III, Div. 2, Subsection CC-3430 for Service Load Combination. U = Allowable Stress as in ASME Section III, Div. 2, Subsection CC-3420 for Factored Load Combination.

*7: The peak responses of dynamic loads do not occur at the same instant. SRSS method to combine peak dynamic responses is acceptable for concrete structures.

Table 6.3.2-1 Detail Load Combinations for Reinforced Concrete Structures

					Combination No. in DCD	Dead Load: Normal Operation & LOCA (DLO1)	Dead Load: LOCA Flooding (DLO2)	Live Load: Normal Operation (LLO)	Live Load: Soil Pressure (Static) (SPO)	Pressure Load: Test (Max.) (PTL1)	Pressure Load: Test (Diff.) (PTL2)	Pressure Load: Normal Operation (POL)	Pressure Load: LOCA After 5 seconds (PL1)	Pressure Load: LOCA After 6 minutes (PL2)	Pressure Load: LOCA After 10 hours (PL3)	Pressure Load: LOCA After 72 hours (PL4)	Pressure Load: Annulus Pressure (AP)	Pressure Load: HELB in MS Tunnel (PLMS)	Pressure Load: HELB in Other Room (HOTH)	Thermal Load: Normal Operation Summer (TLS0)	Thermal Load: Normal Operation Winter (TLW0)	LOCA (GDCS Condition1*1) After 5 seconds Summer (TLS1)	LOCA (GDCS Condition1*1) After 5 seconds Winter (TLW1)	LOCA (GDCS Condition1*1) After 6 minutes Summer (TLS2)	LOCA (GDCS Condition1*1) After 6 minutes Winter (TLW2)	LOCA (GDCS Condition1*1) After 10 hours Summer (TLS3)	LOCA (GDCS Condition1*1) After 10 hours Winter (TLW3)	LOCA (GDCS Condition1*1) After 72 hours Summer (TLS4)	LOCA (GDCS Condition1*1) After 72 hours Winter (TLW4)	LOCA (GDCS Condition2*2) After 5 sec. Summer (TLS5)	LOCA (GDCS Condition2*2) After 5 sec. Winter (TLW5)	LOCA (GDCS Condition2*2) After 6 minutes Summer (TLS6)	LOCA (GDCS Condition2*2) After 6 minutes Winter (TLW6)	LOCA (GDCS Condition2*2) After 10 hours Summer (TLS7)	LOCA (GDCS Condition2*2) After 10 hours Winter (TLW7)	LOCA (GDCS Condition2*2) After 72 hours Summer (TLS8)	LOCA (GDCS Condition2*2) After 72 hours Winter (TLW8)	LOCA Flooding After 5 sec. Summer (TFS5)	LOCA Flooding After 5 sec. Winter (TFW5)	LOCA Flooding After 6 minutes Summer (TFS6)	LOCA Flooding After 6 minutes Winter (TFW6)	LOCA Flooding After 10 hours Summer (TFS7)	LOCA Flooding After 10 hours Winter (TFW7)	LOCA Flooding After 72 hours Summer (TFS8)	LOCA Flooding After 72 hours Winter (TFW8)	LOCA & LOFCF After 72 hours (both Accident) Summer (TSS8)	LOCA & LOFCF After 72 hours (both Accident) Winter (TSW8)	LOCA & LOFCF After 72 hours (both Accident) Winter (TWC1)	LOCA & LOFCF After 72 hours (both Accident) Winter (TWC2)	LOCA & LOFCF After 72 hours (both Accident) Winter (TWC3)	LOCA & LOFCF After 72 hours (both Accident) Winter (TWC4)	SPF LOFCF (after 72hr.) Summer (TSS0)	SPF LOFCF (after 72hr.) Winter (TSW0)	Seismic Load: Normal Operation & LOCA (KSO1)	Seismic Load: LOCA Flooding (KSO2)	Pipe Reac.: During AP JET1 (JET1)	Pipe Reac.: During AP JET2 (JET2)	Hydrodynamic Load: SRV Positive (HOS1)	Hydrodynamic Load: SRV Negative (HOS2)	LOCA PS Pool Swell (HLPS)	LOCA PS Froth 1 (HLP2)	LOCA PS Froth 2 (HLP3)	LOCA PS Fall Back (HLP4)	LOCA CO Positive (HLO1)	LOCA CO Negative (HLO2)	LOCA CH Positive (HLC1)	LOCA CH Negative (HLC2)	Reaction SRV NonFlood (SRN*)	Reaction SRV Flood (FRN*)	Reaction PS+AP NonFlood (PSL*)	Reaction PS+AP Flood (FSL*)	Reaction CO NonFlood (COL*)	Reaction CO Flood (FOL*)	Reaction CH NonFlood (CHL*)	Reaction CH Flood (FHL*)	Wind Load: N to S (WON)	Wind Load: S to N (WOS)	Wind Load: E to W (WOE)	Wind Load: W to E (WOW)	Tornado Load: N to S (WTN)	Tornado Load: S to N (WTS)	Tornado Load: E to W (WTE)	Tornado Load: W to E (WTW)	Tornado Differential Load (WTD)	Acceptance Criteria
CV-1	Test																																																																																					
	Maximum Pressure			1100	N/A	1.0		1.0	1.0	1.0																																																																										S
	Differential Pressure			1200	N/A	1.0		1.0	1.0		1.0																																																																									S
CV-3	Normal Operation																																																																																				
		w/o Temp		2000	N/A	1.0		1.0	1.0			1.0																																																																						S
			SRVPos.	2001	N/A	1.0		1.0	1.0			1.0																																								1.0										1.0																	S
			SRVNeg.	2005	N/A	1.0		1.0	1.0			1.0																																									1.0									1.0																	S
		Summer		2010	N/A	1.0		1.0	1.0			1.0								1.0																																																										S
			SRVPos.	2011	N/A	1.0		1.0	1.0			1.0								1.0																																			1.0										1.0																	S
			SRVNeg.	2015	N/A	1.0		1.0	1.0			1.0								1.0																																				1.0									1.0																	S
		Winter		2020	N/A	1.0		1.0	1.0			1.0									1.0																																																									S
			SRVPos.	2021	N/A	1.0		1.0	1.0			1.0									1.0																																			1.0										1.0																	S
			SRVNeg.	2025	N/A	1.0		1.0	1.0			1.0									1.0																																				1.0									1.0																	S
FB-C1	1.4D+1.7L (Normal Operation)																																																																																						
		w/o Temp		2500	N/A	1.4		1.7	1.7																																																							1.7																	U
FB-C2	1.05D+1.3L+1.3To (Normal Operation)																																																																																						
		Summer		3011	N/A	1.05		1.3	1.3											1.3																																												1.3																	U
		Winter		3021	N/A	1.05		1.3	1.3												1.3																																											1.3																	U
FB-C3	1.4D+1.7L+1.7W (Normal Operation)																																																																																						
			N to S Wind	3501	N/A	1.40		1.7	1.7																																																																	1.7									U
			S to N Wind	3502	N/A	1.40		1.7	1.7																																																																	1.7								U
			E to W Wind	3503	N/A	1.40		1.7	1.7																																																																		1.7							U
			W to E Wind	3504	N/A	1.40		1.7	1.7																																																																			1.7						U
FB-C4	1.05D+1.3L+1.3To+1.3W (Normal Operation)																																																																																						
		Summer	N to S Wind	4011	N/A	1.05		1.3	1.3											1.3																																																					1.3									U
			S to N Wind	4012	N/A	1.05		1.3	1.3											1.3																																																						1.3								U
			E to W Wind	4013	N/A	1.05		1.3	1.3											1.3																																																							1.3							U
			W to E Wind	4014	N/A	1.05		1.3	1.3											1.3																																																								1.3						U
		Winter	N to S Wind	4021	FB-4	1.05		1.3	1.3												1.3																																																			1.3									U
			S to N Wind	4022	N/A	1.05		1.3	1.3												1.3																																																				1.3								U
			E to W Wind	4023	N/A	1.05		1.3	1.3												1.3																																																					1.3							U
			W to E Wind	4024	N/A	1.05		1.3	1.3												1.3																																																						1.3						U
FB-C7	Tornado (Normal Operation)																																																																																						
		w/o Temp	N to S Wind	5001	N/A	1.0		1.0	1.0																																																																						1.0					U
			S to N Wind	5002	N/A	1.0		1.0	1.0																																																																						1.0				U
			E to W Wind	5003	N/A	1.0		1.0	1.0																																																																						1.0			U
			W to E Wind	5004	N/A	1.0		1.0	1.0																																																																							1.0		U
			N to S Wind+DP/2	5005	N/A	1.0		1.0	1.0																																																																						1.0				0.5	U
			S to N Wind+DP/2	5006	N/A	1.0		1.0	1.0																																																																							1.0			0.5	U
			E to W Wind+DP/2	5007	N/A	1.0		1.0	1.0																																																																							1.0		0.5	U
			W to E Wind+DP/2	5008	N/A	1.0		1.0	1.0																																																																								1.0	0.5	U
			Differential	5009	N/A	1.0		1.0	1.0																																																																										1.0	U
		Summer	N to S Wind	5011	N/A	1.0		1.0	1.0											1.0																																																												1.0					U
			S to N Wind	5012	N/A	1.0		1.0	1.0											1.0																																																													1.0				U
			E to W Wind	5013	N/A	1.0		1.0	1.0											1.0																																																												1.0			U
			W to E Wind	5014	N/A	1.0		1.0	1.0											1.0																																																													1.0		U
			N to S Wind+DP/2	5015	N/A	1.0		1.0	1.0											1.0																																																												1.0				0.5	U
			S to N Wind+DP/2	5016	N/A	1.0		1.0	1.0											1.0																																																												1.0			0.5	U
			E to W Wind+DP/2	5017	N/A	1.0		1.0	1.0											1.0																																																													1.0		0.5	U
			W to E Wind+DP/2	5018	N/A	1.0		1.0	1.0											1.0																																																													1.0	0.5	U
			Differential	5019	N/A	1.0		1.0	1.0											1.0																																																														1.0	U
		Winter	N to S Wind	5021	N/A	1.0		1.0	1.0												1.0																																																										1.0					U
			S to N Wind	5022	N/A	1.0		1.0	1.0												1.0																																																										1.0				U
			E to W Wind	5023	N/A	1.0		1.0	1.0												1.0																																																										1.0			U
			W to E Wind	5024	N/A	1.0		1.0	1.0												1.0																																																											1.0		U
			N to S Wind+DP/2	5025	N/A	1.0		1.0	1.0												1.0																																																									1.0				0.5	U
			S to N Wind+DP/2	5026	N/A	1.0		1.0	1.0												1.0																																																										1.0			0.5	U
			E to W Wind+DP/2	5027	N/A	1.0		1.0	1.0												1.0																																																										1.0		0.5	U
			W to E Wind+DP/2	5028	N/A	1.0		1.0	1.0												1.0																																																											1.0	0.5	U
			Differential	5029	N/A	1.0		1.0	1.0												1.0																																																													1.0	U

Note *1: GDCS Pool Water Depth is 4.48 m.
*2: GDCS Pool Water Depth is 0.792 mm.
Opposite sign of stresses due to the hydrodynamic load or combination of hydrodynamic and seismic load to the other loads is considered. In that case, 500 is added to the original LOAD ID.
For acceptance criteria, S = Allowable Stress as in ASME Section III, Div. 2, Subsection CC-3430 for Service Load Combination. U = Allowable Stress as in ASME Section III, Div. 2, Subsection CC-3420 for Factored Load Combination.
For unit load cases which are shaded in the table, the results of stress analysis are based on the RB/FB global FE model which is used in Appendix E of ESBWR Reactor Building Structural Design Report, Reference 2.1.2-g.

Table 6.3.2-1 Detail Load Combinations for Reinforced Concrete Structures (Continued)

					No.	Combination No. in DCD	DLO1 (Dead Load: Normal Operation & LOCA)	DLO2 (Dead Load: LOCA Flooding)	LLO (Live Load: Normal Operation)	SPO (Live Load: Soil Pressure (Static))	PTL1 (Pressure: Test (Max.))	PTL2 (Pressure: Test (DiffP))	POL (Pressure: Normal Operation)	PL1 (LOCA After 5 seconds)	PL2 (LOCA After 6 minutes)	PL3 (LOCA After 10 hours)	PL4 (LOCA After 72 hours)	AP (Annulus Pressure)	PLMS (HELB in MS Tunnel)	HOTH (HELB in Other Room)	TLS0 (Thermal: Normal Operation Summer)	TLW0 (Normal Operation Winter)	TLS1 (LOCA (GDCS Condition1*1) After 5 seconds Summer)	TLW1 (After 5 seconds Winter)	TLS2 (After 6 minutes Summer)	TLW2 (After 6 minutes Winter)	TLS3 (After 10 hours Summer)	TLW3 (After 10 hours Winter)	TLS4 (After 72 hours Summer)	TLW4 (After 72 hours Winter)	TLS5 (LOCA (GDCS Condition2*2) After 5 sec. Summer)	TLW5 (After 5 sec. Winter)	TLS6 (After 6 minutes Summer)	TLW6 (After 6 minutes Winter)	TLS7 (After 10 hours Summer)	TLW7 (After 10 hours Winter)	TLS8 (After 72 hours Summer)	TLW8 (After 72 hours Winter)	TFS5 (LOCA Flooding After 5 sec. Summer)	TFW5 (After 5 sec. Winter)	TFS6 (After 6 minutes Summer)	TFW6 (After 6 minutes Winter)	TFS7 (After 10 hours Summer)	TFW7 (After 10 hours Winter)	TFS8 (After 72 hours Summer)	TFW8 (After 72 hours Winter)	TSS8 (LOCA & LOFCF After 72 hours (both Accident) Summer)	TSW8 (Winter)	TWC1 (Winter)	TWC2 (Winter)	TWC3 (Winter)	TWC4 (Winter)	TSS0 (SPF LOFCF (after 72hr.) Summer)	TSW0 (SPF LOFCF Winter)	KSO1 (Seismic Load: Normal Operation & LOCA)	KSO2 (Seismic Load: LOCA Flooding)	JET1 (Pipe Reac.: During AP)	JET2 (Pipe Reac.: During AP)	HOS1 (Hydrodynamic: SRV Positive)	HOS2 (SRV Negative)	HLPS (LOCA PS Pool Swell)	HLP2 (PS Froth 1)	HLP3 (PS Froth 2)	HLP4 (PS Fall Back)	HLO1 (CO Positive)	HLO2 (CO Negative)	HLC1 (CH Positive)	HLC2 (CH Negative)	SRN* (Reaction SRV NonFlood)	FRN* (SRV Flood)	PSL* (PS-AP NonFlood)	FSL* (PS-AP Flood)	COL* (CO NonFlood)	FOL* (CO Flood)	CHL* (CH NonFlood)	FHL* (CH Flood)	WON (Wind Load N to S)	WOS (S to N)	WOE (E to W)	WOW (W to E)	WTN (Tornado Load N to S)	WTS (S to N)	WTE (E to W)	WTW (W to E)	WTD (Tornado Differential Load)	Acceptance Criteria
CV-7	Abnormal ;LOCA (1.5P)																																																																																				
	5 sec. After	GDCS Condition1	w/o Temp	(PS+SRVPos.)	6101	N/A	1.0		1.0	1.0				1.5				1.5																																							1.5	1.5	1.25		1.5								1.25		1.5															U
					6102	N/A	1.0		1.0	1.0				1.5				1.5																																							1.5	1.5	1.25			1.5	1.5						1.25		1.5															U
					6103	N/A	1.0		1.0	1.0				1.5				1.5																																							1.5	1.5	1.25		1.5			1.5					1.25		1.5															U
				(PS+SRVNeg.)	6105	N/A	1.0		1.0	1.0				1.5				1.5																																							1.5	1.5		1.25	1.5								1.25		1.5															U
					6106	N/A	1.0		1.0	1.0				1.5				1.5																																							1.5	1.5		1.25		1.5	1.5						1.25		1.5															U
					6107	N/A	1.0		1.0	1.0				1.5				1.5																																							1.5	1.5		1.25	1.5			1.5					1.25		1.5															U
			Summer	(PS+SRVPos.)	6111	N/A	1.0		1.0	1.0				1.5				1.5					1.0																																		1.5	1.5	1.25		1.5								1.25		1.5															U
					6112	N/A	1.0		1.0	1.0				1.5				1.5					1.0																																		1.5	1.5	1.25			1.5	1.5						1.25		1.5															U
					6113	N/A	1.0		1.0	1.0				1.5				1.5					1.0																																		1.5	1.5	1.25		1.5			1.5					1.25		1.5															U
				(PS+SRVNeg.)	6115	N/A	1.0		1.0	1.0				1.5				1.5					1.0																																		1.5	1.5		1.25	1.5								1.25		1.5															U
					6116	N/A	1.0		1.0	1.0				1.5				1.5					1.0																																		1.5	1.5		1.25		1.5	1.5						1.25		1.5															U
					6117	N/A	1.0		1.0	1.0				1.5				1.5					1.0																																		1.5	1.5		1.25	1.5			1.5					1.25		1.5															U
			Winter	(PS+SRVPos.)	6121	N/A	1.0		1.0	1.0				1.5				1.5						1.0																																	1.5	1.5	1.25		1.5								1.25		1.5															U
					6122	N/A	1.0		1.0	1.0				1.5				1.5						1.0																																	1.5	1.5	1.25			1.5	1.5						1.25		1.5															U
					6123	N/A	1.0		1.0	1.0				1.5				1.5						1.0																																	1.5	1.5	1.25		1.5			1.5					1.25		1.5															U
				(PS+SRVNeg.)	6125	N/A	1.0		1.0	1.0				1.5				1.5						1.0																																	1.5	1.5		1.25	1.5								1.25		1.5															U
					6126	N/A	1.0		1.0	1.0				1.5				1.5						1.0																																	1.5	1.5		1.25		1.5	1.5						1.25		1.5															U
					6127	N/A	1.0		1.0	1.0				1.5				1.5						1.0																																	1.5	1.5		1.25	1.5			1.5					1.25		1.5															U
		GDCS Condition2	Summer	(PS+SRVPos.)	6131	N/A	1.0		1.0	1.0				1.5				1.5													1.0																										1.5	1.5	1.25		1.5								1.25		1.5															U
					6132	N/A	1.0		1.0	1.0				1.5				1.5													1.0																										1.5	1.5	1.25			1.5	1.5						1.25		1.5															U
					6133	N/A	1.0		1.0	1.0				1.5				1.5													1.0																										1.5	1.5	1.25		1.5			1.5					1.25		1.5															U
				(PS+SRVNeg.)	6135	N/A	1.0		1.0	1.0				1.5				1.5													1.0																										1.5	1.5		1.25	1.5								1.25		1.5															U
					6136	N/A	1.0		1.0	1.0				1.5				1.5													1.0																										1.5	1.5		1.25		1.5	1.5						1.25		1.5															U
					6137	N/A	1.0		1.0	1.0				1.5				1.5													1.0																										1.5	1.5		1.25	1.5			1.5					1.25		1.5															U
			Winter	(PS+SRVPos.)	6141	N/A	1.0		1.0	1.0				1.5				1.5														1.0																									1.5	1.5	1.25		1.5								1.25		1.5															U
					6142	N/A	1.0		1.0	1.0				1.5				1.5														1.0																									1.5	1.5	1.25			1.5	1.5						1.25		1.5															U
					6143	N/A	1.0		1.0	1.0				1.5				1.5														1.0																									1.5	1.5	1.25		1.5			1.5					1.25		1.5															U
				(PS+SRVNeg.)	6145	N/A	1.0		1.0	1.0				1.5				1.5														1.0																									1.5	1.5		1.25	1.5								1.25		1.5															U
					6146	N/A	1.0		1.0	1.0				1.5				1.5														1.0																									1.5	1.5		1.25		1.5	1.5						1.25		1.5															U
					6147	N/A	1.0		1.0	1.0				1.5				1.5														1.0																									1.5	1.5		1.25	1.5			1.5					1.25		1.5															U
		LOCA Flooding	w/o Temp	(PS+SRVPos.)	6151	N/A		1.0	1.0	1.0				1.5				1.5																																							1.5	1.5	1.25		1.5									1.25		1.5														U
					6152	N/A		1.0	1.0	1.0				1.5				1.5																																							1.5	1.5	1.25			1.5	1.5							1.25		1.5														U
					6153	N/A		1.0	1.0	1.0				1.5				1.5																																							1.5	1.5	1.25		1.5			1.5						1.25		1.5														U
				(PS+SRVNeg.)	6155	N/A		1.0	1.0	1.0				1.5				1.5																																							1.5	1.5		1.25	1.5									1.25		1.5														U
					6156	N/A		1.0	1.0	1.0				1.5				1.5																																							1.5	1.5		1.25		1.5	1.5							1.25		1.5														U
					6157	N/A		1.0	1.0	1.0				1.5				1.5																																							1.5	1.5		1.25	1.5			1.5						1.25		1.5														U
			Summer	(PS+SRVPos.)	6161	N/A		1.0	1.0	1.0				1.5				1.5																					1.0																		1.5	1.5	1.25		1.5									1.25		1.5														U
					6162	N/A		1.0	1.0	1.0				1.5				1.5																					1.0																		1.5	1.5	1.25			1.5	1.5							1.25		1.5														U
					6163	N/A		1.0	1.0	1.0				1.5				1.5																					1.0																		1.5	1.5	1.25		1.5			1.5						1.25		1.5														U
				(PS+SRVNeg.)	6165	N/A		1.0	1.0	1.0				1.5				1.5																					1.0																		1.5	1.5		1.25	1.5									1.25		1.5														U
					6166	N/A		1.0	1.0	1.0				1.5				1.5																					1.0																		1.5	1.5		1.25		1.5	1.5							1.25		1.5														U
					6167	N/A		1.0	1.0	1.0				1.5				1.5																					1.0																		1.5	1.5		1.25	1.5			1.5						1.25		1.5														U
			Winter	(PS+SRVPos.)	6171	N/A		1.0	1.0	1.0				1.5				1.5																						1.0																	1.5	1.5	1.25		1.5									1.25		1.5														U
					6172	N/A		1.0	1.0	1.0				1.5				1.5																						1.0																	1.5	1.5	1.25			1.5	1.5							1.25		1.5														U
					6173	N/A		1.0	1.0	1.0				1.5				1.5																						1.0																	1.5	1.5	1.25		1.5			1.5						1.25		1.5														U
				(PS+SRVNeg.)	6175	N/A		1.0	1.0	1.0				1.5				1.5																						1.0																	1.5	1.5		1.25	1.5									1.25		1.5														U
					6176	N/A		1.0	1.0	1.0				1.5				1.5																						1.0																	1.5	1.5		1.25		1.5	1.5							1.25		1.5														U
					6177	N/A		1.0	1.0	1.0				1.5				1.5																						1.0																	1.5	1.5		1.25	1.5			1.5						1.25		1.5														U

Note *1: GDCS Pool Water Depth is 4.48 m.
*2: GDCS Pool Water Depth is 0.792 mm.
Opposite sign of stresses due to the hydrodynamic load or combination of hydrodynamic and seismic load to the other loads is considered. In that case, 500 is added to the original LOAD ID.
For acceptance criteria, U = Allowable Stress as in ASME Section III, Div. 2, Subsection CC-3420 for Factored Load Combination.
For unit load cases which are shaded in the table, the results of stress analysis are based on the RB/FB global FE model which is used in Appendix E of ESBWR Reactor Building Structural Design Report, Reference 2.1.2-g.

Table 6.3.2-1 Detail Load Combinations for Reinforced Concrete Structures (Continued)

CV-7 Abnormal ;LOCA (1.5P)

Dead Load, Live Load and Pressure Load

Time	Condition	Temperature	Loading	Combination No.	DCD	DLO1 (Dead Load: Normal Operation & LOCA)	DLO2 (Dead Load: LOCA Flooding)	LLO (Live Load: Normal Operation)	SPO (Live Load: Soil Pressure (Static))	PTL1 (Test (Max.))	PTL2 (Test (DtE))	POL (Normal Operation)	PL1 (LOCA After 5 seconds)	PL2 (LOCA After 6 minutes)	PL3 (LOCA After 10 hours)	PL4 (LOCA After 72 hours)	AP (Annulus Pressure)	PLMS (HELB in MS Tunnel)	HOTH (HELB in Other Room)
6 min. After	GDCS Condition1	w/o Temp	(CO+SRV)Pos.	6201	N/A	1.0		1.0	1.0					1.5					
			(CO+SRV)Neg.	6205	N/A	1.0		1.0	1.0					1.5					
		Summer	(CO+SRV)Pos.	6211	N/A	1.0		1.0	1.0					1.5					
			(CO+SRV)Neg.	6215	N/A	1.0		1.0	1.0					1.5					
		Winter	(CO+SRV)Pos.	6221	N/A	1.0		1.0	1.0					1.5					
			(CO+SRV)Neg.	6225	N/A	1.0		1.0	1.0					1.5					
	GDCS Condition2	Summer	(CO+SRV)Pos.	6231	N/A	1.0		1.0	1.0					1.5					
			(CO+SRV)Neg.	6235	N/A	1.0		1.0	1.0					1.5					
		Winter	(CO+SRV)Pos.	6241	N/A	1.0		1.0	1.0					1.5					
			(CO+SRV)Neg.	6245	N/A	1.0		1.0	1.0					1.5					
	LOCA Flooding	w/o Temp	(CO+SRV)Pos.	6251	N/A		1.0	1.0	1.0					1.5					
			(CO+SRV)Neg.	6255	N/A		1.0	1.0	1.0					1.5					
		Summer	(CO+SRV)Pos.	6261	N/A		1.0	1.0	1.0					1.5					
			(CO+SRV)Neg.	6265	N/A		1.0	1.0	1.0					1.5					
		Winter	(CO+SRV)Pos.	6271	N/A		1.0	1.0	1.0					1.5					
			(CO+SRV)Neg.	6275	N/A		1.0	1.0	1.0					1.5					
10 hours After	GDCS Condition1	w/o Temp	(CH+SRV)Pos.	6301	N/A	1.0		1.0	1.0						1.5				
			(CH+SRV)Neg.	6305	N/A	1.0		1.0	1.0						1.5				
		Summer	(CH+SRV)Pos.	6311	N/A	1.0		1.0	1.0						1.5				
			(CH+SRV)Neg.	6315	N/A	1.0		1.0	1.0						1.5				
		Winter	(CH+SRV)Pos.	6321	N/A	1.0		1.0	1.0						1.5				
			(CH+SRV)Neg.	6325	N/A	1.0		1.0	1.0						1.5				
	GDCS Condition2	Summer	(CH+SRV)Pos.	6331	N/A	1.0		1.0	1.0						1.5				
			(CH+SRV)Neg.	6335	N/A	1.0		1.0	1.0						1.5				
		Winter	(CH+SRV)Pos.	6341	N/A	1.0		1.0	1.0						1.5				
			(CH+SRV)Neg.	6345	N/A	1.0		1.0	1.0						1.5				
	LOCA Flooding	w/o Temp	(CH+SRV)Pos.	6351	N/A		1.0	1.0	1.0						1.5				
			(CH+SRV)Neg.	6355	N/A		1.0	1.0	1.0						1.5				
		Summer	(CH+SRV)Pos.	6361	N/A		1.0	1.0	1.0						1.5				
			(CH+SRV)Neg.	6365	N/A		1.0	1.0	1.0						1.5				
		Winter	(CH+SRV)Pos.	6371	N/A		1.0	1.0	1.0						1.5				
			(CH+SRV)Neg.	6375	N/A		1.0	1.0	1.0						1.5				
72 hours After	GDCS Condition1	w/o Temp	(CH+SRV)Pos.	6401	N/A	1.0		1.0	1.0							1.5			
			(CH+SRV)Neg.	6405	N/A	1.0		1.0	1.0							1.5			
		Summer	(CH+SRV)Pos.	6411	N/A	1.0		1.0	1.0							1.5			
			(CH+SRV)Neg.	6415	N/A	1.0		1.0	1.0							1.5			
		Winter	(CH+SRV)Pos.	6421	N/A	1.0		1.0	1.0							1.5			
			(CH+SRV)Neg.	6425	N/A	1.0		1.0	1.0							1.5			
	GDCS Condition2	Summer	(CH+SRV)Pos.	6431	N/A	1.0		1.0	1.0							1.5			
			(CH+SRV)Neg.	6435	N/A	1.0		1.0	1.0							1.5			
		Winter	(CH+SRV)Pos.	6441	FB-8	1.0		1.0	1.0							1.5			
			(CH+SRV)Neg.	6445	N/A	1.0		1.0	1.0							1.5			
	LOCA Flooding	w/o Temp	(CH+SRV)Pos.	6451	N/A		1.0	1.0	1.0							1.5			
			(CH+SRV)Neg.	6455	N/A		1.0	1.0	1.0							1.5			
		Summer	(CH+SRV)Pos.	6461	N/A		1.0	1.0	1.0							1.5			
			(CH+SRV)Neg.	6465	N/A		1.0	1.0	1.0							1.5			
		Winter	(CH+SRV)Pos.	6471	N/A		1.0	1.0	1.0							1.5			
			(CH+SRV)Neg.	6475	N/A		1.0	1.0	1.0							1.5			
	LOCA & LOFCF	Summer	(CH+SRV)Pos.	6481	N/A	1.0		1.0	1.0							1.5			
			(CH+SRV)Neg.	6482	N/A	1.0		1.0	1.0							1.5			
		Winter	(CH+SRV)Pos.	6483	N/A	1.0		1.0	1.0							1.5			
			(CH+SRV)Neg.	6484	N/A	1.0		1.0	1.0							1.5			
		Winter	(CH+SRV)Pos.	8501	N/A	1.0		1.0	1.0							1.5			
			(CH+SRV)Neg.	8502	N/A	1.0		1.0	1.0							1.5			
		Winter	(CH+SRV)Pos.	8503	N/A	1.0		1.0	1.0							1.5			
			(CH+SRV)Neg.	8504	N/A	1.0		1.0	1.0							1.5			
		Winter	(CH+SRV)Pos.	8505	N/A	1.0		1.0	1.0							1.5			
			(CH+SRV)Neg.	8506	N/A	1.0		1.0	1.0							1.5			
		Winter	(CH+SRV)Pos.	8507	N/A	1.0		1.0	1.0							1.5			
			(CH+SRV)Neg.	8508	N/A	1.0		1.0	1.0							1.5			
SPF Loss of FAPCS cooling function	NORMAL & LOFCF	Summer	SRVPos.	6491	N/A	1.0		1.0	1.0			1.0							
			SRVNeg.	6492	N/A	1.0		1.0	1.0			1.0							
		Winter	SRVPos.	6493	N/A	1.0		1.0	1.0			1.0							
			SRVNeg.	6494	N/A	1.0		1.0	1.0			1.0							
HELB	MS Tunnel	w/o Temp		6501	N/A	1.0		1.0	1.0									1.5	
		Summer		6511	N/A	1.0		1.0	1.0									1.5	
		Winter		6521	N/A	1.0		1.0	1.0									1.5	
	Other Room	w/o Temp		6561	N/A	1.0		1.0	1.0										1.5
		Summer		6571	N/A	1.0		1.0	1.0										1.5
		Winter		6581	N/A	1.0		1.0	1.0										1.5

Thermal Load (Normal Operation; LOCA (GDCS Condition1*1); LOCA (GDCS Condition2*2); LOCA Flooding; LOCA & LOFCF; SPF LOFCF)

Combination No.	TLS0 (Normal Operation, Summer)	TLW0 (Normal Operation, Winter)	TLS1 (Cond.1 After 5 seconds, Summer)	TLW1 (Cond.1 After 5 seconds, Winter)	TLS2 (Cond.1 After 6 minutes, Summer)	TLW2 (Cond.1 After 6 minutes, Winter)	TLS3 (Cond.1 After 10 hours, Summer)	TLW3 (Cond.1 After 10 hours, Winter)	TLS4 (Cond.1 After 72 hours, Summer)	TLW4 (Cond.1 After 72 hours, Winter)	TLS5 (Cond.2 After 5 sec., Summer)	TLW5 (Cond.2 After 5 sec., Winter)	TLS6 (Cond.2 After 6 minutes, Summer)	TLW6 (Cond.2 After 6 minutes, Winter)	TLS7 (Cond.2 After 10 hours, Summer)	TLW7 (Cond.2 After 10 hours, Winter)	TLS8 (Cond.2 After 72 hours, Summer)	TLW8 (Cond.2 After 72 hours, Winter)	TFS5 (Flooding After 5 sec., Summer)	TFW5 (Flooding After 5 sec., Winter)	TFS6 (Flooding After 6 minutes, Summer)	TFW6 (Flooding After 6 minutes, Winter)	TFS7 (Flooding After 10 hours, Summer)	TFW7 (Flooding After 10 hours, Winter)	TFS8 (Flooding After 72 hours, Summer)	TFW8 (Flooding After 72 hours, Winter)	TSS8 (LOCA & LOFCF After 72 hours, Summer)	TSW8 (LOCA & LOFCF After 72 hours, Winter)	TWC1 (After 72 hours (both Accident), Winter)	TWC2 (Winter)	TWC3 (Winter)	TWC4 (Winter)	TSS0 (SPF LOFCF (after 72hr.), Summer)	TSW0 (SPF LOFCF (after 72hr.), Winter)
6201																																		
6205																																		
6211					1.0																													
6215					1.0																													
6221						1.0																												
6225						1.0																												
6231													1.0																					
6235													1.0																					
6241														1.0																				
6245														1.0																				
6251																																		
6255																																		
6261																					1.0													
6265																					1.0													
6271																						1.0												
6275																						1.0												
6301																																		
6305																																		
6311							1.0																											
6315							1.0																											
6321								1.0																										
6325								1.0																										
6331															1.0																			
6335															1.0																			
6341																1.0																		
6345																1.0																		
6351																																		
6355																																		
6361																							1.0											
6365																							1.0											
6371																								1.0										
6375																								1.0										
6401																																		
6405																																		
6411									1.0																									
6415									1.0																									
6421										1.0																								
6425										1.0																								
6431																	1.0																	
6435																	1.0																	
6441																		1.0																
6445																		1.0																
6451																																		
6455																																		
6461																									1.0									
6465																									1.0									
6471																										1.0								
6475																										1.0								
6481																											1.0							
6482																											1.0							
6483																												1.0						
6484																												1.0						
8501																													1.0					
8502																													1.0					
8503																														1.0				
8504																														1.0				
8505																															1.0			
8506																															1.0			
8507																																1.0		
8508																																1.0		
6491																																	1.0	
6492																																	1.0	
6493																																		1.0
6494																																		1.0
6501																																		
6511	1.0																																	
6521		1.0																																
6561																																		
6571	1.0																																	
6581		1.0																																

Seismic Load, Pipe Reac., Hydrodynamic Load (LOCA; Reaction), Wind Load, Tornado Load and Acceptance Criteria

Combination No.	KSO1 (Seismic: Normal Operation & LOCA)	KSO2 (Seismic: LOCA Flooding)	JET1 (During AP)	JET2 (During AP)	HOS1 (SRV Positive)	HOS2 (SRV Negative)	HLPS (PS Pool Swell)	HLP2 (PS Froth 1)	HLP3 (PS Froth 2)	HLP4 (PS Fall Back)	HLO1 (CO Positive)	HLO2 (CO Negative)	HLC1 (CH Positive)	HLC2 (CH Negative)	SRN* (Reaction SRV NonFlood)	FRN* (Reaction SRV Flood)	PSL* (PS+AP NonFlood)	FSL* (PS+AP Flood)	COL* (CO NonFlood)	FOL* (CO Flood)	CHL* (CH NonFlood)	FHL* (CH Flood)	WON (Wind N to S)	WOS (Wind S to N)	WOE (Wind E to W)	WOW (Wind W to E)	WTN (Tornado N to S)	WTS (Tornado S to N)	WTE (Tornado E to W)	WTW (Tornado W to E)	WTD (Tornado Differential Load)	Acceptance Criteria
6201					1.25						1.5				1.25				1.5													U
6205						1.25						1.5			1.25				1.5													U
6211					1.25						1.5				1.25				1.5													U
6215						1.25						1.5			1.25				1.5													U
6221					1.25						1.5				1.25				1.5													U
6225						1.25						1.5			1.25				1.5													U
6231					1.25						1.5				1.25				1.5													U
6235						1.25						1.5			1.25				1.5													U
6241					1.25						1.5				1.25				1.5													U
6245						1.25						1.5			1.25				1.5													U
6251					1.25						1.5					1.25				1.5												U
6255						1.25						1.5				1.25				1.5												U
6261					1.25						1.5					1.25				1.5												U
6265						1.25						1.5				1.25				1.5												U
6271					1.25						1.5					1.25				1.5												U
6275						1.25						1.5				1.25				1.5												U
6301					1.25								1.5		1.25						1.5											U
6305						1.25								1.5	1.25						1.5											U
6311					1.25								1.5		1.25						1.5											U
6315						1.25								1.5	1.25						1.5											U
6321					1.25								1.5		1.25						1.5											U
6325						1.25								1.5	1.25						1.5											U
6331					1.25								1.5		1.25						1.5											U
6335						1.25								1.5	1.25						1.5											U
6341					1.25								1.5		1.25						1.5											U
6345						1.25								1.5	1.25						1.5											U
6351					1.25								1.5			1.25						1.5										U
6355						1.25								1.5		1.25						1.5										U
6361					1.25								1.5			1.25						1.5										U
6365						1.25								1.5		1.25						1.5										U
6371					1.25								1.5			1.25						1.5										U
6375						1.25								1.5		1.25						1.5										U
6401					1.25								1.5		1.25						1.5											U
6405						1.25								1.5	1.25						1.5											U
6411					1.25								1.5		1.25						1.5											U
6415						1.25								1.5	1.25						1.5											U
6421					1.25								1.5		1.25						1.5											U
6425						1.25								1.5	1.25						1.5											U
6431					1.25								1.5		1.25						1.5											U
6435						1.25								1.5	1.25						1.5											U
6441					1.25								1.5		1.25						1.5											U
6445						1.25								1.5	1.25						1.5											U
6451					1.25								1.5			1.25						1.5										U
6455						1.25								1.5		1.25						1.5										U
6461					1.25								1.5			1.25						1.5										U
6465						1.25								1.5		1.25						1.5										U
6471					1.25								1.5			1.25						1.5										U
6475						1.25								1.5		1.25						1.5										U
6481					1.25								1.5		1.25						1.5											U
6482						1.25								1.5	1.25						1.5											U
6483					1.25								1.5		1.25						1.5											U
6484						1.25								1.5	1.25						1.5											U
8501					1.25								1.5		1.25						1.5											U
8502						1.25								1.5	1.25						1.5											U
8503					1.25								1.5		1.25						1.5											U
8504						1.25								1.5	1.25						1.5											U
8505					1.25								1.5		1.25						1.5											U
8506						1.25								1.5	1.25						1.5											U
8507					1.25								1.5		1.25						1.5											U
8508						1.25								1.5	1.25						1.5											U
6491					1.25										1.25																	U
6492						1.25									1.25																	U
6493					1.25										1.25																	U
6494						1.25									1.25																	U
6501																																U
6511																																U
6521																																U
6561																																U
6571																																U
6581																																U

Note *1: GDCS Pool Water Depth is 4.48 m.

*2: GDCS Pool Water Depth is 0.792 mm.

Opposite sign of stresses due to the hydrodynamic load or combination of hydrodynamic and seismic load to the other loads is considered. In that case, 500 is added to the original LOAD ID.

For acceptance criteria, U = Allowable Stress as in ASME Section III, Div. 2, Subsection CC-3420 for Factored Load Combination.

For unit load cases which are shaded in the table, the results of stress analysis are based on the RB/FB global FE model which is used in Appendix E of ESBWR Reactor Building Structural Design Report, Reference 2.1.2-g.

Table 6.3.2-1 Detail Load Combinations for Reinforced Concrete Structures (Continued)

					Combination No. in DCD	DLO1	DLO2	LLO	SPO	PTL1	PTL2	POL	PL1	PL2	PL3	PL4	AP	PLMS	HOTH	TLS0	TLW0	TLS1	TLW1	TLS2	TLW2	TLS3	TLW3	TLS4	TLW4	TLS5	TLW5	TLS6	TLW6	TLS7	TLW7	TLS8	TLW8	TFS5	TFW5	TFS6	TFW6	TFS7	TFW7	TFS8	TFW8	TSS8	TSW8	TWC1	TWC2	TWC3	TWC4	TSS0	TSW0	KSO1	KSO2	JET1	JET2	HOS1	HOS2	HLPS	HLP2	HLP3	HLP4	HLO1	HLO2	HLC1	HLC2	SRN*	FRN*	PSL*	FSL*	COL*	FOL*	CHL*	FHL*	WON	WOS	WOE	WOW	WTN	WTS	WTE	WTW	WTD	Acceptance Criteria
						Dead Load		Live Load		Pressure Load			LOCA							Thermal Load: Normal Operation		LOCA (GDCS Condition1*1)								LOCA (GDCS Condition2*2)								LOCA Flooding								LOCA & LOFCF						SPF LOFCF		Seismic Load		Pipe Reac.		Hydrodynamic Load		LOCA								Reaction								Wind Load				Tornado Load					
						Normal Operation & LOCA	LOCA Flooding	Normal Operation	Soil Pressure (Static)	Test (Max.)	Test (Diff.)	Normal Operation	After 5 seconds	After 6 minutes	After 10 hours	After 72 hours	Annulus Pressure	HELB in MS Tunnel	HELB in Other Room	Summer	Winter	After 5 seconds Summer	Winter	After 6 minutes Summer	Winter	After 10 hours Summer	Winter	After 72 hours Summer	Winter	After 5 sec. Summer	Winter	After 6 minutes Summer	Winter	After 10 hours Summer	Winter	After 72 hours Summer	Winter	After 5 sec. Summer	Winter	After 6 minutes Summer	Winter	After 10 hours Summer	Winter	After 72 hours Summer	Winter	After 72 hours Summer	Winter	After 72 hours (both Accident) Winter	Winter	Winter	Winter	SPF LOFCF (after 72hr.) Summer	Winter	Normal Operation & LOCA	LOCA Flooding	During AP JET1	JET2	SRV Positive	Negative	PS Pool Swell	Froth 1	Froth 2	Fall Back	CO Positive	Negative	CH Positive	Negative	SRV NonFlood	Flood	PS+AP NonFlood	Flood	CO NonFlood	Flood	CH NonFlood	Flood	N to S	S to N	E to W	W to E	N to S	S to N	E to W	W to E	Tornado Differential Load	
CV-11	Abnormal/Extreme Environmental																																																																																				
5 sec. After	GDCS Condition1	w/o Temp	SRVPos.	7101	N/A	1.0		1.0	1.0				1.0				1.0																																					1.0		1.0	1.0	1.0		1.0								1.0		1.0															U
				7102	N/A	1.0		1.0	1.0				1.0				1.0																																					1.0		1.0	1.0	1.0			1.0	1.0						1.0		1.0															U
				7103	N/A	1.0		1.0	1.0				1.0				1.0																																					1.0		1.0	1.0	1.0		1.0			1.0					1.0		1.0															U
		Summer	SRVPos.	7111	N/A	1.0		1.0	1.0				1.0				1.0					1.0																																1.0		1.0	1.0	1.0		1.0								1.0		1.0															U
				7112	N/A	1.0		1.0	1.0				1.0				1.0					1.0																																1.0		1.0	1.0	1.0			1.0	1.0						1.0		1.0															U
				7113	N/A	1.0		1.0	1.0				1.0				1.0					1.0																																1.0		1.0	1.0	1.0		1.0			1.0					1.0		1.0															U
		Winter	SRVPos.	7121	N/A	1.0		1.0	1.0				1.0				1.0						1.0																														1.0		1.0	1.0	1.0		1.0								1.0		1.0															U
				7122	N/A	1.0		1.0	1.0				1.0				1.0						1.0																														1.0		1.0	1.0	1.0			1.0	1.0						1.0		1.0															U
				7123	N/A	1.0		1.0	1.0				1.0				1.0						1.0																														1.0		1.0	1.0	1.0		1.0			1.0					1.0		1.0															U
	GDCS Condition2	Summer	SRVPos.	7131	N/A	1.0		1.0	1.0				1.0				1.0													1.0																								1.0		1.0	1.0	1.0		1.0								1.0		1.0															U
				7132	N/A	1.0		1.0	1.0				1.0				1.0													1.0																								1.0		1.0	1.0	1.0			1.0	1.0						1.0		1.0															U
				7133	N/A	1.0		1.0	1.0				1.0				1.0													1.0																								1.0		1.0	1.0	1.0		1.0			1.0					1.0		1.0															U
		Winter	SRVPos.	7141	N/A	1.0		1.0	1.0				1.0				1.0														1.0																							1.0		1.0	1.0	1.0		1.0								1.0		1.0															U
				7142	N/A	1.0		1.0	1.0				1.0				1.0														1.0																							1.0		1.0	1.0	1.0			1.0	1.0						1.0		1.0															U
				7143	N/A	1.0		1.0	1.0				1.0				1.0														1.0																							1.0		1.0	1.0	1.0		1.0			1.0					1.0		1.0															U
	LOCA Flooding	w/o Temp	SRVPos.	7151	N/A		1.0	1.0	1.0				1.0				1.0																																						1.0	1.0	1.0	1.0		1.0									1.0		1.0														U
				7152	N/A		1.0	1.0	1.0				1.0				1.0																																						1.0	1.0	1.0	1.0			1.0	1.0							1.0		1.0														U
				7153	N/A		1.0	1.0	1.0				1.0				1.0																																						1.0	1.0	1.0	1.0		1.0			1.0						1.0		1.0														U
		Summer	SRVPos.	7161	N/A		1.0	1.0	1.0				1.0				1.0																					1.0																	1.0	1.0	1.0	1.0		1.0									1.0		1.0														U
				7162	N/A		1.0	1.0	1.0				1.0				1.0																					1.0																	1.0	1.0	1.0	1.0			1.0	1.0							1.0		1.0														U
				7163	N/A		1.0	1.0	1.0				1.0				1.0																					1.0																	1.0	1.0	1.0	1.0		1.0			1.0						1.0		1.0														U
		Winter	SRVPos.	7171	N/A		1.0	1.0	1.0				1.0				1.0																						1.0																1.0	1.0	1.0	1.0		1.0									1.0		1.0														U
				7172	N/A		1.0	1.0	1.0				1.0				1.0																						1.0																1.0	1.0	1.0	1.0			1.0	1.0							1.0		1.0														U
				7173	N/A		1.0	1.0	1.0				1.0				1.0																						1.0																1.0	1.0	1.0	1.0		1.0			1.0						1.0		1.0														U
6 min. After	GDCS Condition1	w/o Temp	(CO+SRV)Pos.	7201	N/A	1.0		1.0	1.0					1.0																																								1.0				1.0						1.0				1.0				1.0													U
		Summer	(CO+SRV)Pos.	7211	N/A	1.0		1.0	1.0					1.0										1.0																														1.0				1.0						1.0				1.0				1.0													U
		Winter	(CO+SRV)Pos.	7221	N/A	1.0		1.0	1.0					1.0											1.0																													1.0				1.0						1.0				1.0				1.0													U
	GDCS Condition2	Summer	(CO+SRV)Pos.	7231	N/A	1.0		1.0	1.0					1.0																		1.0																						1.0				1.0						1.0				1.0				1.0													U
		Winter	(CO+SRV)Pos.	7241	N/A	1.0		1.0	1.0					1.0																			1.0																					1.0				1.0						1.0				1.0				1.0													U
	LOCA Flooding	w/o Temp	(CO+SRV)Pos.	7251	N/A		1.0	1.0	1.0					1.0																																									1.0			1.0						1.0					1.0				1.0												U
		Summer	(CO+SRV)Pos.	7261	N/A		1.0	1.0	1.0					1.0																										1.0															1.0			1.0						1.0					1.0				1.0												U
		Winter	(CO+SRV)Pos.	7271	N/A		1.0	1.0	1.0					1.0																											1.0														1.0			1.0						1.0					1.0				1.0												U
10 hours After	GDCS Condition1	w/o Temp	(CH+SRV)Pos.	7301	N/A	1.0		1.0	1.0						1.0																																							1.0				1.0								1.0		1.0						1.0											U
		Summer	(CH+SRV)Pos.	7311	N/A	1.0		1.0	1.0						1.0											1.0																												1.0				1.0								1.0		1.0						1.0											U
		Winter	(CH+SRV)Pos.	7321	N/A	1.0		1.0	1.0						1.0												1.0																											1.0				1.0								1.0		1.0						1.0											U
	GDCS Condition2	Summer	(CH+SRV)Pos.	7331	N/A	1.0		1.0	1.0						1.0																			1.0																				1.0				1.0								1.0		1.0						1.0											U
		Winter	(CH+SRV)Pos.	7341	N/A	1.0		1.0	1.0						1.0																				1.0																			1.0				1.0								1.0		1.0						1.0											U
	LOCA Flooding	w/o Temp	(CH+SRV)Pos.	7351	N/A		1.0	1.0	1.0						1.0																																								1.0			1.0								1.0			1.0						1.0										U
		Summer	(CH+SRV)Pos.	7361	N/A		1.0	1.0	1.0						1.0																											1.0												1.0			1.0								1.0			1.0						1.0										U
		Winter	(CH+SRV)Pos.	7371	N/A		1.0	1.0	1.0						1.0																												1.0											1.0			1.0								1.0			1.0						1.0										U
72 hours After	GDCS Condition1	w/o Temp	(CH+SRV)Pos.	7401	N/A	1.0		1.0	1.0							1.0																																						1.0				1.0								1.0		1.0						1.0											U
		Summer	(CH+SRV)Pos.	7411	N/A	1.0		1.0	1.0							1.0												1.0																										1.0				1.0								1.0		1.0						1.0											U
		Winter	(CH+SRV)Pos.	7421	N/A	1.0		1.0	1.0							1.0													1.0																									1.0				1.0								1.0		1.0						1.0											U
	GDCS Condition2	Summer	(CH+SRV)Pos.	7431	N/A	1.0		1.0	1.0							1.0																				1.0																		1.0				1.0								1.0		1.0						1.0											U
		Winter	(CH+SRV)Pos.	7441	FB-9	1.0		1.0	1.0							1.0																					1.0																	1.0				1.0								1.0		1.0						1.0											U
	LOCA Flooding	w/o Temp	(CH+SRV)Pos.	7451	N/A		1.0	1.0	1.0							1.0																																							1.0			1.0								1.0			1.0						1.0										U
		Summer	(CH+SRV)Pos.	7461	N/A		1.0	1.0	1.0							1.0																												1.0											1.0			1.0								1.0			1.0						1.0										U
		Winter	(CH+SRV)Pos.	7471	N/A		1.0	1.0	1.0							1.0																													1.0										1.0			1.0								1.0			1.0						1.0										U
	LOCA & LOFCF	Summer	(CH+SRV)Pos.	7481	N/A	1.0		1.0	1.0							1.0																														1.0								1.0				1.0								1.0		1.0						1.0											U
		Winter	(CH+SRV)Pos.	7482	N/A	1.0		1.0	1.0							1.0																															1.0							1.0				1.0								1.0		1.0						1.0											U
		Winter	(CH+SRV)Pos.	8511	N/A	1.0		1.0	1.0							1.0																																1.0						1.0				1.0								1.0		1.0						1.0											U
		Winter	(CH+SRV)Pos.	8512	N/A	1.0		1.0	1.0							1.0																																	1.0					1.0				1.0								1.0		1.0						1.0											U
		Winter	(CH+SRV)Pos.	8513	N/A	1.0		1.0	1.0							1.0																																		1.0				1.0				1.0								1.0		1.0						1.0											U
		Winter	(CH+SRV)Pos.	8514	N/A	1.0		1.0	1.0							1.0																																			1.0			1.0				1.0								1.0		1.0						1.0											U
SPF Loss of FAPCS cooling function	NORMAL & LOFCF	Summer	SRVPos.	7491	N/A	1.0		1.0	1.0			1.0																																								1.0		1.0				1.0										1.0																	U
		Winter	SRVPos.	7492	N/A	1.0		1.0	1.0			1.0																																									1.0	1.0				1.0										1.0																	U
HELB	MS Tunnel	w/o Temp		7501	N/A	1.0		1.0	1.0									1.0																																				1.0																													U
		Summer		7511	N/A	1.0		1.0	1.0									1.0		1.0																																		1.0																													U
		Winter		7521	N/A	1.0		1.0	1.0									1.0			1.0																																	1.0																													U
	Other Room	w/o Temp		7561	N/A	1.0		1.0	1.0										1.0																																			1.0																													U
		Summer		7571	N/A	1.0		1.0	1.0										1.0	1.0																																		1.0																													U
		Winter		7581	N/A	1.0		1.0	1.0										1.0		1.0																																	1.0																													U

Note *1: GDCS Pool Water Depth is 4.48 m.

*2: GDCS Pool Water Depth is 0.792 mm.

Opposite sign of stresses due to the hydrodynamic load or combination of hydrodynamic and seismic load to the other loads is considered. In that case, 500 is added to the original LOAD ID.

For acceptance criteria, U = Allowable Stress as in ASME Section III, Div. 2, Subsection CC-3420 for Factored Load Combination.

For unit load cases which are shaded in the table, the results of stress analysis are based on the RB/FB global FE model which is used in Appendix E of ESBWR Reactor Building Structural Design Report, Reference 2.1.2-g.

Table 6.3.2-2 Detail Load Combinations for Steel Structures

Load Combination	Case	ID	Dead Load DLO3	Live Load: Normal Operation LLO	Live Load: Soil Pressure (Static) SPO	Pressure Load LOCA: After 5 seconds PL1	Pressure Load LOCA: After 6 minutes PL2	Pressure Load LOCA: After 10 hours PL3	Pressure Load LOCA: After 72 hours PL4	Annulus Pressure AP	HELB in MS Tunnel PLMS	HELB in Other Room HOTH	Thermal Normal Operation: Summer TLS0	Thermal Normal Operation: Winter TLW0	LOCA (GDCS Condition1*1) After 5 seconds: Summer TLS1	After 5 seconds: Winter TLW1	After 6 minutes: Summer TLS2	After 6 minutes: Winter TLW2	After 10 hours: Summer TLS3	After 10 hours: Winter TLW3	After 72 hours: Summer TLS4	After 72 hours: Winter TLW4	LOCA (GDCS Condition2*2) After 5 sec: Summer TLS5	After 5 sec: Winter TLW5	After 6 minutes: Summer TLS6	After 6 minutes: Winter TLW6	After 10 hours: Summer TLS7	After 10 hours: Winter TLW7	After 72 hours: Summer TLS8	After 72 hours: Winter TLW8	LOCA & LOFCF After 72 hours (both Accident): Summer TSS8	Winter TSW8	Winter TWC1	Winter TWC2	Winter TWC3	Winter TWC4	SPF LOFCF (after 72hr): Summer TSS0	SPF LOFCF (after 72hr): Winter TSW0	Seismic Load KSO	Pipe Reac. During AP: JET1	Pipe Reac. During AP: JET2	Hydrodynamic SRV: Positive HOS1	LOCA PS: Pool Swell HLPS	LOCA PS: Froth 1 HLP2	LOCA PS: Froth 2 HLP3	LOCA PS: Fall Back HLP4	LOCA CO: Positive HLO1	LOCA CH: Positive HLC1	Reaction SRV SRN	Reaction PS+AP PSL	Reaction CO COL	Reaction CH CHL	Wind Load N to S WON	Wind Load S to N WOS	Wind Load E to W WOE	Wind Load W to E WOW	Tornado Load N to S WTN	Tornado Load S to N WTS	Tornado Load E to W WTE	Tornado Load W to E WTW	Tornado Differential Load WTD	Acceptance Criteria
STEEL-Construction 1.0D+1.0L																																																														
		1001	1.0	1.0																																																								S
STEEL-S3	1.0D+1.0L+1.0W (Normal Operation)																																																												
	N to S Wind	3001	1.0	1.0	1.0																																														1.0									S
	S to N Wind	3002	1.0	1.0	1.0																																															1.0								S
	E to W Wind	3003	1.0	1.0	1.0																																																1.0							S
	W to E Wind	3004	1.0	1.0	1.0																																																	1.0						S
STEEL-S4	1.0D+1.0L+1.0To+1.0W (Normal Operation)																																																												
	Summer N to S Wind	4011	1.0	1.0	1.0								1.0																																						1.0									S(a)
	S to N Wind	4012	1.0	1.0	1.0								1.0																																							1.0								S(a)
	E to W Wind	4013	1.0	1.0	1.0								1.0																																								1.0							S(a)
	W to E Wind	4014	1.0	1.0	1.0								1.0																																									1.0						S(a)
	Winter N to S Wind	4021	1.0	1.0	1.0									1.0																																					1.0									S(a)
	S to N Wind	4022	1.0	1.0	1.0									1.0																																						1.0								S(a)
	E to W Wind	4023	1.0	1.0	1.0									1.0																																							1.0							S(a)
	W to E Wind	4024	1.0	1.0	1.0									1.0																																								1.0						S(a)
STEEL-S5	SSE (Normal Operation)																																																												
	Summer	5001	1.0	1.0	1.0								1.0																										1.0																								1.6S(b)(c)
	Winter	5002	1.0	1.0	1.0									1.0																									1.0																								1.6S(b)(c)
	w/o Temp	5003	1.0	1.0	1.0																																		1.0																								1.6S(b)(c)
STEEL-S6	Tornado (Normal Operation)																																																												
	Summer N to S Wind	6011	1.0	1.0	1.0								1.0																																										1.0					1.6S(b)(c)
	S to N Wind	6012	1.0	1.0	1.0								1.0																																											1.0				1.6S(b)(c)
	E to W Wind	6013	1.0	1.0	1.0								1.0																																												1.0			1.6S(b)(c)
	W to E Wind	6014	1.0	1.0	1.0								1.0																																													1.0		1.6S(b)(c)
	N to S Wind+DP/2	6015	1.0	1.0	1.0								1.0																																										1.0				0.5	1.6S(b)(c)
	S to N Wind+DP/2	6016	1.0	1.0	1.0								1.0																																											1.0			0.5	1.6S(b)(c)
	E to W Wind+DP/2	6017	1.0	1.0	1.0								1.0																																												1.0		0.5	1.6S(b)(c)
	W to E Wind+DP/2	6018	1.0	1.0	1.0								1.0																																													1.0	0.5	1.6S(b)(c)
	Differential	6019	1.0	1.0	1.0								1.0																																														1.0	1.6S(b)(c)
	Winter N to S Wind	6021	1.0	1.0	1.0									1.0																																									1.0					1.6S(b)(c)
	S to N Wind	6022	1.0	1.0	1.0									1.0																																										1.0				1.6S(b)(c)
	E to W Wind	6023	1.0	1.0	1.0									1.0																																											1.0			1.6S(b)(c)
	W to E Wind	6024	1.0	1.0	1.0									1.0																																												1.0		1.6S(b)(c)
	N to S Wind+DP/2	6025	1.0	1.0	1.0									1.0																																									1.0				0.5	1.6S(b)(c)
	S to N Wind+DP/2	6026	1.0	1.0	1.0									1.0																																										1.0			0.5	1.6S(b)(c)
	E to W Wind+DP/2	6027	1.0	1.0	1.0									1.0																																											1.0		0.5	1.6S(b)(c)
	W to E Wind+DP/2	6028	1.0	1.0	1.0									1.0																																												1.0	0.5	1.6S(b)(c)
	Differential	6029	1.0	1.0	1.0									1.0																																													1.0	1.6S(b)(c)
	w/o Temp N to S Wind	6001	1.0	1.0	1.0																																																		1.0					1.6S(b)(c)
	S to N Wind	6002	1.0	1.0	1.0																																																			1.0				1.6S(b)(c)
	E to W Wind	6003	1.0	1.0	1.0																																																				1.0			1.6S(b)(c)
	W to E Wind	6004	1.0	1.0	1.0																																																					1.0		1.6S(b)(c)
	N to S Wind+DP/2	6005	1.0	1.0	1.0																																																		1.0				0.5	1.6S(b)(c)
	S to N Wind+DP/2	6006	1.0	1.0	1.0																																																			1.0			0.5	1.6S(b)(c)
	E to W Wind+DP/2	6007	1.0	1.0	1.0																																																				1.0		0.5	1.6S(b)(c)
	W to E Wind+DP/2	6008	1.0	1.0	1.0																																																				1.0	0.5	1.6S(b)(c)
	Differential	6009	1.0	1.0	1.0																																																					1.0	1.6S(b)(c)

Note *1: GDCS Pool Water Depth is 4.48 m.
*2: GDCS Pool Water Depth is 0.792 mm.
Opposite sign of stresses due to the hydrodynamic load or combination of hydrodynamic and seismic load to the other loads is considered. In that case, 500 is added to the original LOAD ID.
The acceptance criteria are specified in Part 1 of ANSI/AISC N-690-1994-s2 (2004).
For unit load cases which are shaded in the table, the results of stress analysis are based on the RB/FB global FE model which is used in Appendix E of ESBWR Reactor Building Structural Design Report, Reference 2.1.2-g.

Table 6.3.2-2 Detail Load Combinations for Steel Structures (Continued)

						Live Load		Pressure Load							Thermal Load																											Pipe Reac.		Hydrodynamic Load											Wind Load				Tornado Load					
								LOCA									LOCA (GDCS Condition1*1)								LOCA (GDCS Condition2*2)								LOCA & LOFCF						SPF LOFCF							LOCA						Reaction														
					Dead Load	Normal Operation	Soil Pressure (Static)	After 5 seconds	After 6 minutes	After 10 hours	After 72 hours	Annulus Pressure	HELB in MS Tunnel	HELB in Other Room	Normal Operation		After 5 seconds		After 6 minutes		After 10 hours		After 72 hours		After 5 sec		After 6 minutes		After 10 hours		After 72 hours				After 72 hours (both Accident)				SPF LOFCF (after 72hr.)		Seismic Load	During AP		SRV	PS				CO	CH	SRV	PS+AP	CO	CH	N to S	S to N	E to W	W to E	N to S	S to N	E to W	W to E	Tornado Differential Load	Acceptance Criteria
															Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Winter	Winter	Winter	Winter	Summer	Winter		JET1	JET2	Positive	Pool Swell	Froth 1	Froth 2	Fall Back	Positive	Positive														
					DLO3	LLO	SPO	PL1	PL2	PL3	PL4	AP	PLMS	HOTH	TLS0	TLW0	TLS1	TLW1	TLS2	TLW2	TLS3	TLW3	TLS4	TLW4	TLS5	TLW5	TLS6	TLW6	TLS7	TLW7	TLS8	TLW8	TSS8	TSW8	TWC1	TWC2	TWC3	TWC4	TSS0	TSW0	KSO	JET1	JET2	HOS1	HLPS	HLP2	HLP3	HLP4	HLO1	HLC1	SRN	PSL	COL	CHL	WON	WOS	WOE	WOW	WTN	WTS	WTE	WTW	WTD	
STEEL-S7	LOCA																																																														
	5 sec. After	GDCS Condition1	Summer	7001	1.0	1.0	1.0	1.0				1.0					1.0																									1.0	1.0	1.0	1.0						1.0	1.0												1.6S(b)(c)
				7002	1.0	1.0	1.0	1.0				1.0					1.0																									1.0	1.0	1.0		1.0	1.0				1.0	1.0												1.6S(b)(c)
				7003	1.0	1.0	1.0	1.0				1.0					1.0																									1.0	1.0	1.0	1.0			1.0			1.0	1.0												1.6S(b)(c)
			Winter	7004	1.0	1.0	1.0	1.0				1.0						1.0																								1.0	1.0	1.0	1.0						1.0	1.0												1.6S(b)(c)
				7005	1.0	1.0	1.0	1.0				1.0						1.0																								1.0	1.0	1.0		1.0	1.0				1.0	1.0												1.6S(b)(c)
				7006	1.0	1.0	1.0	1.0				1.0						1.0																								1.0	1.0	1.0	1.0			1.0			1.0	1.0												1.6S(b)(c)
		GDCS Condition2	Summer	7007	1.0	1.0	1.0	1.0				1.0													1.0																	1.0	1.0	1.0	1.0						1.0	1.0												1.6S(b)(c)
				7008	1.0	1.0	1.0	1.0				1.0													1.0																	1.0	1.0	1.0		1.0	1.0				1.0	1.0												1.6S(b)(c)
				7009	1.0	1.0	1.0	1.0				1.0													1.0																	1.0	1.0	1.0	1.0			1.0			1.0	1.0												1.6S(b)(c)
			Winter	7010	1.0	1.0	1.0	1.0				1.0														1.0																1.0	1.0	1.0	1.0						1.0	1.0												1.6S(b)(c)
				7011	1.0	1.0	1.0	1.0				1.0														1.0																1.0	1.0	1.0		1.0	1.0				1.0	1.0												1.6S(b)(c)
				7012	1.0	1.0	1.0	1.0				1.0														1.0																1.0	1.0	1.0	1.0			1.0			1.0	1.0												1.6S(b)(c)
			w/o Temp	7013	1.0	1.0	1.0	1.0				1.0																														1.0	1.0	1.0	1.0						1.0	1.0												1.6S(b)(c)
				7014	1.0	1.0	1.0	1.0				1.0																														1.0	1.0	1.0		1.0	1.0				1.0	1.0												1.6S(b)(c)
				7015	1.0	1.0	1.0	1.0				1.0																														1.0	1.0	1.0	1.0			1.0			1.0	1.0												1.6S(b)(c)
	6 min. After	GDCS Condition1	Summer	7016	1.0	1.0	1.0		1.0										1.0																									1.0					1.0		1.0		1.0											1.6S(b)(c)
			Winter	7017	1.0	1.0	1.0		1.0											1.0																								1.0					1.0		1.0		1.0											1.6S(b)(c)
		GDCS Condition2	Summer	7018	1.0	1.0	1.0		1.0																		1.0																	1.0					1.0		1.0		1.0											1.6S(b)(c)
			Winter	7019	1.0	1.0	1.0		1.0																			1.0																1.0					1.0		1.0		1.0											1.6S(b)(c)
			w/o Temp	7020	1.0	1.0	1.0		1.0																																			1.0					1.0		1.0		1.0											1.6S(b)(c)
	10 hours After	GDCS Condition1	Summer	7021	1.0	1.0	1.0			1.0											1.0																							1.0						1.0	1.0			1.0										1.6S(b)(c)
			Winter	7022	1.0	1.0	1.0			1.0												1.0																						1.0						1.0	1.0			1.0										1.6S(b)(c)
		GDCS Condition2	Summer	7023	1.0	1.0	1.0			1.0																			1.0															1.0						1.0	1.0			1.0										1.6S(b)(c)
			Winter	7024	1.0	1.0	1.0			1.0																				1.0														1.0						1.0	1.0			1.0										1.6S(b)(c)
			w/o Temp	7025	1.0	1.0	1.0			1.0																																		1.0						1.0	1.0			1.0										1.6S(b)(c)
	72 hours After	GDCS Condition1	Summer	7026	1.0	1.0	1.0				1.0												1.0																					1.0						1.0	1.0			1.0										1.6S(b)(c)
			Winter	7027	1.0	1.0	1.0				1.0													1.0																				1.0						1.0	1.0			1.0										1.6S(b)(c)
		GDCS Condition2	Summer	7028	1.0	1.0	1.0				1.0																			1.0													1.0						1.0	1.0			1.0										1.6S(b)(c)
			Winter	7029	1.0	1.0	1.0				1.0																				1.0												1.0						1.0	1.0			1.0										1.6S(b)(c)
			w/o Temp	7030	1.0	1.0	1.0				1.0																																1.0						1.0	1.0			1.0										1.6S(b)(c)
	LOCA & LOFCF		Summer	7031	1.0	1.0	1.0				1.0																					1.0											1.0						1.0	1.0			1.0										1.6S(b)(c)
			Winter	7032	1.0	1.0	1.0				1.0																						1.0										1.0						1.0	1.0			1.0										1.6S(b)(c)
			Winter	7041	1.0	1.0	1.0				1.0																							1.0									1.0						1.0	1.0			1.0										1.6S(b)(c)
			Winter	7042	1.0	1.0	1.0				1.0																								1.0								1.0						1.0	1.0			1.0										1.6S(b)(c)
			Winter	7043	1.0	1.0	1.0				1.0																									1.0							1.0						1.0	1.0			1.0										1.6S(b)(c)
			Winter	7044	1.0	1.0	1.0				1.0																										1.0						1.0						1.0	1.0			1.0										1.6S(b)(c)
SPF Loss of FAPCS cooling function	NORMAL & LOFCF		Summer	7033	1.0	1.0	1.0																																1.0					1.0							1.0													1.6S(b)(c)
			Winter	7034	1.0	1.0	1.0																																	1.0				1.0							1.0													1.6S(b)(c)
	HELB in MS Tunnel		Summer	7035	1.0	1.0	1.0						1.0		1.0																																																	1.6S(b)(c)
			Winter	7036	1.0	1.0	1.0						1.0			1.0																																																1.6S(b)(c)
			w/o Temp	7037	1.0	1.0	1.0						1.0																																																		1.6S(b)(c)
	HELB in Other Room		Summer	7038	1.0	1.0	1.0							1.0	1.0																																																	1.6S(b)(c)
			Winter	7039	1.0	1.0	1.0							1.0		1.0																																															1.6S(b)(c)
			w/o Temp	7040	1.0	1.0	1.0							1.0																																																	1.6S(b)(c)

Note *1: GDCS Pool Water Depth is 4.48 m.
*2: GDCS Pool Water Depth is 0.792 mm.
Opposite sign of stresses due to the hydrodynamic load or combination of hydrodynamic and seismic load to the other loads is considered. In that case, 500 is added to the original LOAD ID.
The acceptance criteria are specified in Part 1 of ANSI/AISC N-690-1994-s2 (2004).
For unit load cases which are shaded in the table, the results of stress analysis are based on the RB/FB global FE model which is used in Appendix E of ESBWR Reactor Building Structural Design Report, Reference 2.1.2-g.

Table 6.3.2-2 Detail Load Combinations for Steel Structures (Continued)

						Live Load		Pressure Load							Thermal Load																										Pipe		Hydrodynamic Load											Wind Load				Tornado Load					Acceptance Criteria
								LOCA									LOCA (GDCS Condition1*1)								LOCA (GDCS Condition2*2)								LOCA & LOFCF						SPF LOFCF			Reac.		LOCA							Reaction													
					Dead Load	Normal Operation	Soil Pressure (Static)	After 5 seconds	After 6 minutes	After 10 hours	After 72 hours	Annulus Pressure	HELB in MS Tunnel	HELB in Other Room	Normal Operation		After 5 seconds		After 6 minutes		After 10 hours		After 72 hours		After 5 sec		After 6 minutes		After 10 hours		After 72 hours		After 72 hours (both Accident)						SPF LOFCF (after 72hr.)		Seismic Load	During AP		SRV	PS				CO	CH	SRV	PS+AP	CO	CH	N to S	S to N	E to W	W to E	N to S	S to N	E to W	W to E	Tornado Differential Load	
															Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Winter	Winter	Winter	Winter	Summer	Winter		JET1	JET2	Positive	Pool Swell	Froth 1	Froth 2	Fall Back	Positive	Positive														
					DLO3	LLO	SPO	PL1	PL2	PL3	PL4	AP	PLMS	HOTH	TLS0	TLW0	TLS1	TLW1	TLS2	TLW2	TLS3	TLW3	TLS4	TLW4	TLS5	TLW5	TLS6	TLW6	TLS7	TLW7	TLS8	TLW8	TSS8	TSW8	TWC1	TWC2	TWC3	TWC4	TSS0	TSW0	KSO	JET1	JET2	HOS1	HLPS	HLP2	HLP3	HLP4	HLO1	HLC1	SRN	PSL	COL	CHL	WON	WOS	WOE	WOW	WTN	WTS	WTE	WTW	WTD	
STEEL-S8	LOCA (LOCA+SSE)																																																																
	5 sec. After	GDCS Condition1	Summer	8001	1.0	1.0	1.0	1.0				1.0					1.0																								1.0	1.0	1.0	1.0	1.0						1.0	1.0												1.7S(b)(c)
				8002	1.0	1.0	1.0	1.0				1.0																													1.0	1.0	1.0	1.0		1.0	1.0				1.0	1.0												1.7S(b)(c)
				8003	1.0	1.0	1.0	1.0				1.0																													1.0	1.0	1.0	1.0	1.0			1.0			1.0	1.0												1.7S(b)(c)
			Winter	8004	1.0	1.0	1.0	1.0				1.0						1.0																							1.0	1.0	1.0	1.0	1.0						1.0	1.0												1.7S(b)(c)
				8005	1.0	1.0	1.0	1.0				1.0																													1.0	1.0	1.0	1.0		1.0	1.0				1.0	1.0												1.7S(b)(c)
				8006	1.0	1.0	1.0	1.0				1.0																													1.0	1.0	1.0	1.0	1.0			1.0			1.0	1.0												1.7S(b)(c)
		GDCS Condition2	Summer	8007	1.0	1.0	1.0	1.0				1.0													1.0																1.0	1.0	1.0	1.0	1.0						1.0	1.0												1.7S(b)(c)
				8008	1.0	1.0	1.0	1.0				1.0																													1.0	1.0	1.0	1.0		1.0	1.0				1.0	1.0												1.7S(b)(c)
				8009	1.0	1.0	1.0	1.0				1.0																													1.0	1.0	1.0	1.0	1.0			1.0			1.0	1.0												1.7S(b)(c)
			Winter	8010	1.0	1.0	1.0	1.0				1.0														1.0															1.0	1.0	1.0	1.0	1.0						1.0	1.0												1.7S(b)(c)
				8011	1.0	1.0	1.0	1.0				1.0																													1.0	1.0	1.0	1.0		1.0	1.0				1.0	1.0												1.7S(b)(c)
				8012	1.0	1.0	1.0	1.0				1.0																													1.0	1.0	1.0	1.0	1.0			1.0			1.0	1.0												1.7S(b)(c)
			w/o Temp	8013	1.0	1.0	1.0	1.0				1.0																													1.0	1.0	1.0	1.0	1.0						1.0	1.0												1.7S(b)(c)
				8014	1.0	1.0	1.0	1.0				1.0																													1.0	1.0	1.0	1.0		1.0	1.0				1.0	1.0												1.7S(b)(c)
				8015	1.0	1.0	1.0	1.0				1.0																													1.0	1.0	1.0	1.0	1.0			1.0			1.0	1.0												1.7S(b)(c)
	6 min. After	GDCS Condition1	Summer	8101	1.0	1.0	1.0		1.0										1.0																						1.0			1.0					1.0		1.0		1.0											1.7S(b)(c)
		Condition1	Winter	8102	1.0	1.0	1.0		1.0											1.0																					1.0			1.0					1.0		1.0		1.0											1.7S(b)(c)
		GDCS	Summer	8103	1.0	1.0	1.0		1.0																		1.0														1.0			1.0					1.0		1.0		1.0											1.7S(b)(c)
		Condition2	Winter	8104	1.0	1.0	1.0		1.0																			1.0													1.0			1.0					1.0		1.0		1.0											1.7S(b)(c)
			w/o Temp	8105	1.0	1.0	1.0		1.0																																1.0			1.0					1.0		1.0		1.0											1.7S(b)(c)
	10 hours After	GDCS	Summer	8106	1.0	1.0	1.0			1.0											1.0																				1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
		Condition1	Winter	8107	1.0	1.0	1.0			1.0												1.0																			1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
		GDCS	Summer	8108	1.0	1.0	1.0			1.0																			1.0												1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
		Condition2	Winter	8109	1.0	1.0	1.0			1.0																				1.0											1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
			w/o Temp	8110	1.0	1.0	1.0			1.0																															1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
	72 hours After	GDCS	Summer	8111	1.0	1.0	1.0				1.0												1.0																		1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
		Condition1	Winter	8112	1.0	1.0	1.0				1.0													1.0																	1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
		GDCS	Summer	8113	1.0	1.0	1.0				1.0																				1.0										1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
		Condition2	Winter	8114	1.0	1.0	1.0				1.0																					1.0									1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
			w/o Temp	8115	1.0	1.0	1.0				1.0																														1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
	LOCA &		Summer	8116	1.0	1.0	1.0				1.0																						1.0								1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
	LOFCF		Winter	8117	1.0	1.0	1.0				1.0																							1.0							1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
			Winter	8126	1.0	1.0	1.0				1.0																								1.0						1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
			Winter	8127	1.0	1.0	1.0				1.0																									1.0					1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
			Winter	8128	1.0	1.0	1.0				1.0																										1.0				1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
			Winter	8129	1.0	1.0	1.0				1.0																											1.0			1.0			1.0						1.0	1.0			1.0										1.7S(b)(c)
SPF Loss of FAPCS	NORMAL &		Summer	8118	1.0	1.0	1.0																																1.0		1.0			1.0							1.0													1.7S(b)(c)
cooling function	LOFCF		Winter	8119	1.0	1.0	1.0																																	1.0	1.0			1.0							1.0													1.7S(b)(c)
	HELB in MS Tunnel		Summer	8120	1.0	1.0	1.0						1.0		1.0																										1.0																							1.7S(b)(c)
			Winter	8121	1.0	1.0	1.0						1.0			1.0																									1.0																							1.7S(b)(c)
			w/o Temp	8122	1.0	1.0	1.0						1.0																												1.0																							1.7S(b)(c)
	HELB in Other Room		Summer	8123	1.0	1.0	1.0							1.0	1.0																										1.0																							1.7S(b)(c)
			Winter	8124	1.0	1.0	1.0							1.0		1.0																									1.0																							1.7S(b)(c)
			w/o Temp	8125	1.0	1.0	1.0							1.0																											1.0																							1.7S(b)(c)

Note *1: GDCS Pool Water Depth is 4.48 m.
*2: GDCS Pool Water Depth is 0.792 mm.
Opposite sign of stresses due to the hydrodynamic load or combination of hydrodynamic and seismic load to the other loads is considered. In that case, 500 is added to the original LOAD ID.
The acceptance criteria are specified in Part 1 of ANSI/AISC N-690-1994-s2 (2004).
For unit load cases which are shaded in the table, the results of stress analysis are based on the RB/FB global FE model which is used in Appendix E of ESBWR Reactor Building Structural Design Report, Reference 2.1.2-g.

Table 6.3.3-1 Combined Forces and Moments: 1.05D + 1.3L +1.3To + 1.3W: Winter: Load ID = 4021 (Selected Load Combination FB-4)

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	OTHR	-2.761	-2.158	-0.833	-0.155	-1.183	0.019	-0.066	-0.940
		TEMP	-1.399	0.244	-0.150	1.389	1.248	0.082	-0.323	-0.124
	60219	OTHR	-2.521	-1.990	-0.577	0.103	-0.753	0.145	0.027	-0.858
		TEMP	2.141	-3.473	1.526	-16.532	-22.653	-0.638	-0.009	-2.744
	70201	OTHR	-0.927	-0.381	0.019	-1.345	-0.894	-0.609	0.588	-0.045
		TEMP	2.590	3.915	-1.049	-5.504	-5.911	0.402	-0.198	0.757
	70204	OTHR	-1.294	-1.779	-0.213	0.449	-1.951	-0.415	-0.086	1.941
		TEMP	1.973	1.474	-0.981	-5.183	-6.088	0.322	0.084	0.078
	110718	OTHR	-0.743	-1.075	-0.846	-0.079	0.018	0.047	0.072	0.103
		TEMP	-2.857	-4.097	-1.806	-2.527	-2.904	0.015	0.243	-0.324
2 Exterior Wall @ EL4.65 ~6.60m	62011	OTHR	-0.206	-1.135	-0.107	0.033	0.189	0.008	0.000	0.075
		TEMP	7.429	2.426	0.697	-1.402	-1.563	0.008	-0.029	-0.075
	62019	OTHR	-0.339	-0.714	-0.078	0.018	0.119	-0.030	0.012	0.059
		TEMP	10.022	0.294	-2.625	-1.562	-1.942	-0.063	0.045	-0.137
	72001	OTHR	-0.073	-0.261	-0.058	-0.268	-0.039	0.054	0.145	0.026
		TEMP	5.610	-1.657	3.481	-0.530	-1.166	0.047	-0.963	0.332
	72004	OTHR	-0.278	-0.666	-0.073	0.390	0.266	0.053	0.061	-0.165
		TEMP	8.962	1.077	3.662	-1.724	-2.091	0.110	-0.068	0.213
3 Exterior Wall @ EL22.50 ~24.60m	64011	OTHR	0.255	-0.308	-0.066	-0.122	-0.585	0.002	-0.002	0.067
		TEMP	5.619	0.223	0.312	-1.261	-0.544	-0.026	-0.006	-0.099
	64019	OTHR	0.004	-0.413	-0.085	-0.069	-0.408	0.056	0.067	0.054
		TEMP	6.640	1.810	1.921	-1.323	-0.590	0.031	-0.009	-0.068
	74001	OTHR	-0.023	-0.056	0.119	0.057	-0.051	-0.042	-0.031	-0.029
		TEMP	3.770	-0.975	-4.229	-0.993	-0.606	0.162	-0.381	0.129
	74004	OTHR	-0.027	-0.227	0.086	-0.084	-0.383	-0.062	0.018	-0.061
		TEMP	5.254	0.289	-4.060	-1.230	-0.396	-0.031	0.029	0.115
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	OTHR	-2.105	-1.488	-0.683	0.638	1.075	0.111	0.184	-0.012
		TEMP	-2.782	-4.484	-0.289	-13.307	-12.914	-1.206	-0.062	-1.487
	70801	OTHR	-1.408	-0.699	-0.089	-3.527	-0.259	-0.424	2.179	-0.351
		TEMP	0.397	4.656	-0.384	-5.261	-5.277	0.027	0.021	-0.027
	70804	OTHR	-1.217	-1.098	-0.094	2.790	1.829	-0.341	0.324	0.256
		TEMP	-0.972	0.944	0.201	-5.140	-5.323	0.365	-0.042	0.181
	110748	OTHR	-0.545	-0.665	-0.428	-0.053	-0.042	-0.069	0.102	-0.059
		TEMP	-0.574	-3.683	-1.399	-1.735	-2.298	-0.112	0.476	-0.198
5 Basemat	90306	OTHR	-4.302	-3.074	0.797	0.965	-0.801	0.431	-0.612	1.576
		TEMP	-0.551	-0.079	0.609	2.135	1.086	0.301	-0.278	0.264
	90310	OTHR	-2.505	-2.555	0.255	-0.649	-0.533	-0.048	0.390	0.184
		TEMP	0.239	0.313	0.518	1.691	1.777	0.959	0.054	-0.064
	90410	OTHR	-3.285	-5.455	0.721	-2.050	-0.017	1.722	1.710	-0.342
		TEMP	-0.173	-0.844	0.141	0.811	2.381	-0.132	-0.103	-0.121
5 Basemat @ Spent Fuel Pool	90486	OTHR	-3.440	-5.735	-0.328	3.065	1.550	-0.126	-0.139	-0.216
		TEMP	-4.244	-2.720	0.470	-24.557	-25.455	2.673	-0.139	0.534
	90490	OTHR	-3.543	-4.705	0.200	-1.336	0.798	0.351	1.536	-0.326
		TEMP	-3.300	3.303	0.448	-29.781	-29.188	0.728	2.617	2.051
	90526	OTHR	-4.260	-6.628	-0.408	0.655	-5.562	-0.299	-0.211	-1.879
		TEMP	3.535	0.045	-0.194	-25.792	-9.116	0.463	-1.405	2.015
6 Slab EL4.65m	93306	OTHR	0.042	-0.229	-0.085	0.100	0.164	0.016	0.034	-0.158
		TEMP	-1.235	-0.073	-1.154	-0.070	0.029	-0.024	0.086	-0.038
	93310	OTHR	-0.038	-0.035	0.140	0.092	0.042	0.011	-0.050	0.004
		TEMP	-2.819	-2.798	-3.576	-0.996	-1.005	-0.291	0.362	0.365
	93410	OTHR	-0.051	-0.174	0.009	0.220	0.058	-0.047	-0.099	-0.017
		TEMP	-0.718	-3.379	-0.128	-0.172	-0.035	0.000	-0.089	-0.038

OTHR: Loads other than thermal loads
TEMP: Thermal loads

Table 6.3.3-2 Combined Forces and Moments: LOCA (1.5Pa): Winter: Load ID = 6441 (Selected Load Combination FB-8)

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	OTHR	-2.180	-2.014	-0.749	-0.156	-1.172	0.013	-0.079	-0.817
		TEMP	-0.932	0.104	-0.283	1.040	0.845	0.081	-0.279	-0.151
		HYDR	0.343	0.293	0.291	0.021	0.118	0.009	0.011	0.040
	60219	OTHR	-1.837	-1.810	-0.486	-0.058	-0.765	0.068	0.027	-0.605
		TEMP	1.775	-2.822	0.999	-12.784	-17.538	-0.622	0.026	-2.138
		HYDR	0.317	0.588	0.207	0.084	0.203	0.013	0.007	0.035
	70201	OTHR	-0.655	-0.304	0.026	-0.934	-0.689	-0.446	0.399	-0.021
		TEMP	2.001	2.952	-0.673	-4.155	-4.561	0.310	-0.183	0.610
		HYDR	0.010	0.175	0.191	0.016	0.053	0.003	0.023	0.017
	70204	OTHR	-0.909	-1.543	-0.127	0.303	-1.514	-0.294	-0.067	1.423
		TEMP	1.559	1.017	-0.470	-3.984	-4.709	0.285	0.069	0.073
		HYDR	0.094	0.569	0.366	0.044	0.100	0.012	0.002	0.023
	110718	OTHR	-0.527	-1.090	-0.694	-0.070	0.033	0.037	0.062	0.118
		TEMP	-2.155	-3.145	-1.392	-1.934	-2.203	0.009	0.190	-0.234
		HYDR	0.159	0.275	0.063	0.016	0.037	0.002	0.004	0.018
2 Exterior Wall @ EL4.65 ~6.60m	62011	OTHR	-0.164	-1.130	-0.068	0.029	0.147	0.007	0.002	0.055
		TEMP	5.880	1.937	0.541	-1.090	-1.228	0.001	-0.030	-0.062
		HYDR	0.101	0.076	0.187	0.003	0.012	0.001	0.004	0.003
	62019	OTHR	-0.256	-0.686	-0.078	0.008	0.087	-0.026	0.008	0.040
		TEMP	7.722	0.133	-2.024	-1.201	-1.492	-0.050	0.033	-0.106
		HYDR	0.061	0.126	0.193	0.003	0.011	0.001	0.001	0.002
	72001	OTHR	-0.044	-0.180	-0.014	-0.199	-0.029	0.034	0.117	0.018
		TEMP	4.333	-1.692	2.655	-0.388	-0.891	0.038	-0.739	0.255
		HYDR	0.023	0.198	0.270	0.007	0.005	0.001	0.002	0.004
	72004	OTHR	-0.202	-0.583	-0.015	0.302	0.200	0.036	0.044	-0.113
		TEMP	7.043	0.683	2.803	-1.318	-1.608	0.083	-0.056	0.166
		HYDR	0.052	0.190	0.321	0.004	0.006	0.001	0.001	0.001
3 Exterior Wall @ EL22.50 ~24.60m	64011	OTHR	0.002	-0.326	-0.056	-0.121	-0.599	0.001	-0.002	0.083
		TEMP	4.710	0.187	0.313	-0.963	-0.391	-0.017	-0.003	-0.083
		HYDR	0.344	0.002	0.133	0.005	0.015	0.002	0.001	0.002
	64019	OTHR	-0.160	-0.426	-0.134	-0.067	-0.419	0.052	0.067	0.067
		TEMP	5.505	1.413	1.655	-1.023	-0.448	0.026	-0.009	-0.051
		HYDR	0.254	0.011	0.101	0.005	0.011	0.004	0.002	0.002
	74001	OTHR	-0.036	-0.042	0.158	0.044	-0.056	-0.036	-0.028	-0.028
		TEMP	2.905	-0.810	-3.488	-0.742	-0.459	0.125	-0.302	0.092
		HYDR	0.020	0.018	0.092	0.009	0.004	0.004	0.005	0.003
	74004	OTHR	-0.101	-0.239	0.179	-0.084	-0.399	-0.055	0.014	-0.080
		TEMP	4.031	0.191	-3.611	-0.936	-0.298	-0.021	0.021	0.087
		HYDR	0.118	0.009	0.173	0.003	0.004	0.004	0.001	0.001
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	OTHR	-1.496	-1.383	-0.597	0.277	0.634	0.027	0.139	-0.023
		TEMP	-2.067	-3.594	-0.353	-10.280	-9.932	-1.102	-0.058	-1.158
		HYDR	0.057	0.403	0.247	0.083	0.054	0.022	0.009	0.015
	70801	OTHR	-0.949	-0.535	-0.048	-2.507	-0.190	-0.332	1.569	-0.269
		TEMP	0.377	3.314	-0.183	-3.883	-4.019	0.017	-0.013	-0.017
		HYDR	0.028	0.219	0.302	0.036	0.010	0.009	0.012	0.005
	70804	OTHR	-0.813	-0.985	-0.033	2.046	1.302	-0.251	0.231	0.205
		TEMP	-0.589	0.585	0.363	-3.927	-4.089	0.317	-0.051	0.144
		HYDR	0.051	0.378	0.366	0.033	0.015	0.017	0.003	0.010
	110748	OTHR	-0.379	-0.726	-0.447	-0.079	-0.049	-0.053	0.092	-0.050
		TEMP	-0.434	-2.821	-1.077	-1.340	-1.771	-0.097	0.369	-0.150
		HYDR	0.060	0.095	0.068	0.010	0.010	0.015	0.002	0.006

OTHR: Loads other than thermal and hydrodynamic loads
TEMP: Thermal loads
HYDR: Hydrodynamic loads

Table 6.3.3-2 Combined Forces and Moments: LOCA (1.5Pa): Winter: Load ID = 6441 (Selected Load Combination FB-8) (Continued)

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
5 Basemat	90306	OTHR	-3.550	-2.447	0.674	0.918	-0.661	0.322	-0.541	1.431
		TEMP	-0.842	-0.093	0.302	1.812	0.786	0.047	-0.013	0.259
		HYDR	0.379	0.165	0.412	0.357	0.091	0.349	0.331	0.408
	90310	OTHR	-1.958	-1.982	0.184	-0.545	-0.444	-0.171	0.342	0.119
		TEMP	0.134	0.271	0.321	1.221	1.339	0.612	0.152	-0.060
		HYDR	0.052	0.139	0.022	0.062	0.063	0.144	0.111	0.142
	90410	OTHR	-2.640	-4.305	0.681	-1.813	0.002	1.619	1.592	-0.270
		TEMP	-0.192	-0.439	0.257	0.435	1.801	0.052	-0.016	-0.216
		HYDR	0.071	0.650	0.200	0.146	0.116	0.471	0.230	0.146
5 Basemat @ Spent Fuel Pool	90486	OTHR	-2.599	-4.369	-0.202	3.046	1.621	0.005	-0.099	-0.152
		TEMP	-3.327	-2.050	0.616	-18.282	-19.282	2.304	-0.005	0.385
		HYDR	0.158	0.207	0.127	1.680	1.236	0.208	0.129	0.088
	90490	OTHR	-2.642	-3.509	0.202	-0.803	0.812	0.385	1.391	-0.177
		TEMP	-2.565	2.723	0.532	-22.985	-22.408	0.850	2.142	1.611
		HYDR	0.057	0.699	0.167	0.334	0.711	0.173	0.524	0.090
	90526	OTHR	-3.180	-4.999	-0.266	0.879	-3.885	-0.140	-0.187	-1.585
		TEMP	2.586	0.040	0.156	-19.469	-6.941	0.735	-0.998	1.464
		HYDR	0.271	0.062	0.398	0.923	0.352	0.426	0.198	0.477
6 Slab EL4.65m	93306	OTHR	0.053	-0.186	-0.139	0.087	0.128	0.012	0.034	-0.142
		TEMP	-0.789	-0.028	-1.656	-0.051	0.035	-0.014	0.080	-0.030
		HYDR	0.184	0.036	0.234	0.034	0.041	0.003	0.008	0.008
	93310	OTHR	-0.037	-0.027	0.108	0.079	0.035	0.013	-0.045	0.002
		TEMP	-2.219	-2.170	-3.223	-0.752	-0.783	-0.242	0.267	0.288
		HYDR	0.035	0.026	0.060	0.032	0.030	0.004	0.034	0.031
	93410	OTHR	-0.015	-0.083	-0.075	0.165	0.045	-0.049	-0.073	-0.015
		TEMP	-0.686	-2.429	-0.064	-0.055	-0.015	0.020	-0.106	-0.032
		HYDR	0.017	0.128	0.106	0.023	0.007	0.012	0.016	0.001

OTHR: Loads other than thermal and hydrodynamic loads
TEMP: Thermal loads
HYDR: Hydrodynamic loads

Table 6.3.3-3 Combined Forces and Moments: LOCA + SSE: Winter: Load ID = 7441 (Selected Load Combination FB-9)

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	OTHR	-2.179	-2.004	-0.745	-0.154	-1.159	0.012	-0.076	-0.809
		TEMP	-0.932	0.104	-0.283	1.040	0.845	0.081	-0.279	-0.151
		SEIS	3.391	1.389	1.662	0.152	1.097	0.062	0.309	0.411
		HYDR	0.241	0.207	0.204	0.015	0.085	0.007	0.008	0.029
	60219	OTHR	-1.837	-1.809	-0.485	-0.058	-0.765	0.071	0.027	-0.605
		TEMP	1.775	-2.822	0.999	-12.784	-17.538	-0.622	0.026	-2.138
		SEIS	4.507	1.922	1.484	2.874	5.191	1.147	0.405	2.304
		HYDR	0.224	0.415	0.145	0.059	0.141	0.008	0.005	0.024
	70201	OTHR	-0.655	-0.307	0.030	-0.935	-0.688	-0.446	0.399	-0.021
		TEMP	2.001	2.952	-0.673	-4.155	-4.561	0.310	-0.183	0.610
		SEIS	0.602	0.811	2.674	1.445	0.852	0.681	0.452	0.270
		HYDR	0.007	0.122	0.136	0.011	0.038	0.002	0.016	0.012
	70204	OTHR	-0.914	-1.541	-0.123	0.304	-1.512	-0.294	-0.067	1.423
		TEMP	1.559	1.017	-0.470	-3.984	-4.709	0.285	0.069	0.073
		SEIS	2.332	2.155	4.012	0.621	2.107	0.487	0.097	1.544
		HYDR	0.067	0.403	0.260	0.031	0.071	0.008	0.001	0.016
	110718	OTHR	-0.526	-1.088	-0.689	-0.070	0.031	0.038	0.062	0.117
		TEMP	-2.155	-3.145	-1.392	-1.934	-2.203	0.009	0.190	-0.234
		SEIS	2.496	1.141	2.693	0.133	0.241	0.123	0.108	0.258
		HYDR	0.114	0.194	0.045	0.011	0.026	0.002	0.003	0.013
2 Exterior Wall @ EL4.65 ~6.60m	62011	OTHR	-0.162	-1.120	-0.066	0.029	0.151	0.007	0.002	0.056
		TEMP	5.880	1.937	0.541	-1.090	-1.228	0.001	-0.030	-0.062
		SEIS	1.284	0.962	2.571	0.199	0.891	0.038	0.042	0.348
		HYDR	0.072	0.054	0.130	0.002	0.008	0.000	0.003	0.002
	62019	OTHR	-0.256	-0.685	-0.078	0.008	0.089	-0.026	0.009	0.040
		TEMP	7.722	0.133	-2.024	-1.201	-1.492	-0.050	0.033	-0.106
		SEIS	0.805	1.650	2.732	0.399	0.738	0.166	0.075	0.202
		HYDR	0.043	0.088	0.135	0.002	0.008	0.001	0.000	0.001
	72001	OTHR	-0.044	-0.197	-0.006	-0.199	-0.029	0.034	0.117	0.018
		TEMP	4.333	-1.692	2.655	-0.388	-0.891	0.038	-0.739	0.255
		SEIS	1.556	3.040	4.567	0.663	0.200	0.165	0.301	0.085
		HYDR	0.016	0.138	0.191	0.005	0.004	0.001	0.001	0.003
	72004	OTHR	-0.198	-0.588	-0.002	0.302	0.200	0.036	0.044	-0.113
		TEMP	7.043	0.683	2.803	-1.318	-1.608	0.083	-0.056	0.166
		SEIS	1.884	2.616	5.021	0.622	0.871	0.106	0.117	0.460
		HYDR	0.037	0.133	0.227	0.002	0.004	0.001	0.001	0.001
3 Exterior Wall @ EL22.50 ~24.60m	64011	OTHR	0.050	-0.326	-0.059	-0.123	-0.604	0.001	-0.002	0.084
		TEMP	4.710	0.187	0.313	-0.963	-0.391	-0.017	-0.003	-0.083
		SEIS	3.265	0.377	1.666	0.160	0.719	0.055	0.028	0.221
		HYDR	0.242	0.001	0.092	0.004	0.011	0.001	0.001	0.001
	64019	OTHR	-0.131	-0.425	-0.116	-0.068	-0.422	0.052	0.067	0.068
		TEMP	5.505	1.413	1.655	-1.023	-0.448	0.026	-0.009	-0.051
		SEIS	2.843	0.448	1.400	0.100	0.545	0.212	0.103	0.088
		HYDR	0.178	0.008	0.070	0.004	0.008	0.002	0.002	0.002
	74001	OTHR	-0.032	-0.046	0.146	0.046	-0.055	-0.037	-0.029	-0.028
		TEMP	2.905	-0.810	-3.488	-0.742	-0.459	0.125	-0.302	0.092
		SEIS	0.221	0.275	1.173	0.154	0.094	0.225	0.073	0.052
		HYDR	0.014	0.013	0.064	0.006	0.003	0.003	0.003	0.002
	74004	OTHR	-0.080	-0.240	0.154	-0.085	-0.400	-0.056	0.014	-0.080
		TEMP	4.031	0.191	-3.611	-0.936	-0.298	-0.021	0.021	0.087
		SEIS	1.773	0.355	2.028	0.120	0.449	0.151	0.071	0.211
		HYDR	0.083	0.006	0.121	0.002	0.003	0.003	0.001	0.001

OTHR: Loads other than thermal, seismic and hydrodynamic loads
TEMP: Thermal loads
SEIS: Seismic loads
HYDR: Hydrodynamic loads

Table 6.3.3-3 Combined Forces and Moments: LOCA + SSE: Winter: Load ID = 7441 (Selected Load Combination FB-9) (Continued)

Location	Element ID		Nx (MN/m)	Ny (MN/m)	Nxy (MN/m)	Mx (MNm/m)	My (MNm/m)	Mxy (MNm/m)	Qx (MN/m)	Qy (MN/m)
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	OTHR	-1.497	-1.381	-0.597	0.277	0.635	0.029	0.139	-0.023
		TEMP	-2.067	-3.594	-0.353	-10.280	-9.932	-1.102	-0.058	-1.158
		SEIS	2.815	1.358	1.990	6.707	2.047	1.474	0.416	1.095
		HYDR	0.039	0.284	0.174	0.058	0.037	0.016	0.006	0.011
	70801	OTHR	-0.950	-0.542	-0.041	-2.508	-0.190	-0.332	1.569	-0.269
		TEMP	0.377	3.314	-0.183	-3.883	-4.019	0.017	-0.013	-0.017
		SEIS	2.446	1.484	3.257	4.046	0.609	0.812	2.099	0.610
		HYDR	0.019	0.153	0.214	0.025	0.007	0.006	0.009	0.003
	70804	OTHR	-0.819	-0.982	-0.023	2.046	1.302	-0.251	0.231	0.205
		TEMP	-0.589	0.585	0.363	-3.927	-4.089	0.317	-0.051	0.144
		SEIS	2.332	1.601	3.755	3.232	1.357	0.538	0.366	0.553
		HYDR	0.036	0.267	0.261	0.023	0.011	0.012	0.002	0.007
	110748	OTHR	-0.379	-0.723	-0.443	-0.078	-0.049	-0.053	0.092	-0.050
		TEMP	-0.434	-2.821	-1.077	-1.340	-1.771	-0.097	0.369	-0.150
		SEIS	1.618	1.105	2.135	0.421	0.143	0.255	0.101	0.099
		HYDR	0.043	0.066	0.049	0.007	0.007	0.011	0.001	0.004
5 Basemat	90306	OTHR	-3.541	-2.445	0.674	0.917	-0.652	0.323	-0.542	1.429
		TEMP	-0.842	-0.093	0.302	1.812	0.786	0.047	-0.013	0.259
		SEIS	2.617	0.678	2.942	1.298	0.418	2.974	2.642	1.674
		HYDR	0.266	0.117	0.292	0.253	0.065	0.246	0.234	0.289
	90310	OTHR	-1.958	-1.979	0.185	-0.542	-0.441	-0.170	0.342	0.115
		TEMP	0.134	0.271	0.321	1.221	1.339	0.612	0.152	-0.060
		SEIS	0.583	1.065	0.300	0.726	0.502	0.939	1.193	2.000
		HYDR	0.036	0.099	0.016	0.044	0.045	0.102	0.078	0.100
	90410	OTHR	-2.630	-4.301	0.674	-1.786	0.003	1.615	1.584	-0.270
		TEMP	-0.192	-0.439	0.257	0.435	1.801	0.052	-0.016	-0.216
		SEIS	0.369	4.923	2.060	1.989	0.824	2.609	1.088	1.731
		HYDR	0.050	0.457	0.140	0.106	0.081	0.332	0.163	0.102
5 Basemat @ Spent Fuel Pool	90486	OTHR	-2.594	-4.374	-0.208	3.019	1.614	-0.002	-0.108	-0.148
		TEMP	-3.327	-2.050	0.616	-18.282	-19.282	2.304	-0.005	0.385
		SEIS	0.450	1.155	1.352	6.105	4.467	2.495	1.324	0.507
		HYDR	0.113	0.145	0.089	1.198	0.875	0.148	0.090	0.061
	90490	OTHR	-2.642	-3.508	0.201	-0.804	0.810	0.377	1.391	-0.182
		TEMP	-2.565	2.723	0.532	-22.985	-22.408	0.850	2.142	1.611
		SEIS	0.329	6.047	1.760	9.878	4.395	1.601	1.904	1.863
		HYDR	0.040	0.495	0.117	0.237	0.504	0.121	0.370	0.063
	90526	OTHR	-3.184	-4.999	-0.266	0.868	-3.882	-0.145	-0.188	-1.583
		TEMP	2.586	0.040	0.156	-19.469	-6.941	0.735	-0.998	1.464
		SEIS	3.195	0.408	3.822	3.345	5.356	4.786	1.856	1.932
		HYDR	0.192	0.044	0.282	0.655	0.248	0.301	0.141	0.339
6 Slab EL4.65m	93306	OTHR	0.051	-0.186	-0.110	0.086	0.127	0.012	0.034	-0.141
		TEMP	-0.789	-0.028	-1.656	-0.051	0.035	-0.014	0.080	-0.030
		SEIS	1.696	0.171	1.135	0.408	0.395	0.029	0.104	0.175
		HYDR	0.129	0.026	0.171	0.024	0.029	0.002	0.005	0.006
	93310	OTHR	-0.034	-0.026	0.124	0.077	0.035	0.014	-0.043	0.002
		TEMP	-2.219	-2.170	-3.223	-0.752	-0.783	-0.242	0.267	0.288
		SEIS	0.577	0.275	0.548	0.580	0.327	0.108	0.431	0.423
		HYDR	0.024	0.018	0.044	0.023	0.022	0.003	0.024	0.022
	93410	OTHR	-0.010	-0.085	-0.080	0.163	0.045	-0.050	-0.072	-0.015
		TEMP	-0.686	-2.429	-0.064	-0.055	-0.015	0.020	-0.106	-0.032
		SEIS	0.606	0.801	1.358	0.813	0.172	0.209	0.392	0.027
		HYDR	0.013	0.091	0.076	0.017	0.005	0.008	0.011	0.001

OTHR: Loads other than thermal, seismic and hydrodynamic loads
TEMP: Thermal loads
SEIS: Seismic loads
HYDR: Hydrodynamic loads

Table 6.4.1.1-1 Material Constants for Stress Calculations

Material	Property	Value	
Concrete	Compressive strength, f_c'	Basemat	27.6 MPa
		Others	34.5 MPa
	Young's modulus	Basemat	2.49×10^4 MPa
		Others	2.78×10^4 MPa
	Poisson's ratio	0.17	
Reinforcement	Yield stress, f_y	413.6 MPa	
	Young's modulus	2.00×10^5 MPa	

Table 6.4.1.1-2 Allowable Stress of Concrete for Membrane Plus Bending

Load Condition	Allowable Compressive Stress (MPa)		
Primary	Basemat	20.7	(0.75 f_c')
	Others	25.9	
Primary plus secondary	Basemat	23.5	(0.85 f_c')
	Others	29.3	

Table 6.4.1.1-3 Allowable Stress of Reinforcement for Membrane Plus Bending

	Allowable Stress (MPa)
Tension	372.2 (0.90 f_y)
Compression	372.2 (0.90 f_y)

Table 6.4.1.1-4 Allowable Stress of Concrete for Membrane Compressive Forces

Load Category	Load Condition	Allowable Compressive Stress (MPa)		
Factored	Primary	Basemat	16.6	(0.60 f_c')
		Others	20.7	
	Primary plus secondary	Basemat	20.7	(0.75 f_c')
		Others	25.9	
Service	Primary	Basemat	8.3	(0.30 f_c')
		Others	10.4	
	Primary plus secondary	Basemat	12.4	(0.45 f_c')
		Others	15.5	

Table 7.3.1.1.1-1 Sectional Thicknesses and Rebar Ratios of FB Used in the Evaluation

Location	Element ID	Thickness (m)	Primary Reinforcement					Shear Tie	
			Position	Direction 1 [*1]		Direction 2 [*1]			
				Arrangement [*2]	Ratio (%)	Arrangement [*2]	Ratio (%)	Arrangement	Ratio (%)
1 Exterior Wall and Pool Wall Bottom	60011	2.0	Inside	3-#11@200	0.755	1-#11@100 +3-#11@200	1.258	#6@200x200	0.710
			Outside	1-#11@100 +3-#11@200	1.258	2-#11@100 +2-#11@200	1.510		
	60219	3.6	Inside	6-#11@200	0.839	6-#11@200	0.839	#6@200x200	0.710
			Outside	1-#11@100 +7-#11@200	1.258	1-#11@100 +7-#11@200	1.258		
	70201 70204	2.0	Inside	3-#11@100 +1-#11@200	1.761	3-#11@100 +1-#11@200	1.761	#6@200x200	0.710
			Outside	3-#11@100 +1-#11@200	1.761	5-#11@100	2.516		
	110718	1.5	Inside	2-#11@200	0.671	3-#11@200 (+1-#11@200)	1.342	#6@400x200	0.355
			Outside	2-#11@200	0.671	3-#11@200 (+1-#11@200)	1.342		
2 Exterior Wall @ EL4.65 to 6.60m	62011 62019	1.0	Inside	2-#11@200	1.006	2-#11@200	1.006	#5@400x400	0.125
			Outside	3-#11@200	1.510	3-#11@200	1.510		
	72001	1.0	Inside	3-#11@200	1.510	3-#11@200	1.510	#5@400x200	0.250
			Outside	3-#11@200	1.510	3-#11@200	1.510		
	72004	1.0	Inside	3-#11@200	1.510	2-#11@200 (+1-#11@200)	1.510	#5@400x200	0.250
			Outside	3-#11@200	1.510	3-#11@200	1.510		
3 Exterior Wall @ EL22.50 to 24.60m	64011	1.0	Inside	2-#11@200	1.006	2-#11@200	1.006	#5@400x400	0.125
			Outside	2-#11@200 (+1-#11@200)	1.510	2-#11@200 (+1-#11@200)	1.510		
	64019	1.0	Inside	2-#11@200	1.006	2-#11@200	1.006	#5@400x400	0.125
			Outside	2-#11@200	1.006	2-#11@200	1.006		
	74001 74004	1.0	Inside	2-#11@200	1.006	2-#11@200	1.006	#5@400x400	0.125
			Outside	3-#11@200	1.510	3-#11@200	1.510		

Note: Updated arrangements of reinforcements and shear ties from standard design are shown in red.

*1: Exterior Wall, Pool Wall — Direction 1: Horizontal — Direction 2: Vertical
Basemat, Slab — Direction 1: N-S — Direction 2: E-W

*2: Rebar in parentheses indicates additional bars locally required.

Table 7.3.1.1.1-1 Sectional Thicknesses and Rebar Ratios of FB Used in the Evaluation (Continued)

Location	Element ID	Thickness (m)	Primary Reinforcement					Shear Tie	
			Position	Direction 1*1		Direction 2*1			
				Arrangement*2	Ratio (%)	Arrangement*2	Ratio (%)	Arrangement	Ratio (%)
4 Spent Fuel Pool Wall @ EL-5.10 to -3.30m	60819	3.6	Inside	6-#11@200	0.839	6-#11@200	0.839	#6@200x200	0.710
			Outside	1-#11@100 +7-#11@200	1.258	1-#11@100 +7-#11@200	1.258		
	70801 70804	2.0	Inside	3-#11@100 +1-#11@200	1.761	3-#11@100 +1-#11@200	1.761	#6@200x200	0.710
			Outside	3-#11@100 +1-#11@200	1.761	5-#11@100	2.516		
	110748	1.5	Inside	2-#11@200	0.671	3-#11@200	1.006	#6@400x400	0.177
			Outside	2-#11@200	0.671	3-#11@200	1.006		
5 Basemat	90306 90310 90410	4.0	Top	4-#11@200	0.503	4-#11@200	0.503	#11@400x400	0.629
			Bottom	5-#11@200	0.629	5-#11@200	0.629		
5 Basemat @ Spent Fuel Pool	90486	5.5	Top	4-#11@200 (+2-#11@200)	0.549	4-#11@200 (+2-#11@200)	0.549	#11@600x400	0.419
			Bottom	5-#11@200	0.457	5-#11@200	0.457		
	90490 90526	5.5	Top	4-#11@200 (+2-#11@200)	0.549	4-#11@200 (+2-#11@200)	0.549	#11@400x400	0.629
			Bottom	5-#11@200	0.457	5-#11@200	0.457		
6 Slab EL4.65m	93306 93310 93410	1.3	Top	2-#11@200	0.774	2-#11@200	0.774	#5@200x200	0.500
			Bottom	2-#11@200	0.774	2-#11@200	0.774		

Note: Updated arrangements of reinforcements and shear ties from standard design are shown in red.

*1: Exterior Wall, Pool Wall — Direction 1: Horizontal — Direction 2: Vertical
Basemat, Slab — Direction 1: N-S — Direction 2: E-W

*2: Rebar in parentheses indicates additional bars locally required.

Table 7.3.1.1.1-2 Rebar and Concrete Stresses of FB: 1.05D+1.3L+1.3To+1.3W: Winter: Load ID = 4021 (Selected Load Combination FB-4)

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
				Calculated				Allowable
		Calculated	Allowable	Direction 1*		Direction 2*		
				In/Top	Out/Bottom	In/Top	Out/Bottom	
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	-3.4	-29.3	-4.5	-19.2	-4.5	-3.3	372.2
	60219	-7.6	-29.3	-9.6	30.1	-32.4	53.7	372.2
	70201	-9.9	-29.3	-12.0	90.3	-10.1	85.1	372.2
	70204	-9.2	-29.3	-4.6	31.0	-30.5	67.6	372.2
	110718	-11.3	-29.3	-16.3	84.8	-26.3	48.4	372.2
2 Exterior Wall @ EL4.65 ~6.60m	62011	-6.4	-29.3	33.6	85.5	-12.0	27.9	372.2
	62019	-10.5	-29.3	53.3	116.8	-27.0	79.9	372.2
	72001	-9.5	-29.3	22.5	108.4	-20.1	80.0	372.2
	72004	-11.5	-29.3	56.9	73.6	-23.0	74.1	372.2
3 Exterior Wall @ EL22.50 ~24.60m	64011	-8.4	-29.3	25.5	101.5	-18.6	66.4	372.2
	64019	-8.4	-29.3	40.6	151.3	-9.4	116.7	372.2
	74001	-4.6	-29.3	23.5	93.7	3.2	80.2	372.2
	74004	-7.5	-29.3	13.7	108.0	1.8	116.4	372.2
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	-5.1	-29.3	-18.1	17.6	-21.1	15.2	372.2
	70801	-11.7	-29.3	-32.2	102.4	1.9	58.6	372.2
	70804	-2.9	-29.3	-12.2	4.0	-5.7	12.8	372.2
	110748	-8.8	-29.3	0.6	57.9	-32.1	33.7	372.2
5 Basemat	90306	-2.1	-23.5	-2.5	-13.7	-5.0	-3.8	372.2
	90310	-0.8	-23.5	-2.6	-4.6	-2.1	-4.9	372.2
	90410	-2.3	-23.5	-7.7	-1.3	-5.7	-15.4	372.2
5 Basemat @ Spent Fuel Pool	90486	-4.0	-23.5	-12.9	8.2	-16.1	8.6	372.2
	90490	-4.2	-23.5	-13.2	23.1	-4.7	11.6	372.2
	90526	-3.1	-23.5	-3.2	12.7	-14.0	4.4	372.2
6 Slab EL4.65m	93306	-1.8	-29.3	18.1	4.0	41.8	5.0	372.2
	93310	-7.5	-29.3	-12.4	53.2	-14.1	56.6	372.2
	93410	-2.6	-29.3	-0.4	-1.8	-16.8	-17.3	372.2

Note: Negative value means compression.
Note *: Exterior Wall, Pool Wall — Direction 1: Horizontal, Direction 2: Vertical
Basemat, Slab — Direction 1: N-S, Direction 2: E-W

Table 7.3.1.1.1-3 Rebar and Concrete Stresses of FB: LOCA (1.5Pa): Winter: Load ID = 6441 (Selected Load Combination FB-8)

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
		Calculated	Allowable	Calculated				Allowable
				Direction 1*		Direction 2*		
				In/Top	Out/Bottom	In/Top	Out/Bottom	
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	-2.8	-29.1	-3.8	-15.3	-8.5	-1.8	370.5
	60219	-6.3	-28.5	-7.2	27.8	-26.9	45.0	366.4
	70201	-7.5	-28.3	-7.7	70.1	-7.9	67.5	364.6
	70204	-7.4	-28.3	-2.6	26.3	-27.2	56.0	364.6
	110718	-8.8	-27.5	-12.7	70.7	-23.7	36.0	359.1
2 Exterior Wall @ EL4.65 ~6.60m	62011	-3.8	-28.3	24.2	64.7	-10.3	22.1	365.0
	62019	-8.6	-28.3	35.5	95.8	-19.8	75.5	365.0
	72001	-8.1	-28.3	24.8	92.9	-19.0	64.9	365.0
	72004	-7.2	-28.3	73.9	56.4	-25.2	59.7	365.0
3 Exterior Wall @ EL22.50 ~24.60m	64011	-8.5	-28.3	29.4	94.3	-17.7	68.8	365.0
	64019	-6.7	-28.3	32.3	96.9	-8.3	75.4	365.0
	74001	-4.0	-28.3	24.1	76.0	6.3	66.2	365.0
	74004	-6.2	-28.3	13.6	102.0	3.8	101.0	365.0
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	-4.3	-28.5	-13.6	17.1	-18.4	13.1	366.4
	70801	-8.6	-28.3	-23.4	81.7	2.2	47.0	364.6
	70804	-2.1	-28.3	-7.7	7.4	-7.1	13.4	364.6
	110748	-7.2	-27.5	2.1	53.8	-25.9	28.5	359.1
5 Basemat	90306	-2.1	-23.2	-2.3	-14.2	-3.9	-3.2	370.3
	90310	-0.7	-23.2	-2.1	-3.9	-1.4	-4.3	370.3
	90410	-2.0	-23.2	-7.3	-0.9	-5.0	-13.1	370.3
5 Basemat @ Spent Fuel Pool	90486	-3.6	-22.9	-10.9	11.3	-13.0	9.3	367.2
	90490	-3.3	-22.9	-10.1	18.9	-4.9	12.3	367.2
	90526	-2.4	-22.9	-3.0	12.7	-10.6	3.5	367.2
6 Slab EL4.65m	93306	-2.4	-28.5	51.7	29.2	72.1	34.7	366.1
	93310	-6.1	-28.5	-5.3	56.5	-7.2	60.8	366.1
	93410	-2.0	-28.5	0.4	-3.5	-12.3	-12.8	366.1

Note: Negative value means compression.
Note *: Exterior Wall, Pool Wall — Direction 1: Horizontal, Direction 2: Vertical
Basemat, Slab — Direction 1: N-S, Direction 2: E-W

Table 7.3.1.1.1-4 Rebar and Concrete Stresses of FB: LOCA + SSE: Winter: Load ID = 7441 (Selected Load Combination FB-9)

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
		Calculated	Allowable	Calculated				Allowable
				Direction 1*		Direction 2*		
				In/Top	Out/Bottom	In/Top	Out/Bottom	
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	-4.6	-29.3	57.3	-25.0	28.0	5.1	372.2
	60219	-10.4	-28.5	35.8	66.5	-39.1	78.8	366.4
	70201	-7.1	-28.3	8.2	127.5	7.5	104.2	364.6
	70204	-11.7	-28.3	72.2	84.6	-40.0	85.8	364.6
	110718	-12.1	-28.1	-10.9	115.7	-18.4	83.9	363.3
2 Exterior Wall @ EL4.65 ~6.60m	62011	-17.3	-29.3	106.8	202.7	257.3	206.1	372.2
	62019	-20.4	-29.3	179.6	233.7	167.4	199.6	372.2
	72001	-16.2	-29.3	176.8	327.0	99.7	204.5	372.2
	72004	-15.8	-29.3	282.2	333.3	251.7	240.1	372.2
3 Exterior Wall @ EL22.50 ~24.60m	64011	-22.1	-29.3	130.4	267.0	42.6	235.8	372.2
	64019	-7.1	-29.3	233.0	291.1	30.6	255.5	372.2
	74001	-8.7	-29.3	77.0	98.6	65.0	82.4	372.2
	74004	-9.6	-29.3	148.1	217.0	5.0	220.4	372.2
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	-8.3	-28.5	-32.5	46.4	-20.9	22.2	366.4
	70801	-14.1	-28.3	67.7	146.0	30.0	86.9	364.6
	70804	-8.6	-28.3	126.3	71.5	85.5	45.1	364.6
	110748	-9.8	-28.1	33.0	92.8	-26.6	62.1	363.3
5 Basemat	90306	-5.6	-23.5	59.9	-23.2	55.2	1.0	372.2
	90310	-1.7	-23.5	-2.5	-6.5	1.1	-7.1	372.2
	90410	-4.0	-23.5	16.1	-5.7	44.9	-22.7	372.2
5 Basemat @ Spent Fuel Pool	90486	-6.0	-22.9	-11.7	35.4	-15.6	17.4	367.2
	90490	-7.0	-22.9	15.8	89.6	99.7	60.3	367.2
	90526	-5.0	-22.9	111.5	19.0	48.6	34.4	367.2
6 Slab EL4.65m	93306	-4.3	-29.3	82.9	90.7	133.5	38.8	372.2
	93310	-8.7	-29.3	36.4	96.6	12.7	92.0	372.2
	93410	-6.9	-29.3	83.9	90.3	20.1	-14.7	372.2

Note: Negative value means compression.
Note *: Exterior Wall, Pool Wall — Direction 1: Horizontal, Direction 2: Vertical
Basemat, Slab — Direction 1: N-S, Direction 2: E-W

Table 7.3.1.1.1-5 Maximum Stress Ratios for Flexure and Membrane Forces

Location	Element ID	Concrete		Primary Reinforcement							
				Direction 1*				Direction 2*			
				In/Top		Out/Bottom		In/Top		Out/Bottom	
		σ/σ_a	Load ID	σ/σ_a	Load ID	σ/σ_a	Load ID	σ/σ_a	Load ID	σ/σ_a	Load ID
1 Exterior Wall	60011	0.246	7461	0.159	7621	0.250	8011	0.112	9013	0.164	7461
and Pool Wall	60219	0.481	8511	0.227	7601	0.256	9011	0.168	7701	0.306	8511
@ EL-11.50	70201	0.448	6981	0.123	7751	0.467	8512	0.111	7751	0.374	8514
~-10.50m	70204	0.551	8511	0.212	7601	0.349	9011	0.217	7701	0.356	8514
	110718	0.719	7492	0.481	7701	0.512	8511	0.111	7751	0.377	7492
2 Exterior Wall	62011	0.692	8514	0.383	9013	0.632	7492	0.729	9012	0.801	7492
@ EL4.65	62019	0.738	8514	0.531	9014	0.638	7471	0.556	7991	0.540	7482
~6.60m	72001	0.576	8511	0.766	7653	0.863	8511	0.761	7653	0.710	7491
	72004	1.033	8512	0.839	7221	0.948	8512	0.979	7632	0.946	8071
3 Exterior Wall	64011	0.778	8511	0.508	7961	0.726	7521	0.451	8071	0.644	8511
@ EL22.50	64019	0.505	7501	0.630	8513	0.798	8513	0.277	8071	0.686	7441
~24.60m	74001	0.306	8511	0.217	8511	0.276	8511	0.188	7581	0.231	8511
	74004	0.460	8511	0.421	8514	0.584	7471	0.327	8061	0.593	7471
4 Spent Fuel	60819	0.343	8511	0.277	7711	0.239	7601	0.086	7611	0.120	7491
Pool Wall	70801	0.700	7491	0.300	7601	0.534	7492	0.220	7601	0.336	7492
@ EL-5.10	70804	0.472	8513	0.434	7861	0.377	7311	0.290	7861	0.253	8513
~-3.30m	110748	0.547	8511	0.517	8001	0.387	8511	0.273	8001	0.278	8511
5 Basemat	90306	0.247	8512	0.181	7121	0.063	8514	0.176	7121	0.017	7911
	90310	0.150	7211	0.042	2011	0.039	7211	0.040	2011	0.044	7961
	90410	0.282	7491	0.061	8021	0.057	7461	0.128	8021	0.199	7711
5 Basemat	90486	0.347	8514	0.158	7251	0.212	7492	0.059	7251	0.165	8514
@ Spent	90490	0.356	8511	0.230	7601	0.304	7492	0.273	7621	0.212	7992
Fuel Pool	90526	0.239	7491	0.300	7921	0.088	7991	0.141	7601	0.145	8512
6 Slab EL4.65m	93306	0.165	7211	0.517	7201	0.245	7301	0.368	8514	0.174	8001
	93310	0.303	8514	0.267	7431	0.268	8514	0.243	7411	0.257	8514
	93410	0.289	7561	0.596	7491	0.395	7701	0.275	7501	0.259	7701

Note *: Exterior Wall, Pool Wall Direction1 : Horizontal, Direction2 : Vertical
Basemat, Slab Direction1 : N-S, Direction2 : E-W

σ and σ_a are calculated and allowable stress.

Exceedance is highlighted. As shown in Figure 7.3.1.1-1, the exceedance is resolved by considering the moment capacity of wall according to the specifications of ACI 349-01.

Table 7.3.1.1.2-1 Membrane Compressive Forces of FB

Location	Element ID	Load ID	Section Forces (MN/m)			Thickness h (m)	Clculated Concrete Stress (MPa)				Allowable Stress σ_a (MPa)	σ_c/σ_a
			Nx	Ny	Nxy		σ_x	σ_y	τ_{xy}	σ_c		
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	7251	-5.591	-3.421	-2.432	2.0	-2.796	-1.711	-1.216	-3.585	-20.7	0.173
	60219	7251	-6.359	-3.814	-1.988	3.6	-1.766	-1.059	-0.552	-2.068	-20.7	0.100
	70201	7201	-1.257	-1.136	2.712	2.0	-0.629	-0.568	1.356	-1.955	-20.7	0.094
	70204	7251	-3.249	-3.768	-4.153	2.0	-1.624	-1.884	-2.077	-3.835	-20.7	0.185
	110718	8511	-7.621	-7.362	-6.148	1.5	-5.081	-4.908	-4.098	-9.094	-25.9	0.351
2 Exterior Wall @ EL4.65 ~6.60m	62011	7491	-3.314	-1.939	3.178	1.0	-3.314	-1.939	3.178	-5.878	-25.9	0.227
	62019	7411	-2.386	-2.691	3.254	1.0	-2.386	-2.691	3.254	-5.796	-25.9	0.224
	72001	7501	-1.599	-3.269	4.578	1.0	-1.599	-3.269	4.578	-7.087	-20.7	0.342
	72004	7501	-2.074	-3.215	5.045	1.0	-2.074	-3.215	5.045	-7.722	-20.7	0.373
3 Exterior Wall @ EL22.50 ~24.60m	64011	7601	-3.251	0.052	1.609	1.0	-3.251	0.052	1.609	-3.905	-20.7	0.189
	64019	7101	-2.993	-0.873	-1.518	1.0	-2.993	-0.873	-1.518	-3.785	-20.7	0.183
	74001	8511	-0.253	-1.193	-2.891	1.0	-0.253	-1.193	-2.891	-3.652	-25.9	0.141
	74004	8511	-1.788	-0.595	-3.522	1.0	-1.788	-0.595	-3.522	-4.763	-25.9	0.184
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	8511	-5.441	-5.636	-3.045	3.6	-1.511	-1.565	-0.846	-2.385	-25.9	0.092
	70801	7251	-3.397	-2.046	-3.314	2.0	-1.698	-1.023	-1.657	-3.052	-20.7	0.147
	70804	7251	-3.152	-2.628	-3.794	2.0	-1.576	-1.314	-1.897	-3.347	-20.7	0.162
	110748	8511	-3.019	-6.596	-4.345	1.5	-2.013	-4.397	-2.897	-6.337	-25.9	0.245
5 Basemat	90306	7251	-6.193	-3.143	3.646	4.0	-1.548	-0.786	0.912	-2.155	-16.6	0.130
	90310	2001	-1.976	-2.034	0.198	4.0	-0.494	-0.509	0.050	-0.551	-8.3	0.067
	90410	7251	-3.005	-9.273	2.743	4.0	-0.751	-2.318	0.686	-2.576	-16.6	0.156
5 Basemat @ Spent Fuel Pool	90486	2001	-2.656	-4.465	-0.269	5.5	-0.483	-0.812	-0.049	-0.819	-8.3	0.099
	90490	7251	-2.977	-9.601	1.971	5.5	-0.541	-1.746	0.358	-1.844	-16.6	0.111
	90526	2001	-3.307	-5.026	-0.442	5.5	-0.601	-0.914	-0.080	-0.933	-8.3	0.113
6 Slab EL4.65m	93306	8514	-2.833	-0.427	-2.614	1.3	-2.180	-0.329	-2.011	-3.468	-25.9	0.134
	93310	2021	-2.208	-2.184	-2.411	1.3	-1.698	-1.680	-1.854	-3.544	-15.5	0.228
	93410	7492	-0.828	-3.805	-1.983	1.3	-0.637	-2.927	-1.525	-3.689	-25.9	0.143

Note: Positive value means tension.

Table 7.3.1.1.3-1 Transverse Shear of FB

Location	Element ID	Load ID	d (m)	pv (%)	Shear Force (MN/m)				Vu/ϕVn
					Vu	Vc	Vs	ϕVn	
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	8511	1.70	0.710	1.55	4.02	5.00	7.67	0.202
	60219	8511	3.05	0.710	4.67	3.77	8.96	10.82	0.432
	70201	7481	1.65	0.710	1.19	1.72	4.84	5.58	0.213
	70204	7481	1.59	0.710	3.14	2.16	4.67	5.81	0.540
	110718	7492	1.12	0.355	0.82	1.14	1.64	2.36	0.346
2 Exterior Wall @ EL4.65 ~6.60m	62011	7571	0.78	0.125	0.49	0.84	0.40	1.06	0.463
	62019	7601	0.72	0.125	0.18	0.13	0.37	0.43	0.407
	72001	7581	0.73	0.250	0.47	0.00	0.76	0.64	0.728
	72004	7612	0.72	0.250	0.46	0.00	0.74	0.63	0.732
3 Exterior Wall @ EL22.50 ~24.60m	64011	7492	0.72	0.125	0.31	0.71	0.37	0.92	0.336
	64019	8511	0.80	0.125	0.22	0.00	0.41	0.35	0.635
	74001	7492	0.73	0.125	0.15	0.18	0.38	0.47	0.321
	74004	8513	0.72	0.125	0.30	0.40	0.37	0.66	0.462
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	8511	3.05	0.710	2.44	4.35	8.97	11.32	0.216
	70801	8514	1.71	0.710	4.03	2.03	5.02	5.99	0.672
	70804	7571	1.62	0.710	1.11	0.69	4.75	4.62	0.240
	110748	8511	1.22	0.177	1.06	1.32	0.89	1.88	0.563
5 Basemat	90306	8514	3.53	0.629	4.82	6.96	9.18	13.73	0.351
	90310	7511	3.52	0.629	2.82	5.95	9.15	12.84	0.220
	90410	7471	3.53	0.629	3.47	6.91	9.19	13.68	0.254
5 Basemat @ Spent Fuel Pool	90486	7492	5.04	0.419	1.86	4.63	8.74	11.36	0.164
	90490	8514	5.04	0.629	5.65	5.53	13.11	15.85	0.356
	90526	7221	5.03	0.629	4.48	9.27	13.07	18.99	0.236
6 Slab EL4.65m	93306	7482	1.10	0.500	0.41	0.79	2.27	2.60	0.158
	93310	7571	1.10	0.500	0.93	2.47	2.27	4.03	0.231
	93410	7501	1.10	0.500	0.46	0.99	2.27	2.77	0.168

Table 7.3.1.1.3-2 Transverse Shear of FB for DCD Load Combinations

Location	Element ID	Load ID	d (m)	pv (%)	Shear Force (MN/m)				Vu/φVn
					Vu	Vc	Vs	φVn	
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	FB-9	1.70	0.710	1.53	3.97	4.99	7.62	0.200
	60219	FB-9	3.05	0.710	4.04	4.08	8.96	11.08	0.364
	70201	FB-9	1.65	0.710	0.98	1.78	4.85	5.64	0.174
	70204	FB-9	1.59	0.710	3.01	2.56	4.67	6.15	0.490
	110718	FB-9	1.12	0.355	0.50	1.13	1.64	2.36	0.211
2 Exterior Wall @ EL4.65 ~6.60m	62011	FB-9	0.72	0.125	0.38	0.75	0.37	0.95	0.400
	62019	FB-9	0.78	0.125	0.17	0.24	0.40	0.55	0.314
	72001	FB-9	0.73	0.250	0.47	0.00	0.76	0.64	0.727
	72004	FB-9	0.72	0.250	0.36	0.00	0.74	0.63	0.567
3 Exterior Wall @ EL22.50 ~24.60m	64011	FB-9	0.72	0.125	0.31	0.71	0.37	0.92	0.334
	64019	FB-9	0.80	0.125	0.22	0.00	0.41	0.35	0.617
	74001	FB-9	0.73	0.125	0.16	0.30	0.38	0.58	0.269
	74004	FB-9	0.72	0.125	0.30	0.41	0.37	0.66	0.457
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	FB-9	3.05	0.710	2.05	6.00	8.97	12.72	0.161
	70801	FB-9	1.71	0.710	3.77	2.16	5.02	6.10	0.617
	70804	FB-9	1.62	0.710	1.02	1.36	4.75	5.19	0.197
	110748	FB-9	1.21	0.177	0.64	1.15	0.88	1.73	0.368
5 Basemat	90306	FB-9	3.53	0.629	4.66	6.92	9.18	13.68	0.341
	90310	FB-9	3.49	0.629	2.66	5.67	9.08	12.54	0.212
	90410	FB-9	3.53	0.629	3.47	6.91	9.19	13.68	0.254
5 Basemat @ Spent Fuel Pool	90486	FB-9	5.04	0.419	1.58	6.56	8.74	13.00	0.122
	90490	FB-9	5.04	0.629	5.35	5.77	13.11	16.05	0.333
	90526	FB-9	5.02	0.629	4.42	9.24	13.07	18.97	0.233
6 Slab EL4.65m	93306	FB-9	1.10	0.500	0.41	0.78	2.27	2.60	0.158
	93310	FB-9	1.10	0.500	0.97	2.85	2.27	4.35	0.223
	93410	FB-9	1.10	0.500	0.57	2.20	2.27	3.80	0.151

Table 7.3.1.2-1 Maximum Stress Ratio of FB Reinforced Concrete Column

ID No.	Sizes (mm)	Column-Row			Checked Items	Section Forces (MN, MN-m) Design Forces Fu				Allowable Strength ϕFn	Ratio Fu/ϕFn
610101	1400 x 1400	F2	FD								
Location [Direction]	Reinforcing			(ratio,%)		Load No.	Thermal Load	Other Loads	Total		
FULL [NS SIDE]	Main Bars	12 - #11		(0.62)	P	7461	0.00	-20.14	-20.14	-41.36	0.49
		12 - #11		(0.62)	M	7491	0.00	3.88	3.88	9.46	0.41
	Other Bars	32 - #11		(1.64)							
	Tie Bars	5 - #6	@200	(0.51)	V	7701	0.00	-0.89	-0.89	-4.48	0.20
FULL [EW SIDE]	Main Bars	16 - #11		(0.82)	P	7461	0.00	-20.14	-20.14	-45.03	0.45
		16 - #11		(0.82)	M	7211	0.00	-3.58	-3.58	-9.91	0.36
	Other Bars	24 - #11		(1.23)							
	Tie Bars	5 - #6	@200	(0.51)	V	7211	0.00	-1.34	-1.34	-7.31	0.18

ID No.	Sizes (mm)	Column-Row			Checked Items	Section Forces (MN, MN-m) Design Forces Fu				Allowable Strength ϕFn	Ratio Fu/ϕFn
610107	1400 x 1400	F2	FD								
Location [Direction]	Reinforcing			(ratio,%)		Load No.	Thermal Load	Other Loads	Total		
FULL [NS SIDE]	Main Bars	7 - #11		(0.36)	P	7261	0.00	-8.73	-8.73	-36.78	0.24
		7 - #11		(0.36)	M	8514	0.00	-4.34	-4.34	-7.56	0.57
	Other Bars	14 - #11		(0.72)							
	Tie Bars	4 - #5	@200	(0.29)	V	8514	0.00	1.61	1.61	5.41	0.30
FULL [EW SIDE]	Main Bars	7 - #11		(0.36)	P	7261	0.00	-8.73	-8.73	-36.78	0.24
		7 - #11		(0.36)	M	7811	0.00	-1.63	-1.63	-5.97	0.27
	Other Bars	14 - #11		(0.72)							
	Tie Bars	4 - #5	@200	(0.29)	V	7711	0.00	0.58	0.58	3.12	0.19

ID No.	Sizes (mm)	Column-Row			Checked Items	Section Forces (MN, MN-m) Design Forces Fu				Allowable Strength ϕFn	Ratio Fu/ϕFn
611302	1500 x 1500	F1	FC								
Location [Direction]	Reinforcing			(ratio,%)		Load No.	Thermal Load	Other Loads	Total		
FULL [NS SIDE]	Main Bars	17 - #11		(0.76)	P	7971	0.00	9.44	9.44	16.32	0.58
		17 - #11		(0.76)	M	7971	0.00	2.05	2.05	8.69	0.24
	Other Bars	30 - #11		(1.34)							
	Tie Bars	8 - #5	@200	(0.53)	V	7961	0.00	-1.02	-1.02	-3.78	0.27
FULL [EW SIDE]	Main Bars	15 - #11		(0.67)	P	9013	0.00	9.59	9.59	20.38	0.47
		15 - #11		(0.67)	M	7371	0.00	0.74	0.74	11.09	0.07
	Other Bars	34 - #11		(1.52)							
	Tie Bars	2 - #5	@200	(0.13)	V	9013	0.00	-0.23	-0.23	-2.57	0.09

Table 7.3.1.2-1 Maximum Stress Ratio of FB Reinforced Concrete Column (Continued)

ID No.	Sizes (mm)	Column-Row				Checked Items	Section Forces (MN, MN-m)				Allowable Strength	Ratio
611312	1500 x 1500	F1		FC			Design Forces Fu					
Location [Direction]	Reinforcing				(ratio,%)		Load No.	Thermal Load	Other Loads	Total	φFn	Fu/φFn
FULL [NS SIDE]	Main Bars	17 - #11			(0.76)	P	8514	0.00	5.63	5.63	17.45	0.32
		17 - #11			(0.76)	M	8511	0.00	3.04	3.04	11.21	0.27
	Other Bars	30 - #11			(1.34)							
	Tie Bars	8 - #5		@200	(0.53)	V	6965	0.00	-0.98	-0.98	-4.77	0.21
FULL [EW SIDE]	Main Bars	15 - #11			(0.67)	P	8514	0.00	5.63	5.63	20.84	0.27
		15 - #11			(0.67)	M	7261	0.00	0.35	0.35	10.51	0.03
	Other Bars	34 - #11			(1.52)							
	Tie Bars	2 - #5		@200	(0.13)	V	8513	0.00	0.25	0.25	2.99	0.08

ID No.	Sizes (mm)	Column-Row				Checked Items	Section Forces (MN, MN-m)				Allowable Strength	Ratio
612002	1500 x 1500	F3		FF			Design Forces Fu					
Location [Direction]	Reinforcing				(ratio,%)		Load No.	Thermal Load	Other Loads	Total	φFn	Fu/φFn
FULL [NS SIDE]	Main Bars	9 - #11			(0.40)	P	7211	0.00	6.14	6.14	10.73	0.57
		9 - #11			(0.40)	M	8511	0.00	-2.41	-2.41	-9.51	0.25
	Other Bars	14 - #11			(0.63)							
	Tie Bars	4 - #5		@200	(0.27)	V	7211	0.00	-0.41	-0.41	-2.11	0.19
FULL [EW SIDE]	Main Bars	7 - #11			(0.31)	P	7571	0.00	6.14	6.14	8.85	0.69
		7 - #11			(0.31)	M	7571	0.00	0.41	0.41	1.17	0.35
	Other Bars	18 - #11			(0.81)							
	Tie Bars	2 - #5		@200	(0.13)	V	7571	0.00	0.24	0.24	2.15	0.11

ID No.	Sizes (mm)	Column-Row				Checked Items	Section Forces (MN, MN-m)				Allowable Strength	Ratio
612012	1500 x 1500	F3		FF			Design Forces Fu					
Location [Direction]	Reinforcing				(ratio,%)		Load No.	Thermal Load	Other Loads	Total	φFn	Fu/φFn
FULL [NS SIDE]	Main Bars	9 - #11			(0.40)	P	4023	0.00	-5.83	-5.83	-43.10	0.14
		9 - #11			(0.40)	M	4022	0.00	-1.57	-1.57	-9.07	0.17
	Other Bars	14 - #11			(0.63)							
	Tie Bars	4 - #5		@200	(0.27)	V	4022	0.00	-0.67	-0.67	-5.40	0.12
FULL [EW SIDE]	Main Bars	7 - #11			(0.31)	P	4023	0.00	-5.83	-5.83	-41.27	0.14
		7 - #11			(0.31)	M	8514	0.00	1.56	1.56	8.07	0.19
	Other Bars	18 - #11			(0.81)							
	Tie Bars	2 - #5		@200	(0.13)	V	8514	0.00	0.80	0.80	5.41	0.15

Table 7.3.1.2-2 Maximum Stress Ratio of FB Reinforced Concrete Girder

ID No.	Sizes (mm)		Column-Row		Checked Items	Section Forces (MN,MN-m)				Allowable Strength fFn	Ratio Fu/fFn
620001	800 x 1500		F1-F2	FE		Design Forces Fu					
Location	Reinforcing			(ratio, %)		Load No.	Thermal Load	Other Loads	Total		
END 1 [F1 SIDE]	Main Bars	Top	10 - #11	(0.84)	P	3011	0.00	-4.78	-4.78	-30.05	0.16
		Bot.	15 - #11	(1.26)	M	7511	0.00	3.55	3.55	7.39	0.48
	Stirrup		6 - #5 @200	(0.75)	V	7471	0.00	1.33	1.33	3.14	0.42
CENTER	Main Bars	Top	10 - #11	(0.84)	P	3011	0.00	-4.78	-4.78	-30.05	0.16
		Bot.	15 - #11	(1.26)	M	7231	0.00	-2.80	-2.80	-6.82	0.41
	Stirrup		6 - #5 @200	(0.75)	V	7461	0.00	1.73	1.73	3.96	0.44
END 2 [F2 SIDE]	Main Bars	Top	10 - #11	(0.84)	P	4014	0.00	-2.58	-2.58	-30.05	0.09
		Bot.	15 - #11	(1.26)	M	7101	0.00	1.13	1.13	8.50	0.13
	Stirrup		6 - #5 @200	(0.75)	V	7221	0.00	-0.58	-0.58	-3.16	0.18

ID No.	Sizes (mm)		Column-Row		Checked Items	Section Forces (MN,MN-m)				Allowable Strength fFn	Ratio Fu/fFn
622001	800 x 1500		F1-F2	FE		Design Forces Fu					
Location	Reinforcing			(ratio, %)		Load No.	Thermal Load	Other Loads	Total		
END 1 [F1 SIDE]	Main Bars	Top	10 - #11	(0.84)	P	8514	0.00	-4.68	-4.68	-27.75	0.17
		Bot.	10 - #11	(0.84)	M	8514	0.00	1.54	1.54	6.67	0.23
				(0.00)							
	Stirrup		4 - #5 @200	(0.50)	V	7561	0.00	-0.41	-0.41	-2.68	0.15
CENTER	Main Bars	Top	10 - #11	(0.84)	P	8514	0.00	-4.30	-4.30	-27.75	0.16
		Bot.	10 - #11	(0.84)	M	8514	0.00	0.93	0.93	6.65	0.14
				(0.00)							
	Stirrup		4 - #5 @200	(0.50)	V	7461	0.00	0.33	0.33	3.60	0.09
END 2 [F2 SIDE]	Main Bars	Top	10 - #11	(0.84)	P	8514	0.00	-3.34	-3.34	-27.75	0.12
		Bot.	10 - #11	(0.84)	M	7431	0.00	-2.38	-2.38	-7.36	0.32
				(0.00)							
	Stirrup		4 - #5 @200	(0.50)	V	7431	0.00	0.98	0.98	2.66	0.37

ID No.	Sizes (mm)		Column-Row		Checked Items	Section Forces (MN,MN-m)				Allowable Strength fFn	Ratio Fu/fFn
620209	800 x 1500		F2	FC-FD		Design Forces Fu					
Location	Reinforcing			(ratio, %)		Load No.	Thermal Load	Other Loads	Total		
END 1 [FD SIDE]	Main Bars	Top	10 - #11	(0.84)	P	4012	0.00	-2.49	-2.49	-27.75	0.09
		Bot.	10 - #11	(0.84)	M	7461	0.00	-2.17	-2.17	-7.20	0.30
				(0.00)							
	Stirrup		4 - #5 @200	(0.50)	V	7471	0.00	-0.77	-0.77	-2.44	0.32
CENTER	Main Bars	Top	10 - #11	(0.84)	P	4012	0.00	-2.49	-2.49	-27.75	0.09
		Bot.	10 - #11	(0.84)	M	7461	0.00	0.67	0.67	7.02	0.09
	Stirrup		4 - #5 @200	(0.50)	V	7471	0.00	-0.78	-0.78	-2.52	0.31
END 2 [FC SIDE]	Main Bars	Top	10 - #11	(0.84)	P	4014	0.00	-1.96	-1.96	-27.75	0.07
		Bot.	10 - #11	(0.84)	M	7491	0.00	-1.03	-1.03	-7.54	0.14
				(0.00)							
	Stirrup		4 - #5 @200	(0.50)	V	7492	0.00	0.30	0.30	2.66	0.11

Table 7.3.1.2-2 Maximum Stress Ratio of FB Reinforced Concrete Girder (Continued)

ID No.	Sizes (mm)		Column-Row			Checked Items	Section Forces (MN,MN-m)				Allowable Strength fFn	Ratio Fu/fFn
622209	800 x 1500		F2	FC-FD			Design Forces Fu					
Location	Reinforcing				(ratio, %)		Load No.	Thermal Load	Other Loads	Total		
END 1 [FD SIDE]	Main Bars	Top	10 - #11		(0.84)	P	7461	0.00	0.40	0.40	10.67	0.04
		Bot.	10 - #11		(0.84)	M	7261	0.00	-1.02	-1.02	-7.79	0.13
					(0.00)							
	Stirrup		4 - #5	@200	(0.50)	V	7261	0.00	-0.53	-0.53	-2.50	0.21
CENTER	Main Bars	Top	10 - #11		(0.84)	P	7461	0.00	0.39	0.39	13.60	0.03
		Bot.	10 - #11		(0.84)	M	7492	0.00	0.55	0.55	7.56	0.07
					(0.00)							
	Stirrup		4 - #5	@200	(0.50)	V	7461	0.00	-0.56	-0.56	-2.58	0.22
END 2 [FC SIDE]	Main Bars	Top	10 - #11		(0.84)	P	7461	0.00	0.28	0.28	14.15	0.02
		Bot.	10 - #11		(0.84)	M	7492	0.00	-0.48	-0.48	-7.75	0.06
					(0.00)							
	Stirrup		4 - #5	@200	(0.50)	V	7441	0.00	0.27	0.27	2.53	0.11

ID No.	Sizes (mm)		Column-Row			Checked Items	Section Forces (MN,MN-m)				Allowable Strength fFn	Ratio Fu/fFn
622201	800 x 1500		F2	FE-FF			Design Forces Fu					
Location	Reinforcing				(ratio, %)		Load No.	Thermal Load	Other Loads	Total		
END 1 [FF SIDE]	Main Bars	Top	10 - #11		(0.84)	P	7481	0.00	0.20	0.20	11.26	0.02
		Bot.	10 - #11		(0.84)	M	8513	0.00	-1.03	-1.03	-7.75	0.13
					(0.00)							
	Stirrup		4 - #5	@200	(0.50)	V	7482	0.00	-0.37	-0.37	-2.62	0.14
CENTER	Main Bars	Top	10 - #11		(0.84)	P	7481	0.00	0.21	0.21	13.47	0.02
		Bot.	10 - #11		(0.84)	M	7521	0.00	0.62	0.62	7.63	0.08
					(0.00)							
	Stirrup		4 - #5	@200	(0.50)	V	8513	0.00	-0.42	-0.42	-2.97	0.14
END 2 [FE SIDE]	Main Bars	Top	10 - #11		(0.84)	P	7481	0.00	0.26	0.26	8.82	0.03
		Bot.	10 - #11		(0.84)	M	7571	0.00	-1.58	-1.58	-7.78	0.20
					(0.00)							
	Stirrup		4 - #5	@200	(0.50)	V	7261	0.00	0.92	0.92	2.54	0.36

{

}

Figure 1-1 RB/FB Global FE Analysis Model

Table 7.3.2-1 Maximum Stress Ratio of FB Steel Girder

Member Name :		FBroof FB										
Section ID :		100		Section Type :		H			CBAR ID :	630301		
Flange PL :		1000 x 75		Web PL :		1550 x 60				i - edge		
Maximum Ratio		Load ID	Design Load (MN,MNm)			Stress (MPa)			Allowable Stress (MPa)			
			P	M	V	fac,fat	fbc,fbt	fv	Fac,Fat	Fbc,Fbt	Fv	
fac/Fac+fbc/Fbc	0.100	8128	-5.05	0.00		-20.8	0.0		327.6	318.2		
fat/Fat+fbt/Fbt	0.018	5503	1.41	0.00		5.8	0.0		330.9	330.9		
fv/Fv	0.159	8103			3.14			30.8			193.1	

Member Name :		FBroof FB										
Section ID :		100		Section Type :		H			CBAR ID :	630305		
Flange PL :		1000 x 75		Web PL :		1550 x 60				j - edge		
Maximum Ratio		Load ID	Design Load (MN,MNm)			Stress (MPa)			Allowable Stress (MPa)			
			P	M	V	fac,fat	fbc,fbt	fv	Fac,Fat	Fbc,Fbt	Fv	
fac/Fac+fbc/Fbc	0.436	5001	-2.10	16.34		-8.6	118.0		307.2	299.5		
fat/Fat+fbt/Fbt	0.164	7520	0.06	7.48		0.2	54.0		330.9	330.9		
fv/Fv	0.072	8103			-1.42			-14.0			193.1	

Member Name :		FBroof FC										
Section ID :		100		Section Type :		H			CBAR ID :	630206		
Flange PL :		1000 x 75		Web PL :		1550 x 60				i - edge		
Maximum Ratio		Load ID	Design Load (MN,MNm)			Stress (MPa)			Allowable Stress (MPa)			
			P	M	V	fac,fat	fbc,fbt	fv	Fac,Fat	Fbc,Fbt	Fv	
fac/Fac+fbc/Fbc	0.500	5001	-1.71	19.34		-7.0	139.6		307.2	299.5		
fat/Fat+fbt/Fbt	0.194	7520	0.05	8.85		0.2	63.9		330.9	330.9		
fv/Fv	0.059	5002			1.17			11.4			193.1	

Member Name :		FBroof FE										
Section ID :		100		Section Type :		H			CBAR ID :	630006		
Flange PL :		1000 x 75		Web PL :		1550 x 60				i - edge		
Maximum Ratio		Load ID	Design Load (MN,MNm)			Stress (MPa)			Allowable Stress (MPa)			
			P	M	V	fac,fat	fbc,fbt	fv	Fac,Fat	Fbc,Fbt	Fv	
fac/Fac+fbc/Fbc	0.368	5001	-1.97	13.63		-8.1	98.4		307.2	299.5		
fat/Fat+fbt/Fbt	0.137	7520	0.03	6.26		0.1	45.2		330.9	330.9		
fv/Fv	0.050	8126			0.98			9.6			193.1	

{

}

Figure 3.1-1 RB and FB Concrete Outline Plan at EL -11500

{{{Security-Related Information - Withheld Under 10 CFR-2.390}}}

{

}

Figure 3.1-2 RB and FB Concrete Outline Plan at EL 4650

{{{Security-Related Information - Withheld Under 10 CFR-2.390}}}

{

}

Figure 3.1-3 RB and FB Concrete Outline Plan at EL 17500

{{{Security-Related Information - Withheld Under 10 CFR-2.390}}}

{

}

Figure 3.1-4 RB and FB Concrete Outline Plan at EL 27000

{{{Security-Related Information - Withheld Under 10 CFR-2.390}}}

{

}

Figure 3.1-5 RB Concrete Outline Plan at EL 34000

{{{Security-Related Information - Withheld Under 10 CFR-2.390}}}

{

}

Figure 3.1-6 RB and FB Concrete Outline N-S Section

{{{Security-Related Information - Withheld Under 10 CFR-2.390}}}

{

}

Figure 3.1-7 RB and FB Concrete Outline E-W Section

{{{Security-Related Information - Withheld Under 10 CFR-2.390}}}

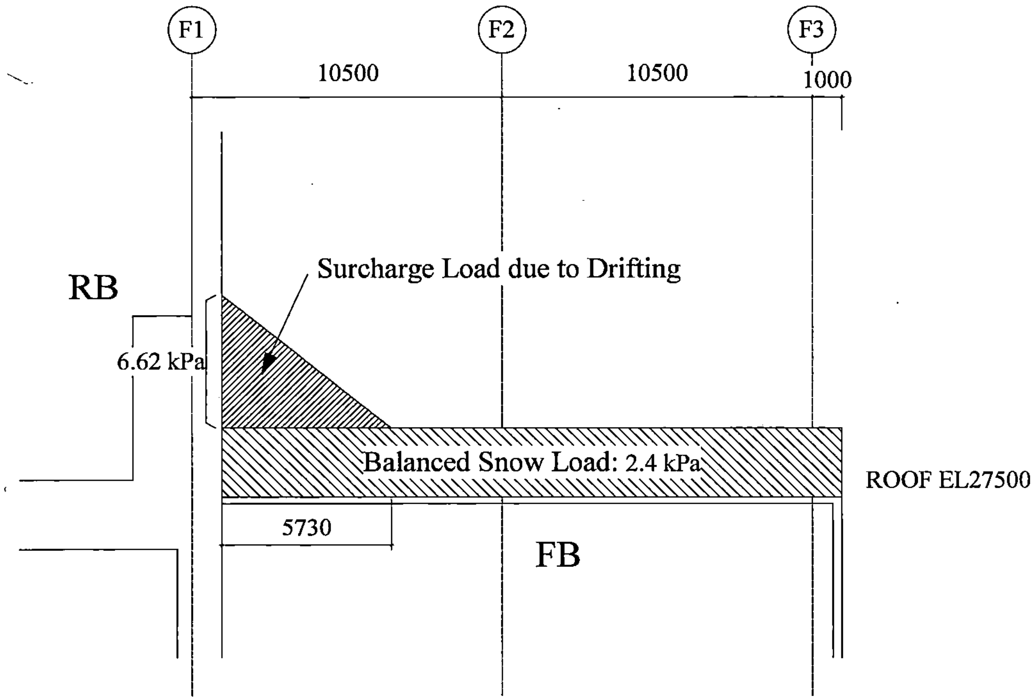


Figure 5.1.2-1 Snow Load Considered Drift Load

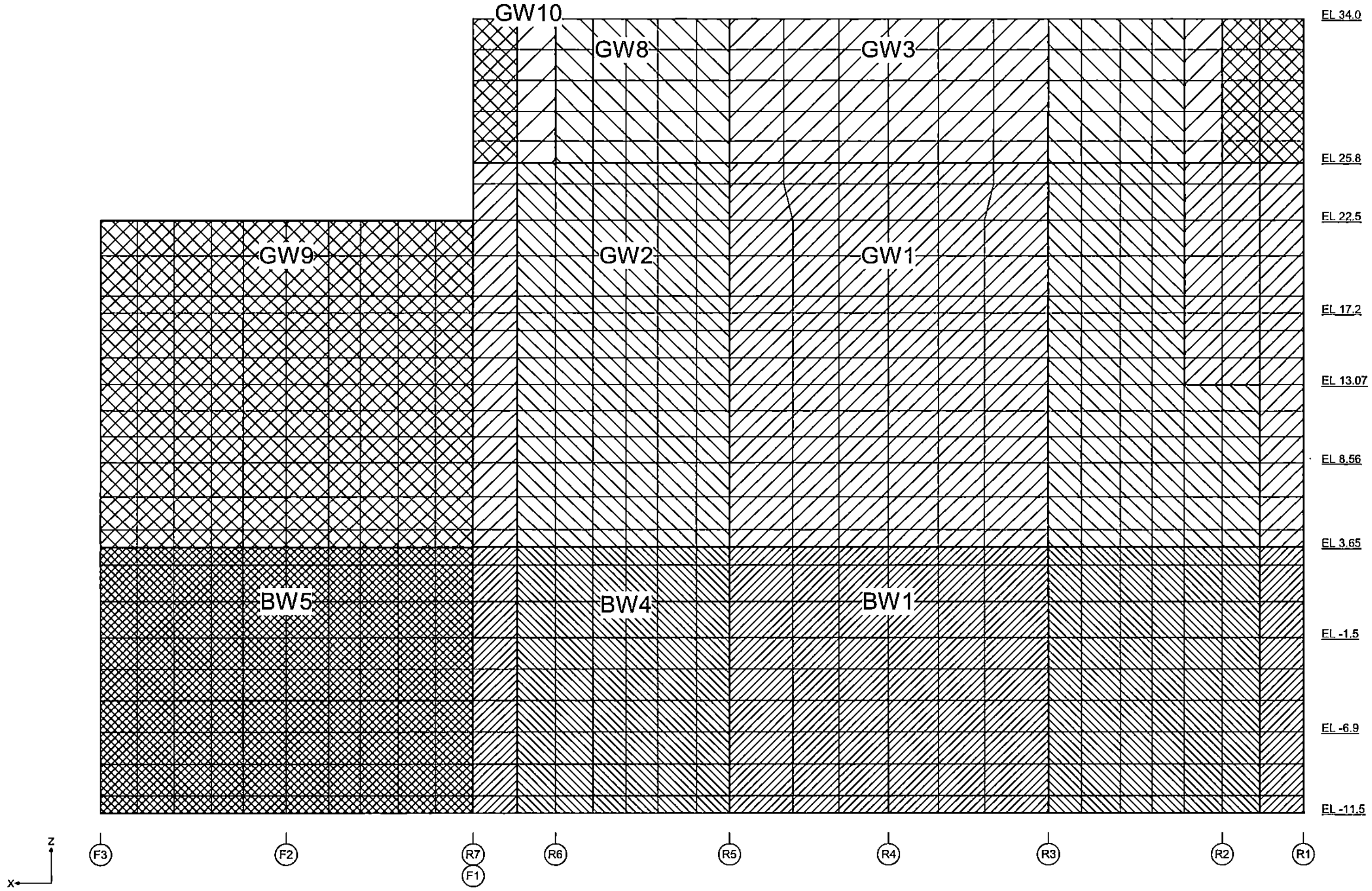


Figure 5.2.2-1 Application of Thermal Load on the External Wall (RA)

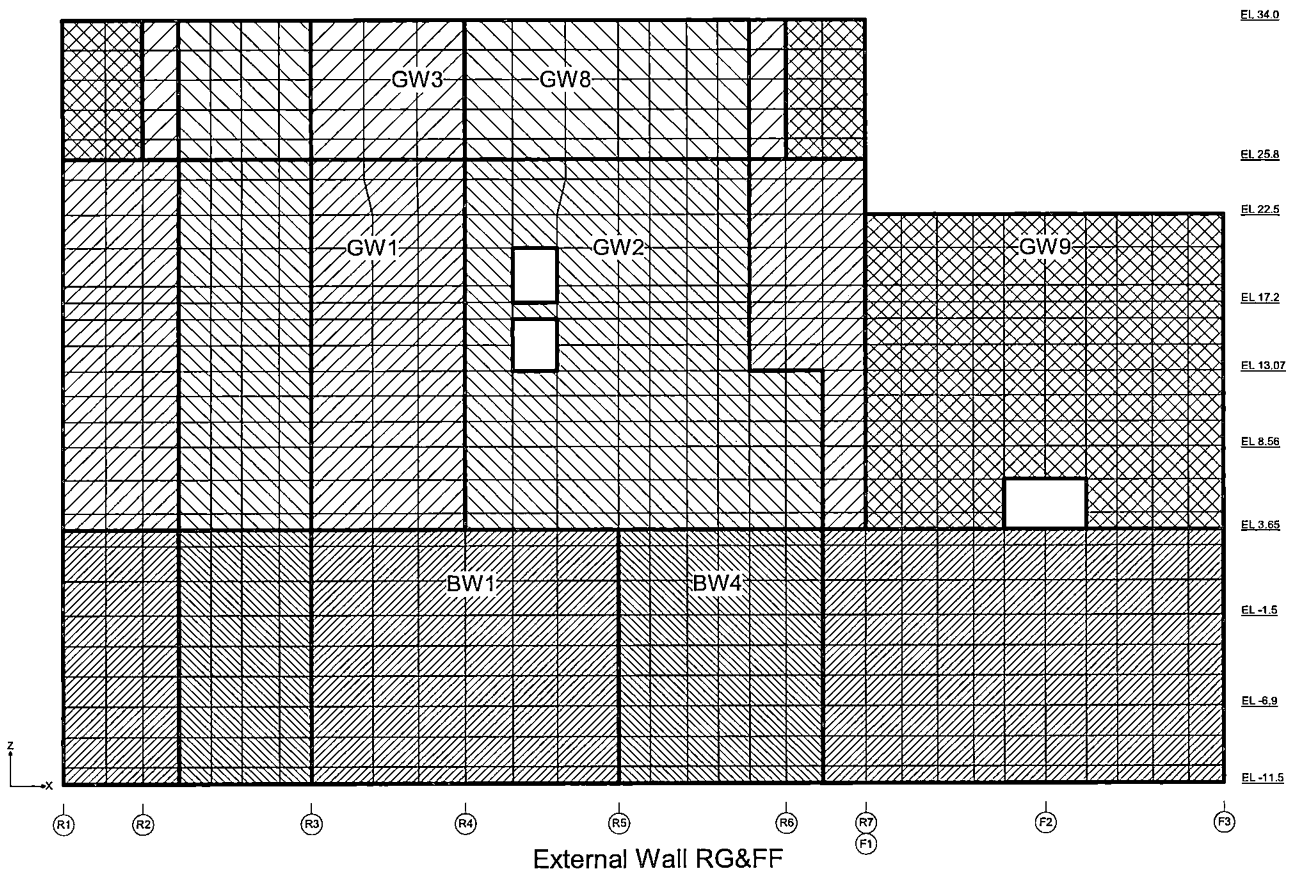


Figure 5.2.2-2 Application of Thermal Load on the External Wall (RG FF)

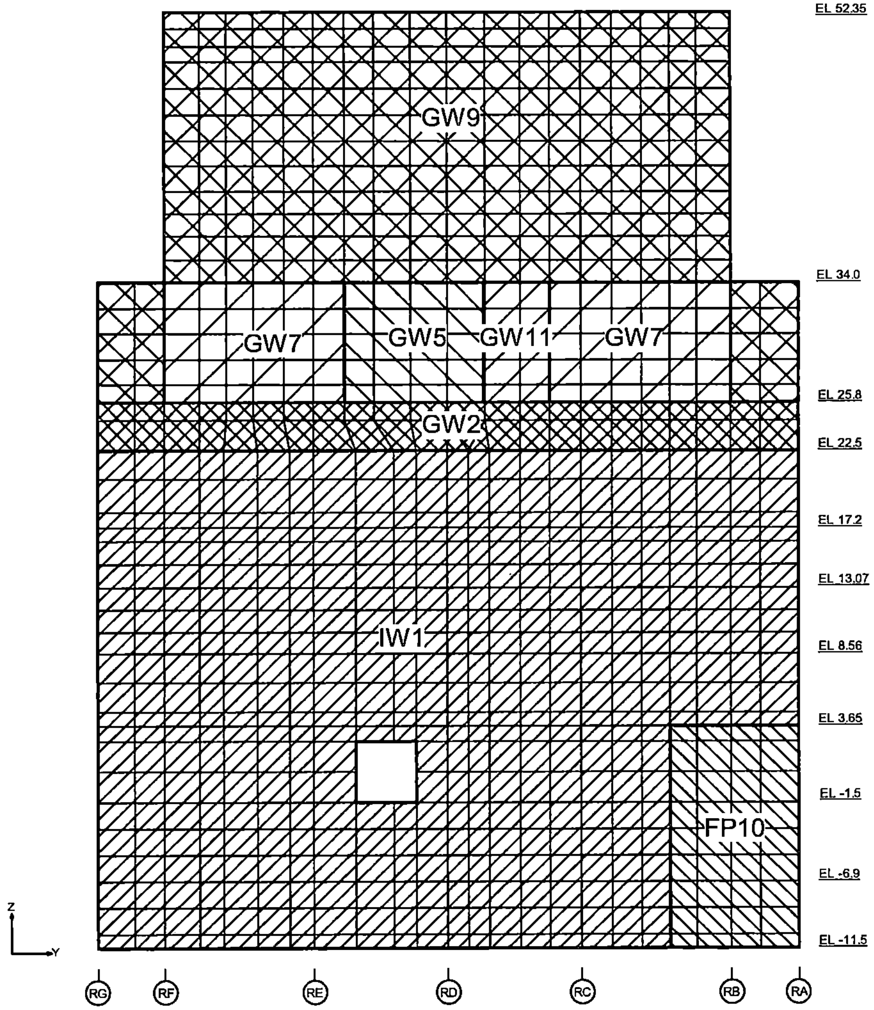


Figure 5.2.2-3 Application of Thermal Load on the External Wall (R7/F1)

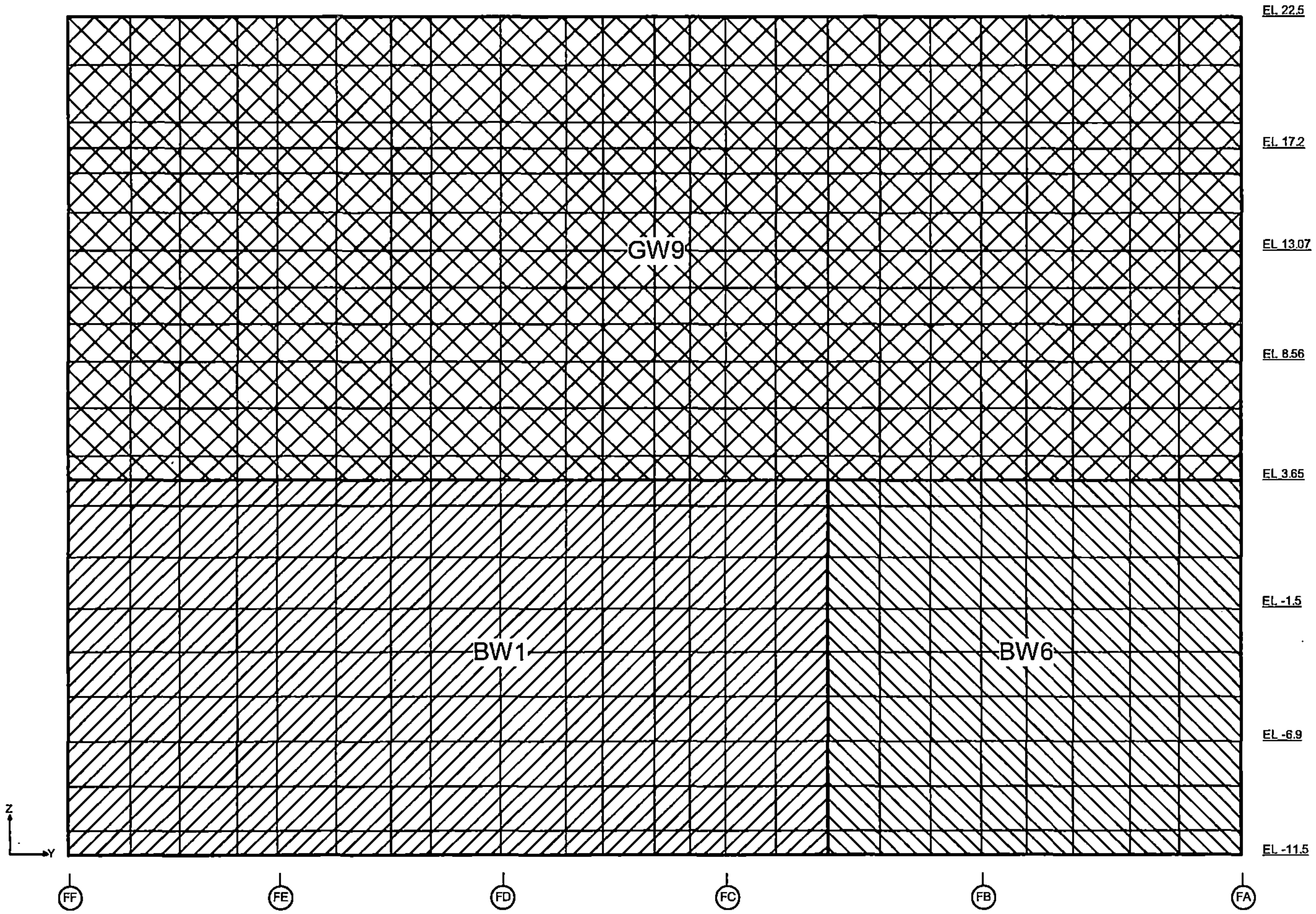


Figure 5.2.2-4 Application of Thermal Load on the External Wall (F3)

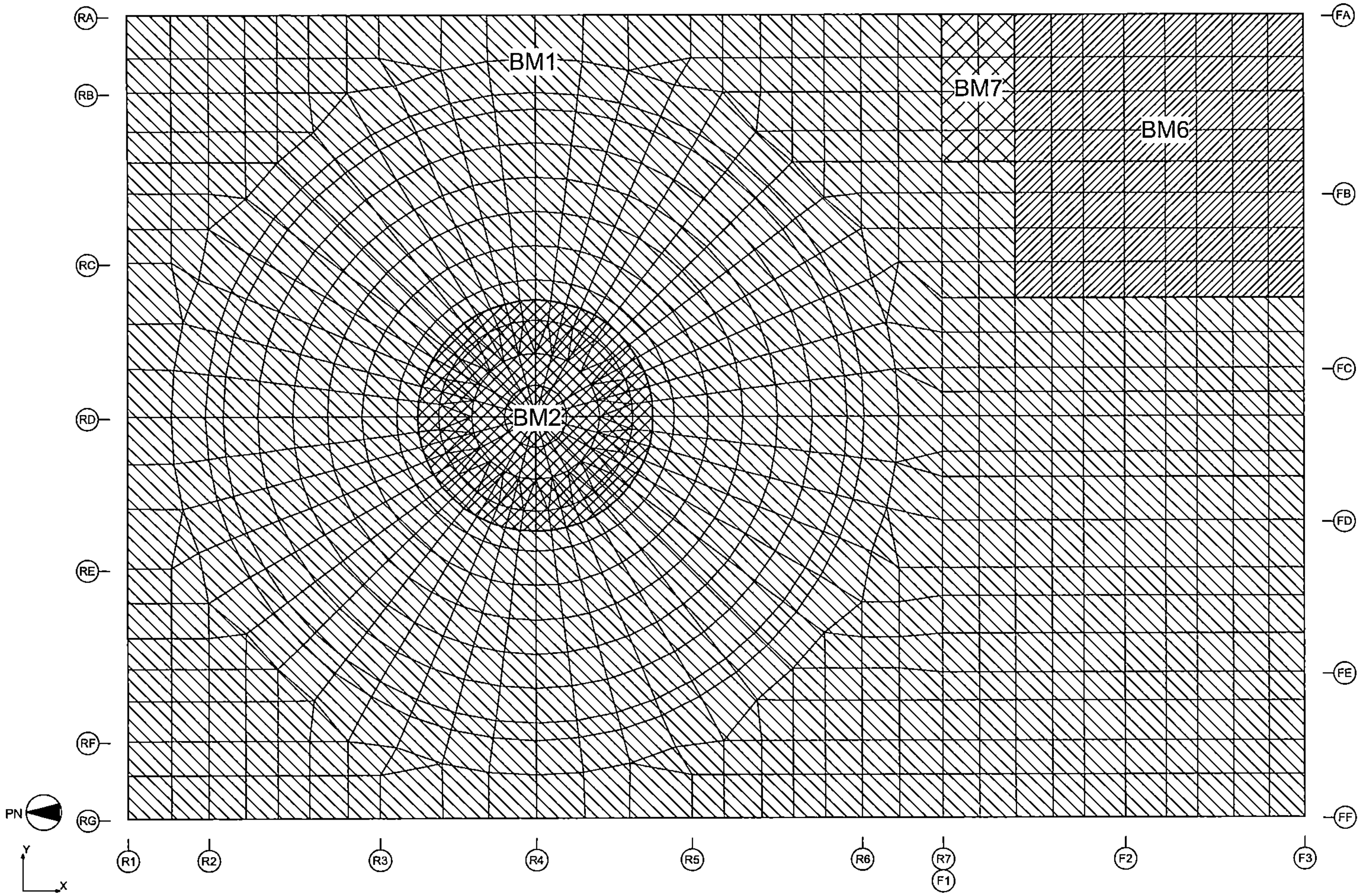
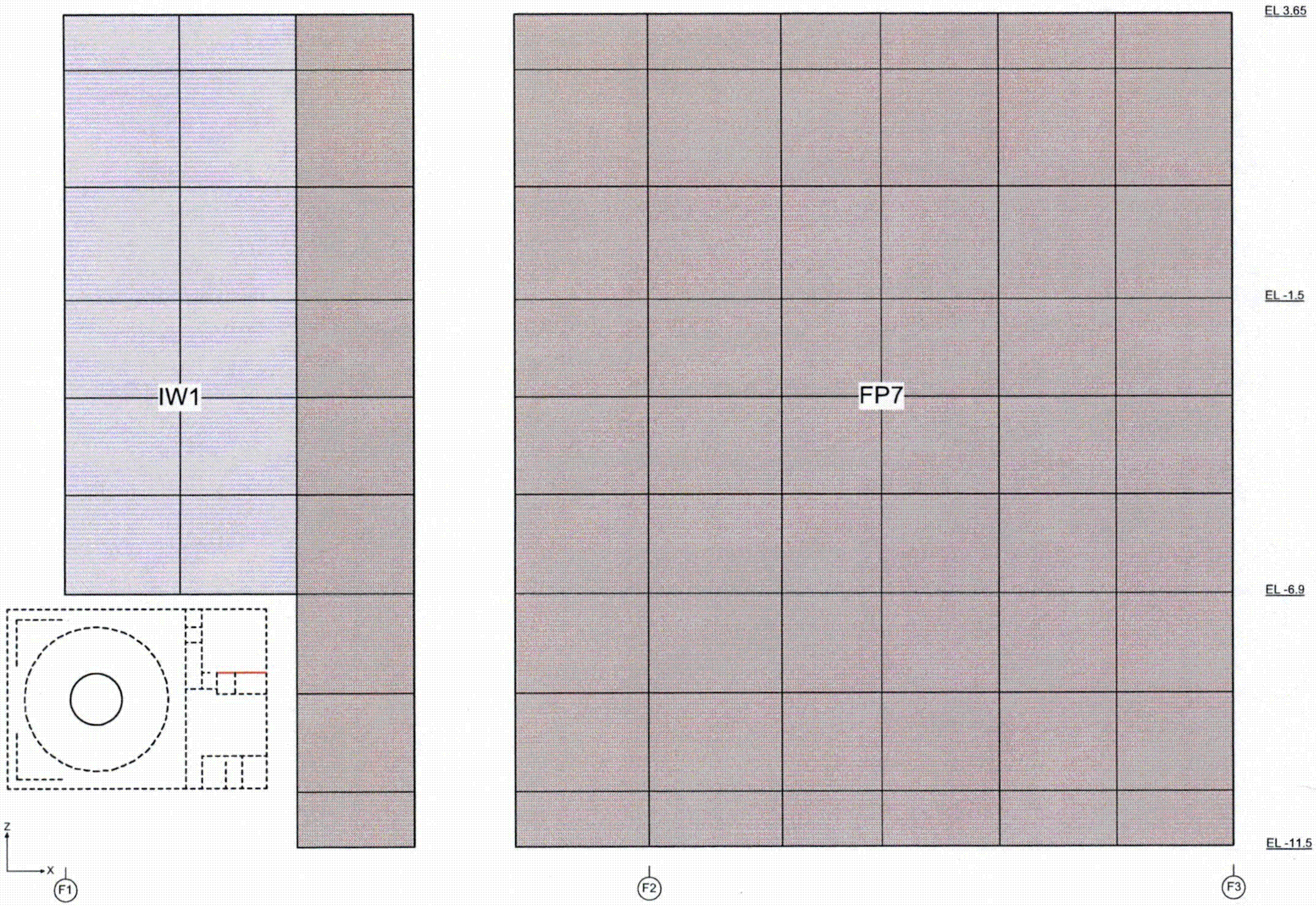


Figure 5.2.2-5 Application of Thermal Load on the Basemat



Note: Target walls are shown in red in the plan

Figure 5.2.2-6 Application of Thermal Load on the Spent Fuel Pool Wall-1

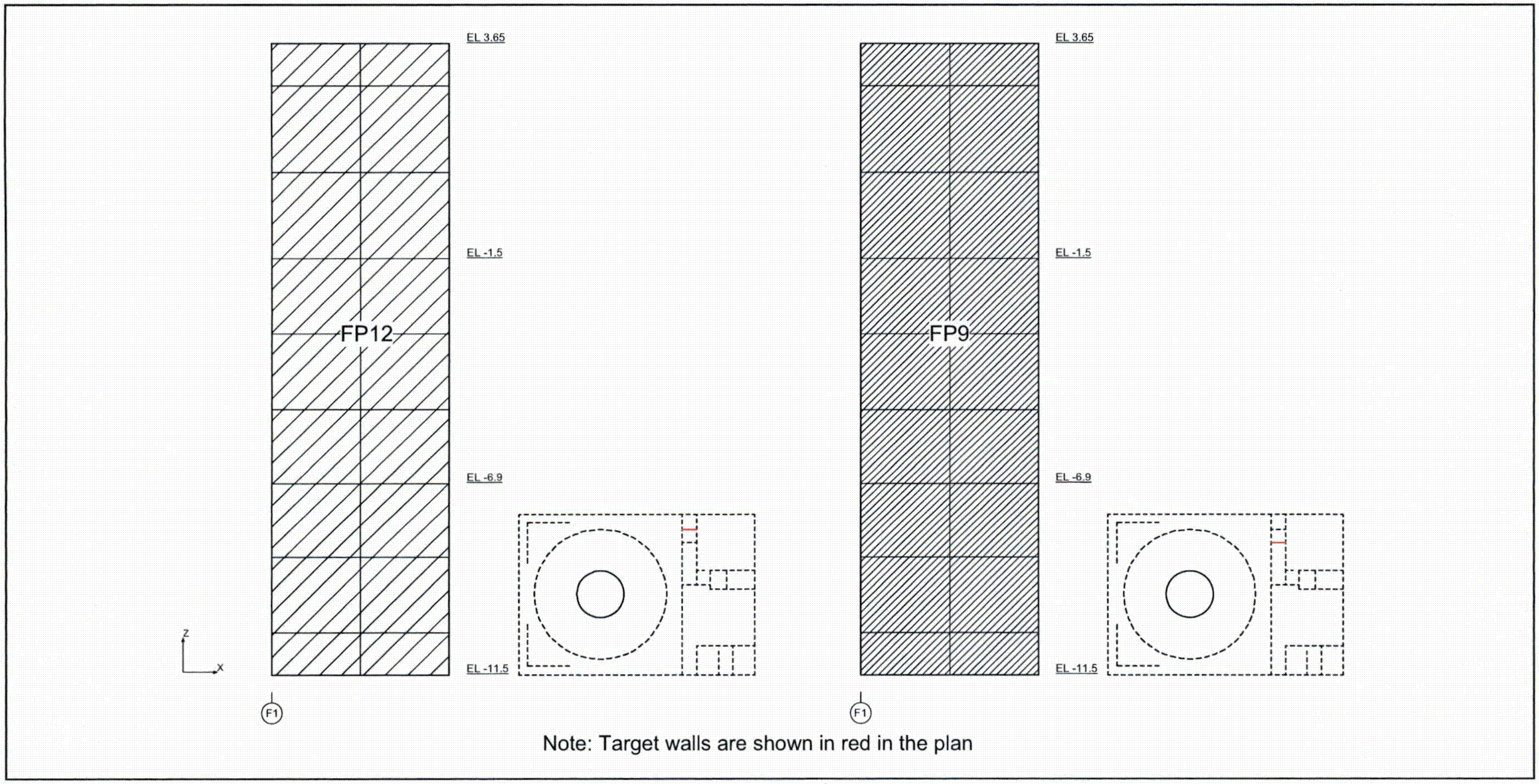


Figure 5.2.2-7 Application of Thermal Load on the Spent Fuel Pool Wall-2

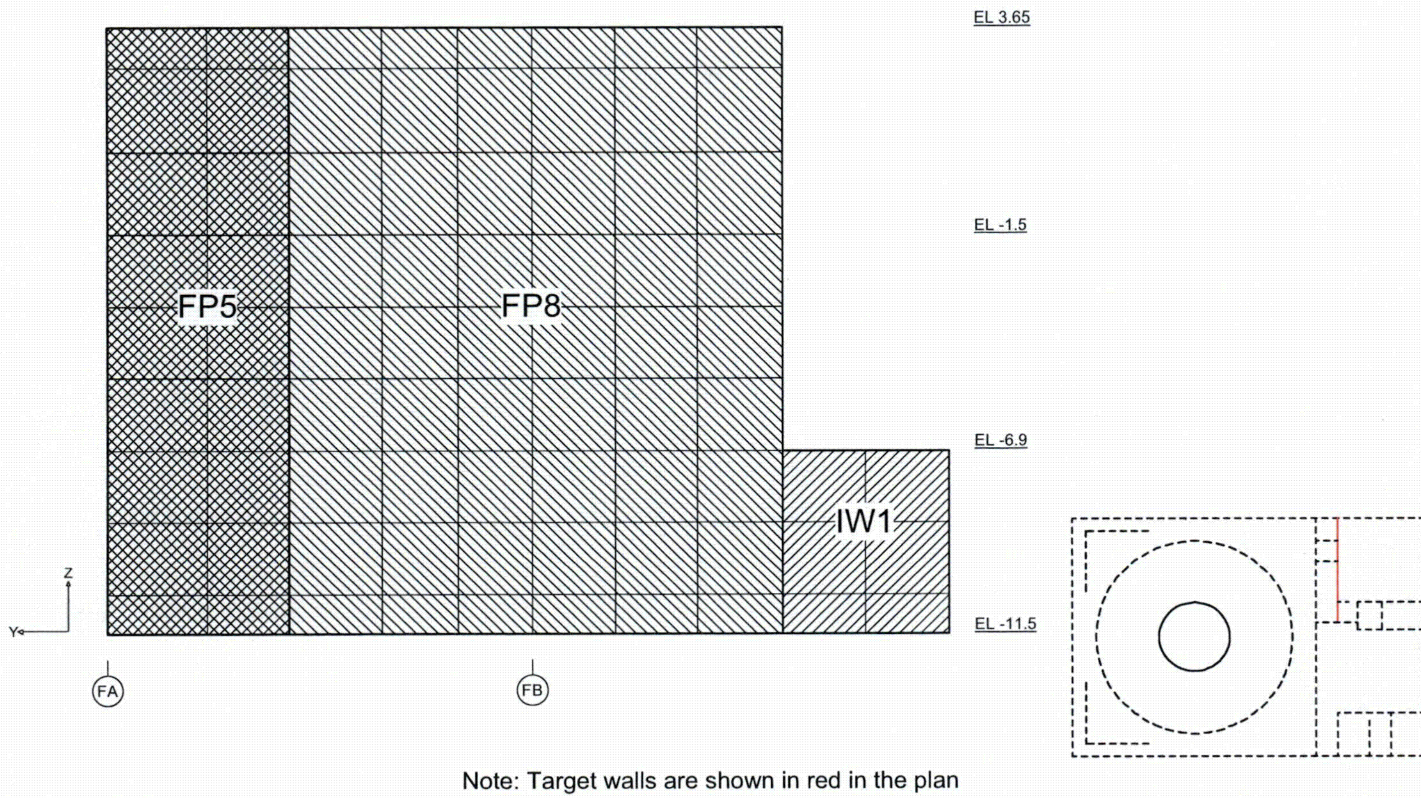
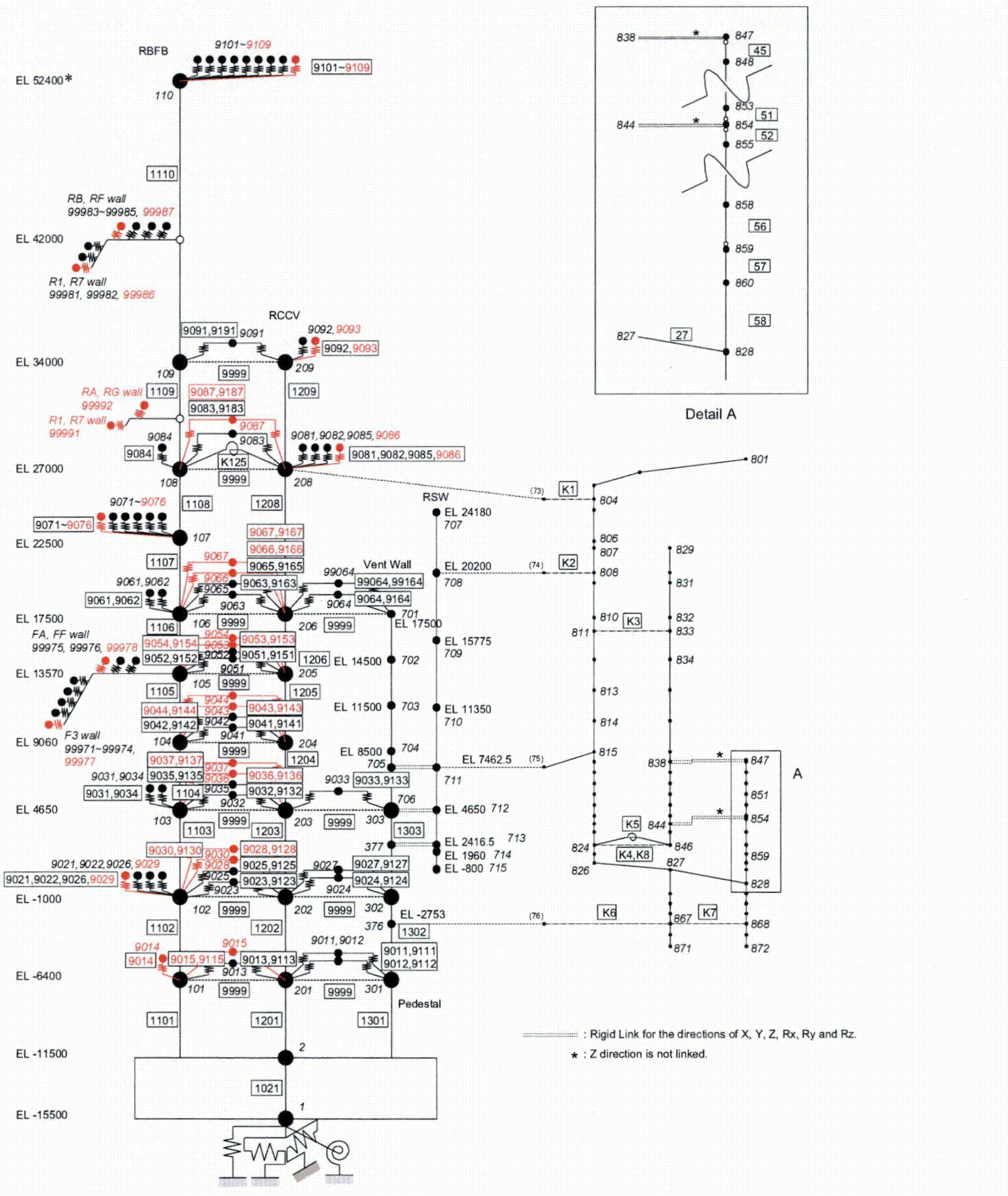


Figure 5.2.2-8 Application of Thermal Load on the Spent Fuel Pool Wall-3



*: The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.

Note: Slab oscillator node 99064 is only for the model considering 0% (CR))) and 50% (CR50) of infill concrete stiffness of the vent wall and diaphragm floor.

Additional oscillators for crack model are shown in red.

Figure 5.3.3-1 Dynamic Analysis Model

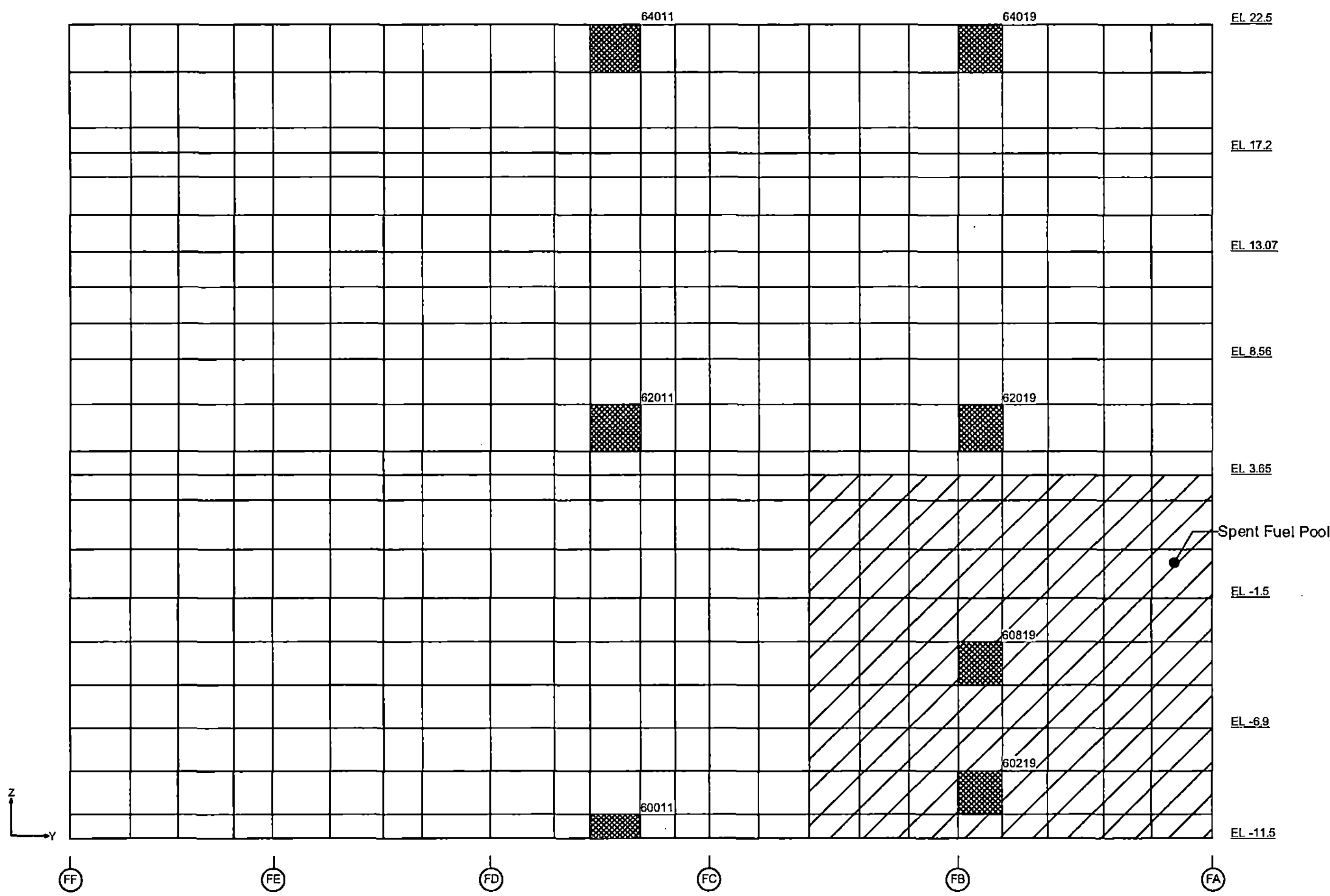


Figure 6.2.4-1 Elements Selected for Tabulation (External Wall F3)

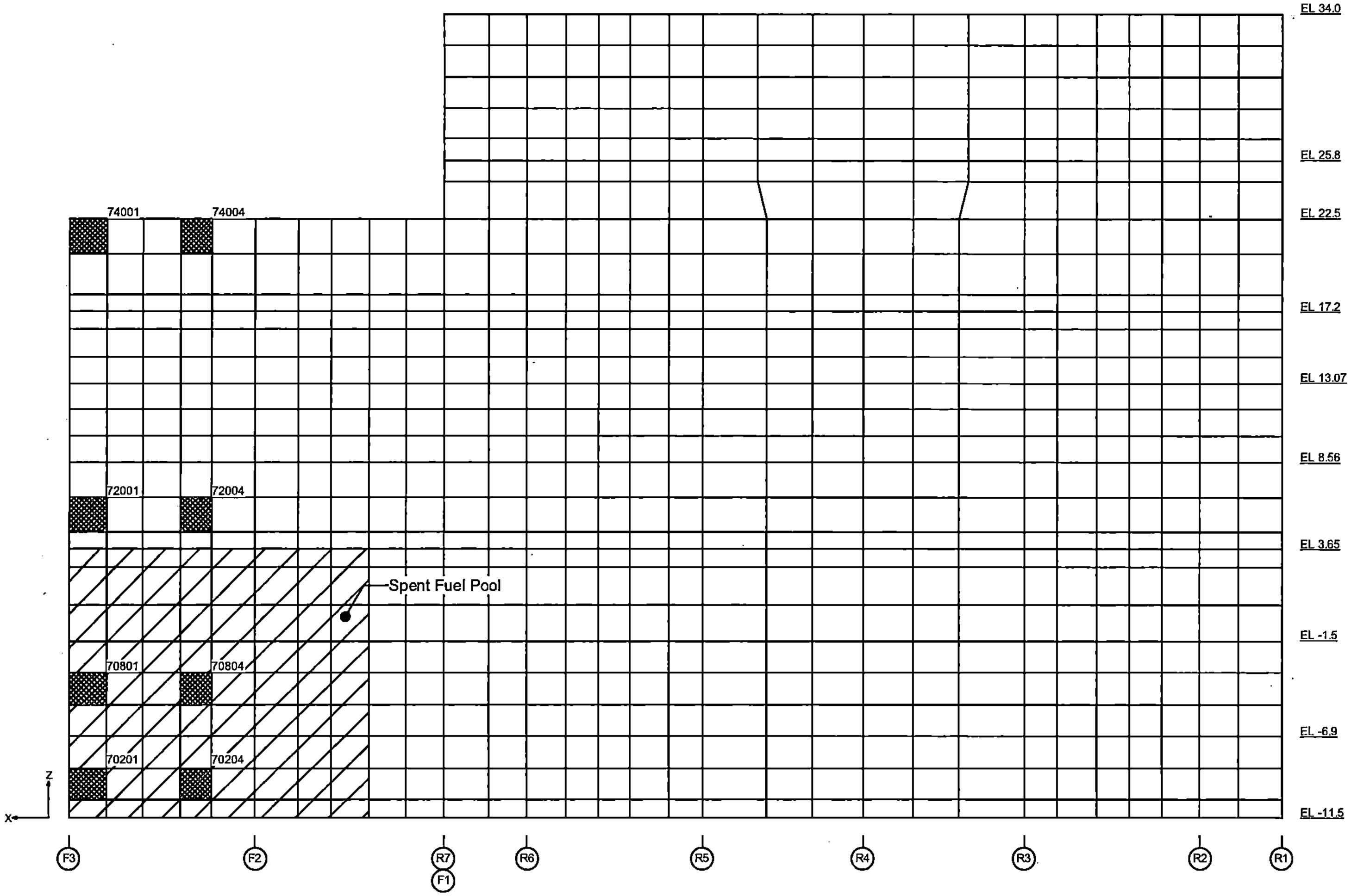


Figure 6.2.4-2 Elements Selected for Tabulation (External Wall RA FA)

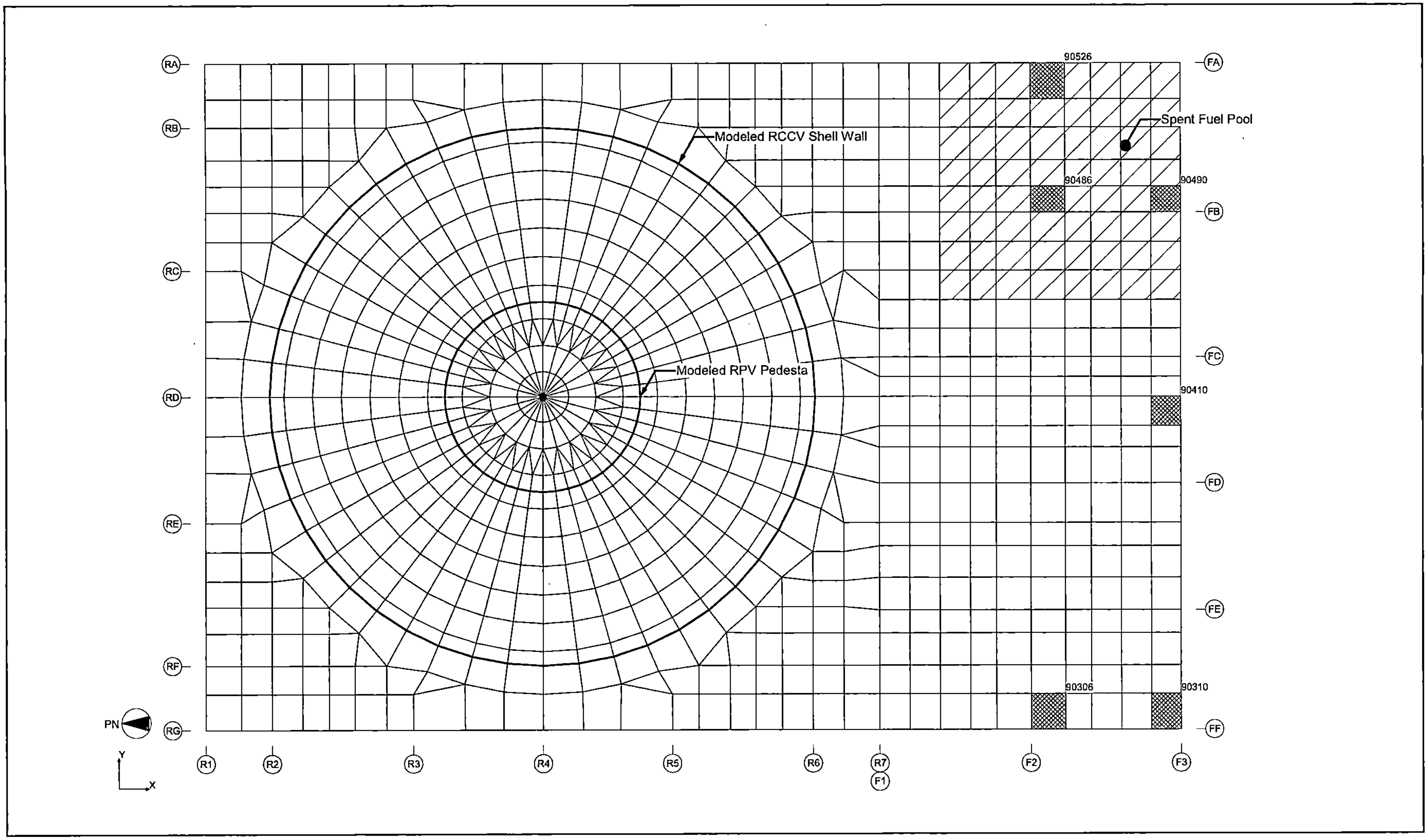


Figure 6.2.4-3 Elements Selected for Tabulation (Basemat)

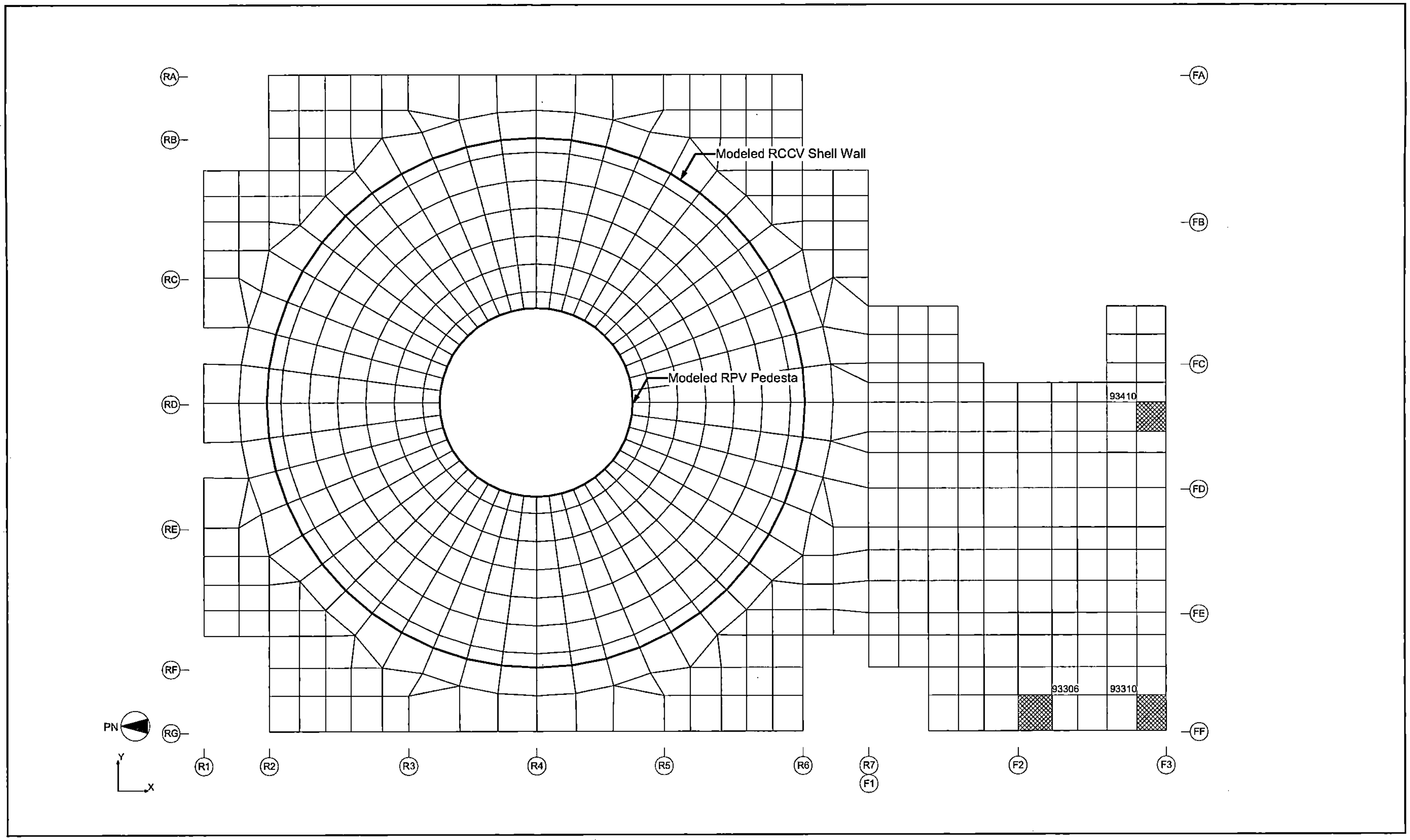


Figure 6.2.4-4 Elements Selected for Tabulation (Slab at EL4,650)

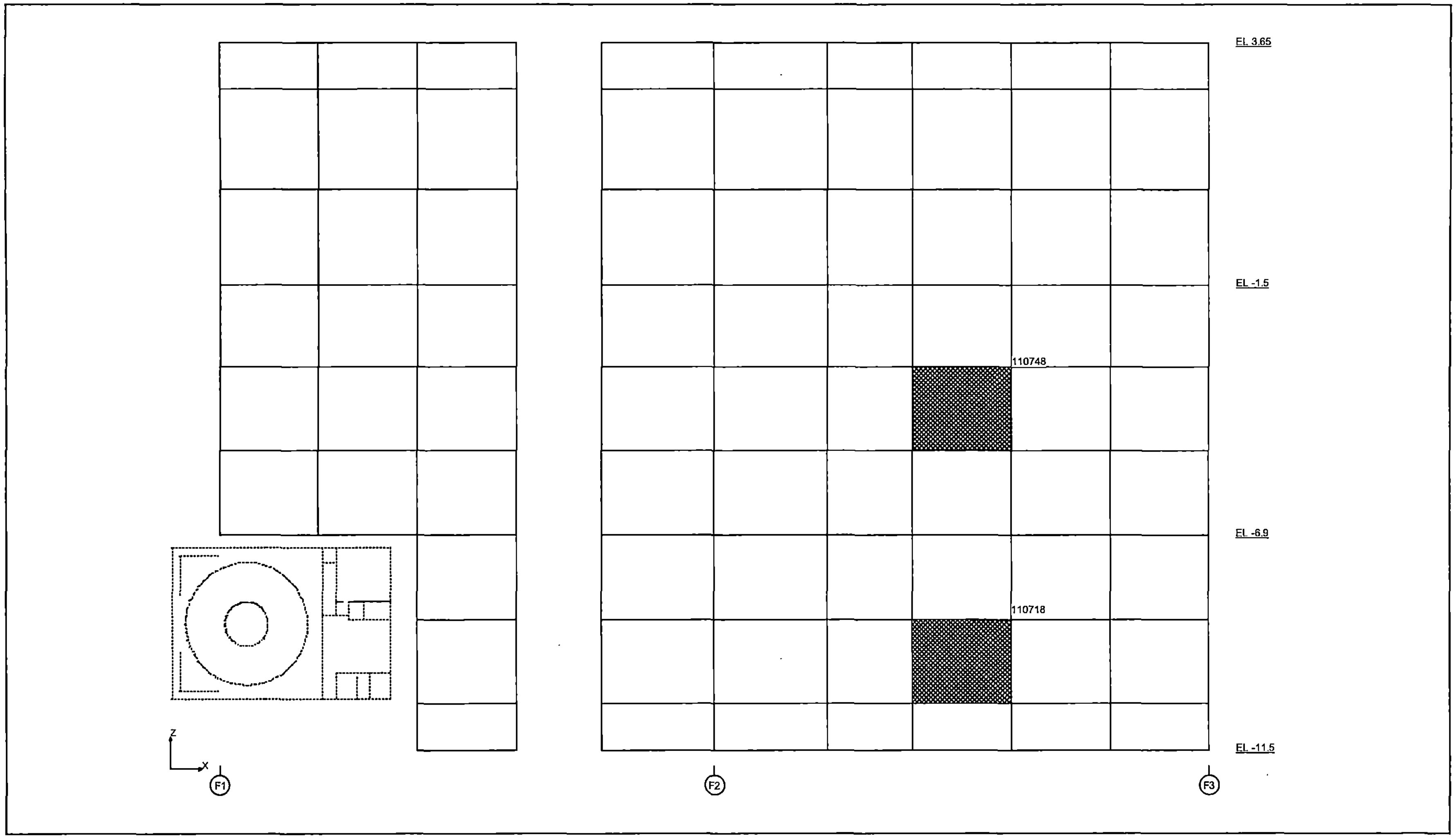
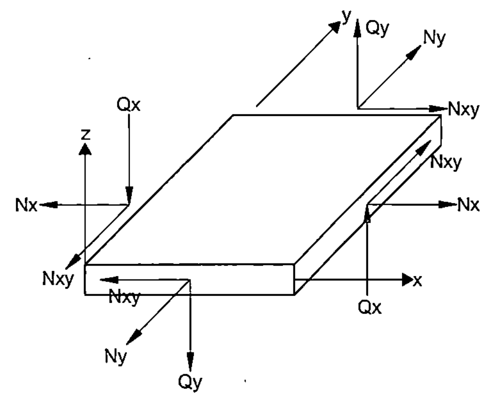
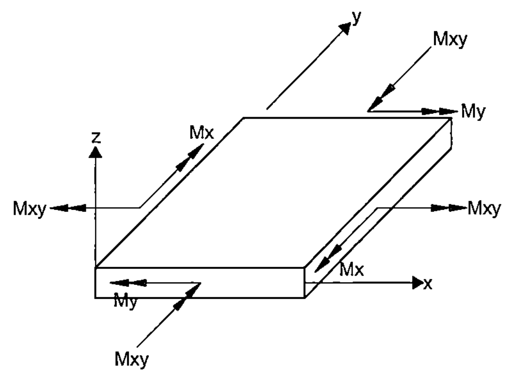


Figure 6.2.4-5 Elements Selected for Tabulation (Spent Fuel Pool Wall)



Membrane and Shear Forces

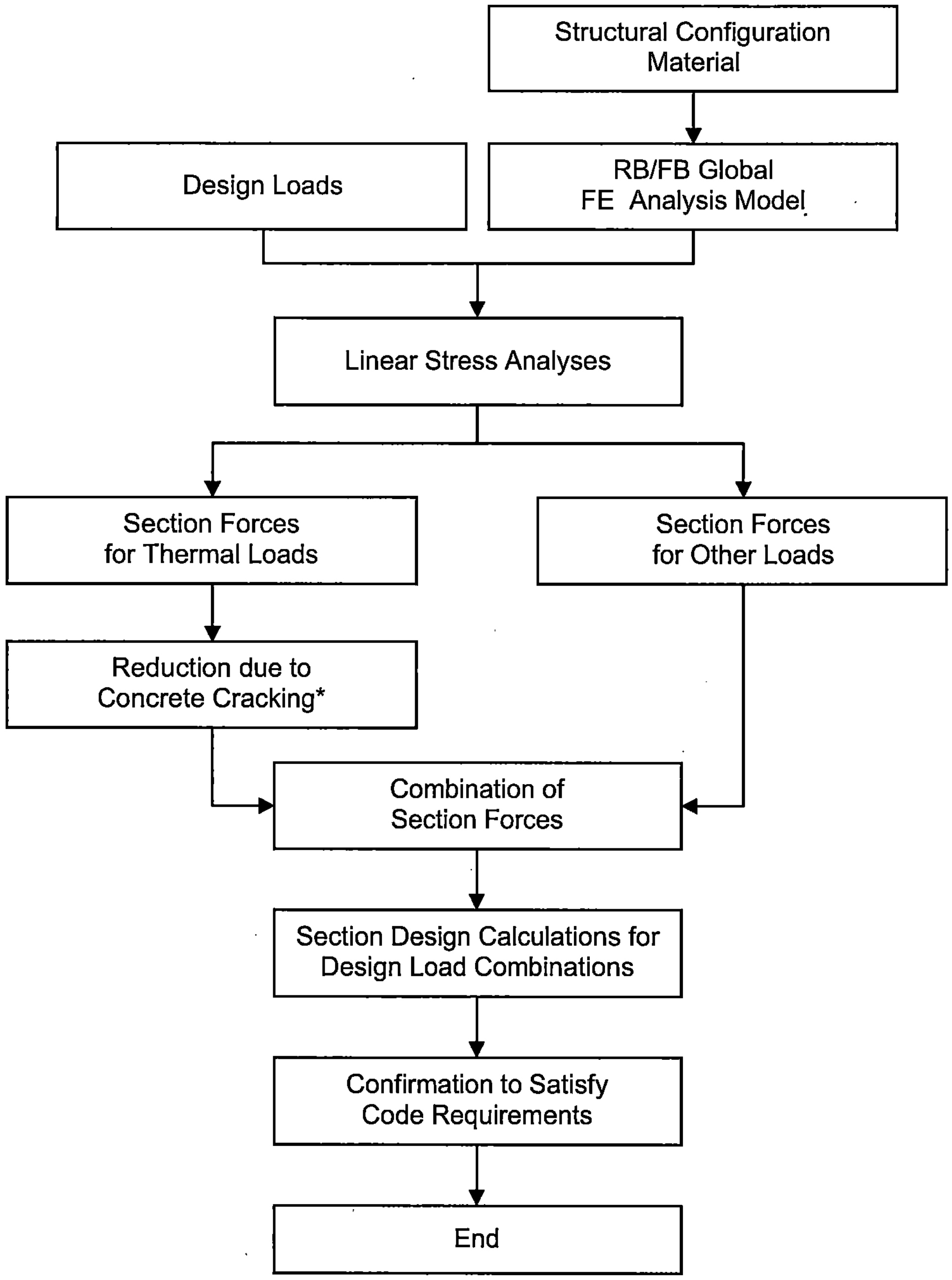


Moments

Definition of Element Coordinate System

Structure	x	y	z
RCCV Wall RPV Pedestal External Wall	horizontal	vertical	outward
Wall in N-S Direction	horizontal	vertical	toward West
Wall in E-W Direction	horizontal	vertical	toward South
Foundation Mat Floor Slab Top Slab	toward South	toward West	downward
Suppression Pool Slab	radial	circumferential	downward

Figure 6.2.4-6 Force and Moment in Shell Element



*: Thermal section forces are reduced using the section design calculation program, SSDP-2D

Figure 6.4.1-1 Design Flow Chart of Reinforced Concrete Structures

axial load N_u

$N_u = 0$

$$v_c = \min(v_{c1}, v_{c2})$$

$$v_{c1} = 1.9\sqrt{f'_c} + 2500\rho_w \frac{V_u d}{M_u}$$

$$v_{c2} = 3.5\sqrt{f'_c}$$

where,

$\left(\frac{V_u d}{M_u}\right)$ shall not exceed 1.0.

$N_u < 0$ (Compression)

$$v_c = \min(v_{c1}, v_{c2})$$

$$v_{c1} = 1.9\sqrt{f'_c} + 2500\rho_w \frac{V_u d}{M_m}$$

$$v_{c2} = 3.5\sqrt{f'_c}\sqrt{1 - \frac{N_u}{500A_g}}$$

$$M_m = M_u + N_u \frac{(4h-d)}{8}$$

if $M_m \leq 0$

$$v_c = v_{c2}$$

$N_u > 0$ (Tension)

$$v_{c2} = 2\left(1 - \frac{N_u}{500A_g}\right)\sqrt{f'_c}$$

$$V_c = v_c d$$

where,

v_c: allowable shear stress carried by concrete, psi

V_c: shear strength provided by concrete, lb / in

d: distance from extreme compression fiber to centroid of tension reinforcement, in

f'_c: specified compressive strength of concrete, psi

ρ_w: ratio of tension reinforcement $(= A_s / b_w d)$

V_u: shear force at section, lb

M_u: moment at section, lb - in

N_u: axial load at section, tension positive, lb

h: overall thickness of section, in

A_g: gross area of section, in^2

Figure 6.4.1.1-1 Calculation of Shear Strength Provided by Concrete

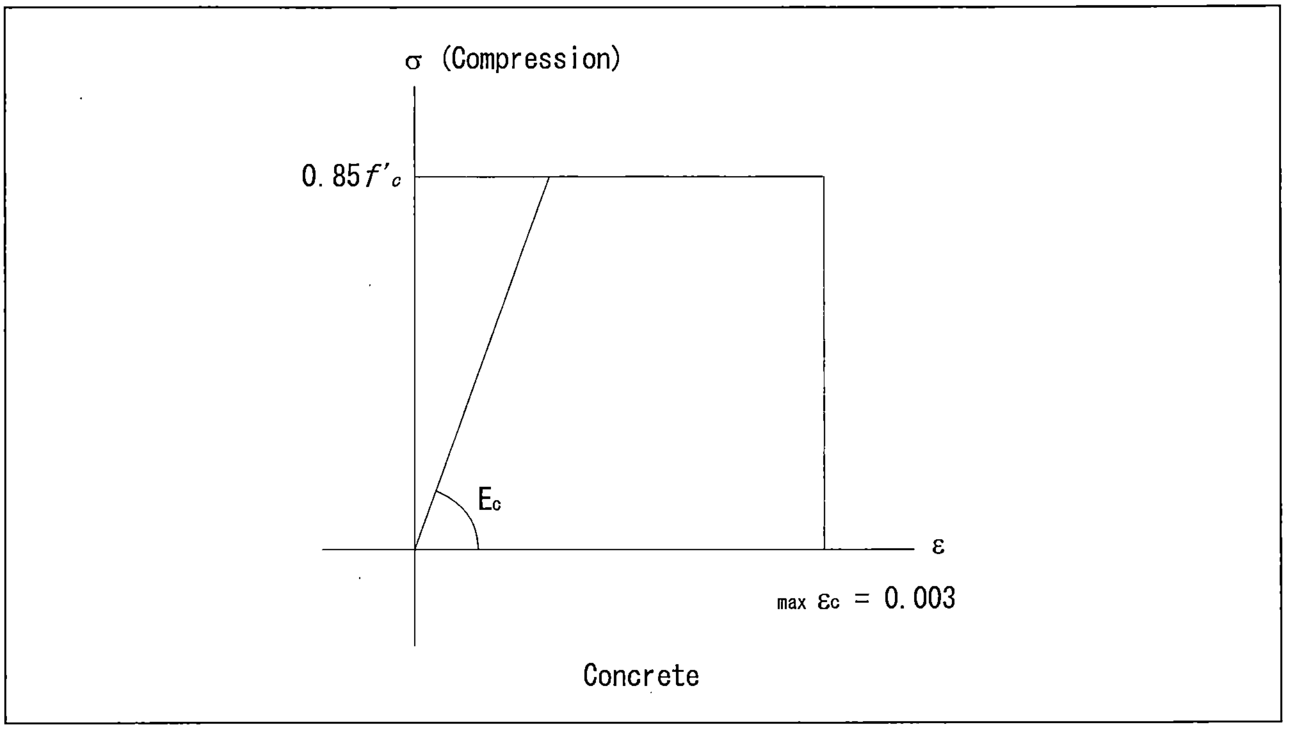


Figure 6.4.1.2-1 Stress-Strain Relationship Assumed for Strength Check

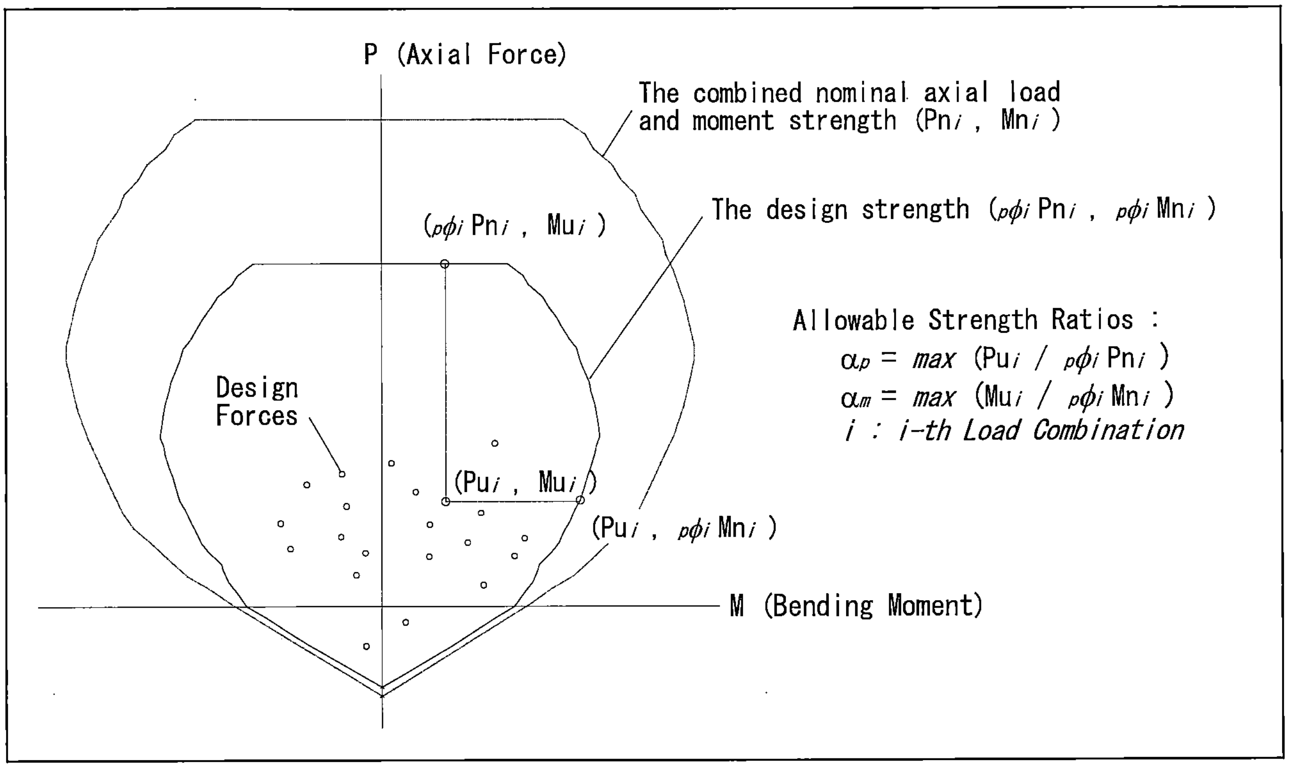


Figure 6.4.1.2-2 Calculation Method of Strength Ratios

Check of laterally unsupported length : l_b

$l_b \le L_c$

where $L_c = min\left(\frac{76 b_f}{\sqrt{F_y}}, \frac{20000}{(d/A_f)F_y}\right)$

$l_b \le L_c$ → Check of compact section of web

$l_b > L_c$ → Tension or Compression

Check of compact section of web

$\frac{d}{t_w} \le \frac{640}{\sqrt{F_y}}\left(1 - 3.74\frac{f_a}{F_y}\right)$ for $f_a / F_y \le 0.16$

$\frac{d}{t_w} \le \frac{257}{\sqrt{F_y}}$ for $f_a / F_y > 0.16$

Compact → Check of compact section of flange

Non-compact → $F_b = 0.60 F_y$

Check of compact section of flange

$\frac{b_f}{2t_f} \le \frac{65}{\sqrt{F_y}}$

Compact → $F_b = 0.66 F_y$

Non-compact →

$F_b = F_y\left[0.79 - 0.002\frac{b_f}{2t_f}\sqrt{F_y}\right]$ (for rolled member)

$F_b = F_y\left[0.79 - 0.002\frac{b_f}{2t_f}\sqrt{\frac{F_y}{k_c}}\right]$ (for built-up member)

where $k_c = \frac{4.05}{(h/t_w)^{0.46}}$ if $h/t_w > 70$, otherwise $k_c = 1.0$

Tension or Compression

Tension → $F_b = 0.60 F_y$

Compression →

when $\sqrt{\frac{102 \times 10^3 C_b}{F_y}} \le \frac{l_b}{r_T} \le \sqrt{\frac{510 \times 10^3 C_b}{F_y}}$:

$F_b = max\left(\left[\frac{2}{3} - \frac{F_y (l_b / r_T)^2}{1530 \times 10^3 C_b}\right]F_y, \frac{12 \times 10^3 C_b}{l_b d / A_f}\right) \le 0.60 F_y$

when $\frac{l_b}{r_T} \ge \sqrt{\frac{510 \times 10^3 C_b}{F_y}}$:

$F_b = max\left(\frac{170 \times 10^3 C_b}{(l_b / r_T)^2}, \frac{12 \times 10^3 C_b}{l_b d / A_f}\right) \le 0.60 F_y$

where

d = full depth of steel member, in.

b_f = flange width, in.

t_f = flange thickness, in.

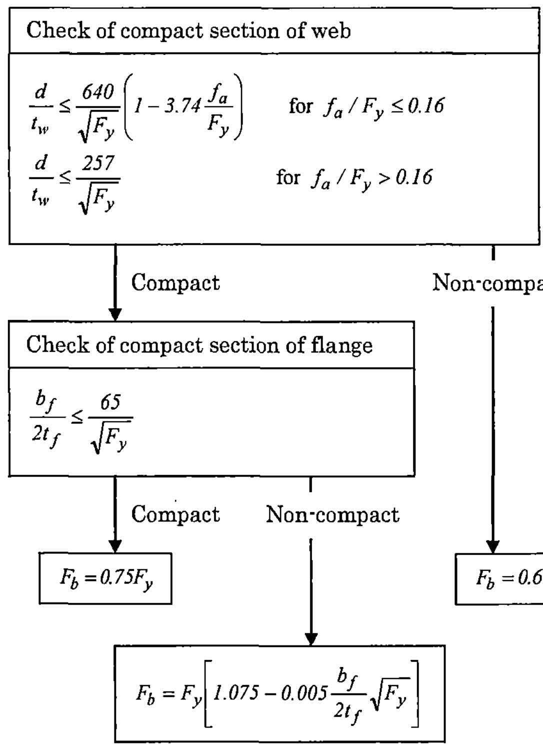
t_w = web thickness, in.

A_f = area of compression flange, in.^{2}

r_T = radius of gyration of a section comprising the compression flange plus 1/3 of the compression web area, taken about an axis in the plane of the web, in

C_b = 1.0 (conservatively taken)

Figure 6.4.2-1 Allowable Stress of W-shaped Members (Strong Axis Bending)



where

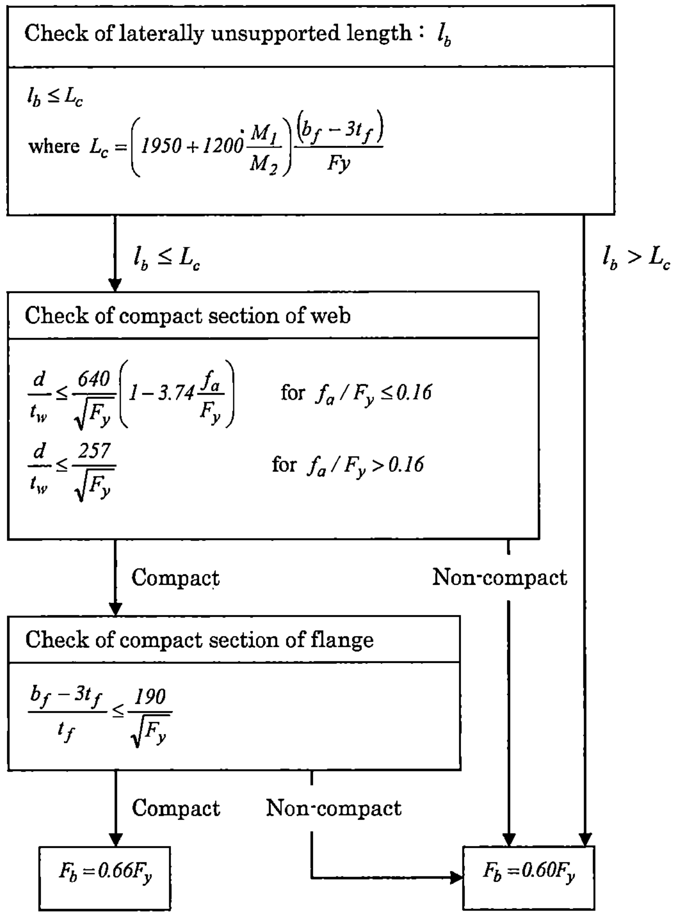
d = full depth of steel member, in.

b_f = flange width, in.

t_f = flange thickness, in.

t_w = web thickness, in.

Figure 6.4.2-2 Allowable Stress of W-shaped Members (Weak Axis Bending)



where

d = full depth of steel member, in. b_f = full flange width, in.

t_f = flange thickness, in. t_w = web thickness, in.

M_1 = the smaller bending moment at the ends of the unbraced length

M_2 = the larger bending moment at the ends of the unbraced length

Figure 6.4.2-3 Allowable Bending Stress of Box Members

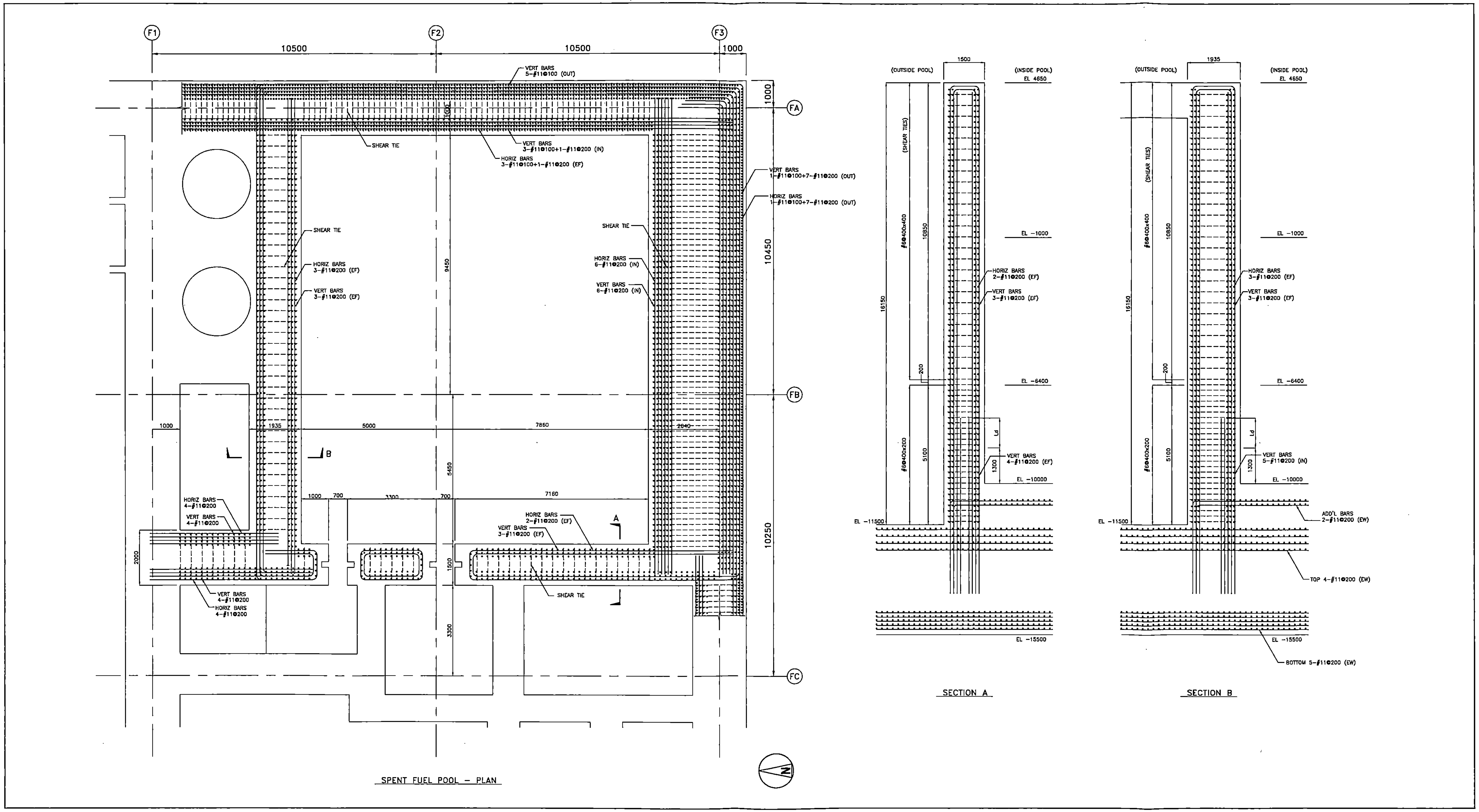


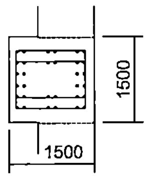
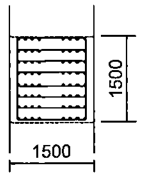
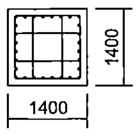
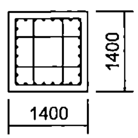
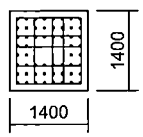
Figure 7.1-1 Reinforcing Steel of Spent Fuel Pool Walls

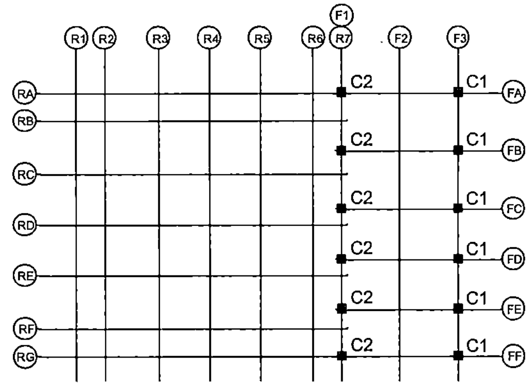
{

}

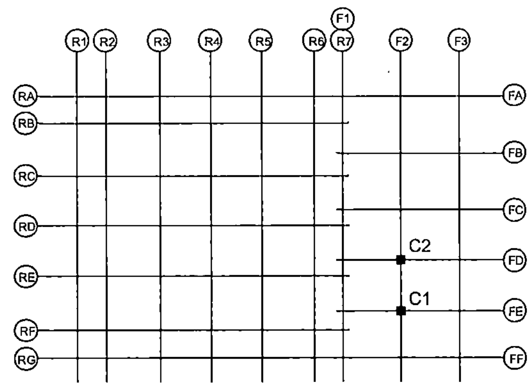
Figure 7.1-2 List of FB Wall and Slab Reinforcement

{{{Security-Related Information - Withheld Under 10 CFR-2.390}}}

FB COLUMN REINFORCING SCHEDULE			
~ EL 4650	TYPE	C1	C2
	SECTION		
	MAIN BAR	32-#11	64-#11
	SHEAR TIE	#5 @200	#5 @200
EL 4650 ~ EL -6400	TYPE	C1,C2	
	SECTION		
	MAIN BAR	28-#11	
	SHEAR TIE	#5 @200	
EL -6400 ~ EL -11500	TYPE	C1	C2
	SECTION		
	MAIN BAR	28-#11	56-#11
	SHEAR TIE	#5 @200	#6 @200



FLOOR EL 4650~

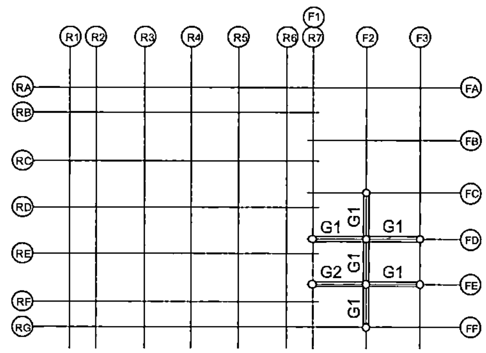


FLOOR EL -11500~EL4650

KEY PLAN FOR COLUMN

Figure 7.1-3 FB Reinforced Concrete Column Reinforcing Schedule

FB GIRDER REINFORCING SCHEDULE			
EL 4650	TYPE	G1, G2	
	SECTION	10-#11 (top), 10-#11 (bottom), 800 × 1500	
	STIRRUP LEG	4-#5	
EL -1000	TYPE	G1, G2	
	SECTION	10-#11 (top), 10-#11 (bottom), 800 × 1500	
	STIRRUP LEG	4-#5	
EL -6400	TYPE	G1	G2
	SECTION	10-#11 (top), 10-#11 (bottom), 800 × 1500	10-#11 (top), 13-#11 (bottom), 800 × 1500
	STIRRUP LEG	4-#5	6-#5



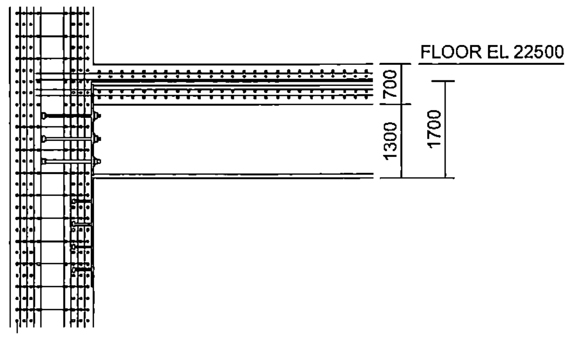
FLOOR EL -6400, EL-1000, EL4650

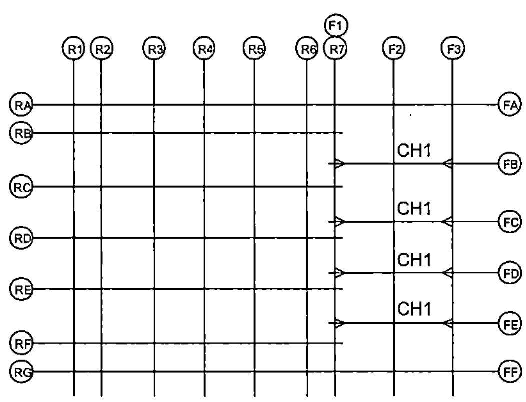
KEY PLAN FOR COLUMN

Figure 7.1-4 FB Reinforced Concrete Girder Reinforcing Schedule

FB ROOF STRUCTURAL STEEL MEMBER SCHEDULE

ID NO.	WELDED PL NUMBER	
	FLG. PL	WEB PL
CH1	1000x75	1550x60

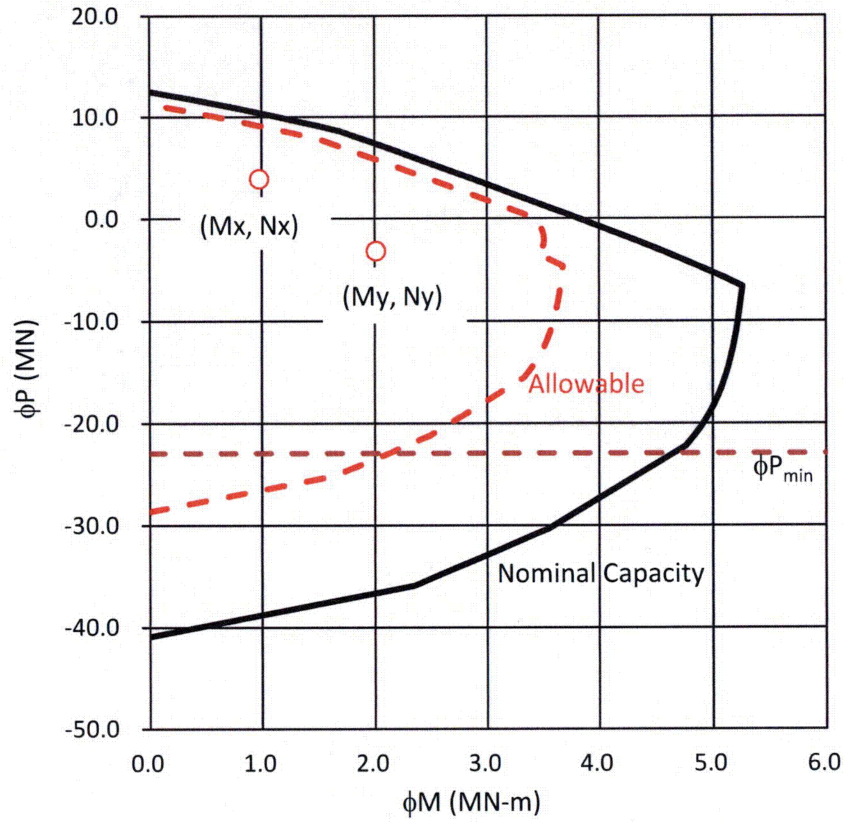




FLOOR EL 22500

KEY PLAN FOR STRUCTURAL STEEL

Figure 7.1-5 FB Steel Girder Member



Note: Negative value means compression.

Figure 7.3.1.1-1 Moment Capacity Check according to ACI349-01 for Element 72004 with New Arrangement of Reinforcement

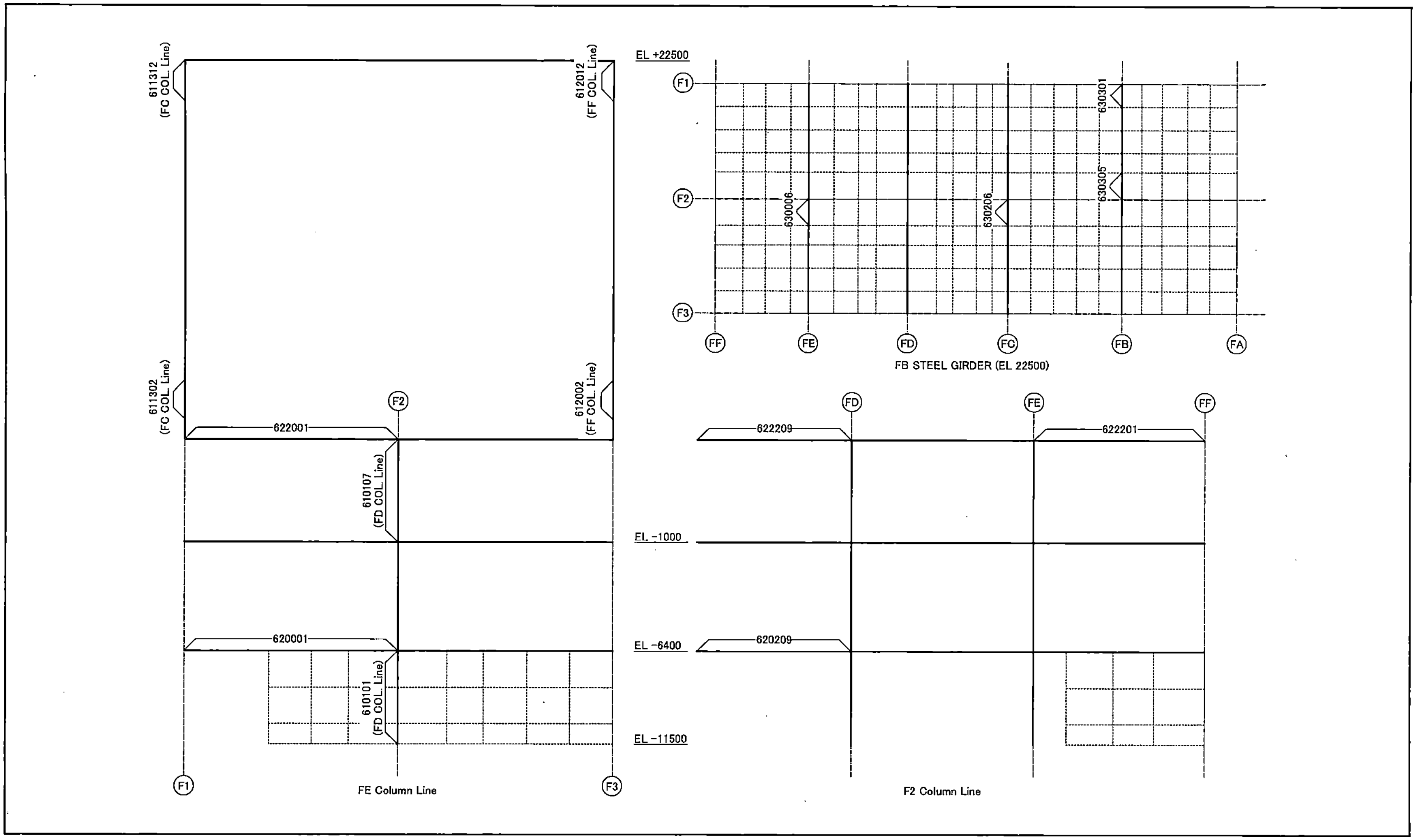


Figure 7.3.1.2-1 Elements Selected for Tabulation - FB Frame -

APPENDIX A

COMPARISON WITH DCD DATA

List of Tables

List of Figures

None

Table A.1-1 Design Seismic Shear Loads for Horizontal

Elev. (m)	Elem No.	Node No.	NS-direction			EW-direction		
			NA3 (MN)	DCD (MN)	Ratio (NA3/DCD)	NA3 (MN)	DCD (MN)	Ratio (NA3/DCD)
52.40*	1110	110	192.2	151.9	1.27	140.0	158.2	0.89
		109	192.2	151.9	1.27	140.0	158.2	0.89
34.00	1109	109	173.2	191.7	0.90	113.9	153.0	0.74
		108	173.2	191.7	0.90	113.9	153.0	0.74
27.00	1108	108	396.0	425.4	0.93	259.4	400.7	0.65
		107	396.0	425.4	0.93	259.4	400.7	0.65
22.50	1107	107	436.4	483.7	0.90	291.8	464.0	0.63
		106	436.4	483.7	0.90	291.8	464.0	0.63
17.50	1106	106	438.4	532.9	0.82	343.5	555.4	0.62
		105	438.4	532.9	0.82	343.5	555.4	0.62
13.57	1105	105	450.7	569.2	0.79	363.7	599.9	0.61
		104	450.7	569.2	0.79	363.7	599.9	0.61
9.06	1104	104	454.6	610.1	0.75	383.4	654.3	0.59
		103	454.6	610.1	0.75	383.4	654.3	0.59
4.65	1103	103	454.7	839.8	0.54	360.1	872.2	0.41
		102	454.7	839.8	0.54	360.1	872.2	0.41
-1.00	1102	102	240.0	871.4	0.28	226.6	938.5	0.24
		101	240.0	871.4	0.28	226.6	938.5	0.24
-6.40	1101	101	237.7	933.6	0.25	200.4	1029.7	0.19
-11.50		2	237.7	933.6	0.25	200.4	1029.7	0.19

*The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.

Table A.1-2 Design Seismic Moment Loads for Horizontal

Elev. (m)	Elem No.	Node No.	NS-direction			EW-direction		
			NA3 (MN-m)	DCD (MN-m)	Ratio (NA3/DCD)	NA3 (MN-m)	DCD (MN-m)	Ratio (NA3/DCD)
52.4*	1110	110	2724	1642	1.66	2143	1808	1.19
			5838	4303	1.36	4488	4465	1.01
34	1109	109	8196	5585	1.47	5821	5497	1.06
			8719	6477	1.35	6389	6317	1.01
27	1108	108	9400	7685	1.22	7162	7106	1.01
			9599	8964	1.07	7958	8596	0.93
22.5	1107	107	11216	9905	1.13	8328	9193	0.91
			11424	11464	1.00	9227	11297	0.82
17.5	1106	106	12105	12386	0.98	9408	11935	0.79
			12349	13778	0.90	10195	13867	0.74
13.57	1105	105	12839	14298	0.90	10255	14377	0.71
			13651	16593	0.82	11216	16740	0.67
9.06	1104	104	13904	16966	0.82	11338	17191	0.66
			15231	19378	0.79	12506	19672	0.64
4.65	1103	103	9392	19064	0.49	6302	20192	0.31
			10952	23163	0.47	7759	24272	0.32
-1	1102	102	6545	23673	0.28	4819	24948	0.19
			7303	27655	0.26	5358	29263	0.18
-6.4	1101	101	4748	28126	0.17	3351	30038	0.11
-11.5		2	5053	32235	0.16	3356	35275	0.10

*The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.

Table A.1-3 Design Seismic Torsion Loads for Horizontal

Elev. (m)	Elem No.	Node No.	Calculated Torsion			Accidental Torsion			Design Torsion		
			NA3 (MN-m)	DCD (MN-m)	Ratio (NA3/DCD)	NA3 (MN-m)	DCD (MN-m)	Ratio (NA3/DCD)	NA3 (MN-m)	DCD (MN-m)	Ratio (NA3/DCD)
52.4*	1110	110	1284	1379	0.93	471	388	1.22	1755	1766	0.99
			1284	1379	0.93	471	388	1.22	1755	1766	0.99
34	1109	109	1938	2405	0.81	424	470	0.90	2362	2874	0.82
			1938	2405	0.81	424	470	0.90	2362	2874	0.82
27	1108	108	2799	3329	0.84	1386	1489	0.93	4185	4822	0.87
			2799	3329	0.84	1386	1489	0.93	4185	4822	0.87
22.5	1107	107	4678	6093	0.77	1527	1693	0.90	6205	7786	0.80
			4678	6093	0.77	1527	1693	0.90	6205	7786	0.80
17.5	1106	106	4023	5068	0.79	1535	1944	0.79	5557	7012	0.79
			4023	5068	0.79	1535	1944	0.79	5557	7012	0.79
13.57	1105	105	4211	5245	0.80	1578	2100	0.75	5788	7344	0.79
			4211	5245	0.80	1578	2100	0.75	5788	7344	0.79
9.06	1104	104	4694	5985	0.78	1591	2290	0.69	6285	8275	0.76
			4694	5985	0.78	1591	2290	0.69	6285	8275	0.76
4.65	1103	103	5248	11425	0.46	1591	3053	0.52	6839	14478	0.47
			5248	11425	0.46	1591	3053	0.52	6839	14478	0.47
-1	1102	102	2718	11523	0.24	840	3285	0.26	3558	14808	0.24
			2718	11523	0.24	840	3285	0.26	3558	14808	0.24
-6.4	1101	101	2079	11690	0.18	832	3604	0.23	2910	15294	0.19
-11.5		2	2079	11690	0.18	832	3604	0.23	2910	15294	0.19

*The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.

Table A.1-4 Vertical Acceleration

(a) RB/FB

Elev. (m)	Node No.	Stick Model	NA3 (g)	DCD (g)	Ratio (NA3/DCD)
52.4*	110	RBFB	1.56	1.25	1.25
34	109	RBFB	1.20	0.83	1.45
27	108	RBFB	1.02	0.73	1.40
22.5	107	RBFB	0.92	0.73	1.26
17.5	106	RBFB	0.80	0.73	1.10
13.57	105	RBFB	0.72	0.74	0.97
9.06	104	RBFB	0.62	0.73	0.85
4.65	103	RBFB	0.56	0.78	0.72
-1	102	RBFB	0.57	0.76	0.75
-6.4	101	RBFB	0.53	0.68	0.78
-11.5	2	RBFB	0.51	0.63	0.81
-15.5	1	RBFB	0.52	0.51	1.02

*The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.

Table A.1-4 Vertical Acceleration (Continued)

(b) Slab Oscillator

Elev. (m)	Node No.	Stick Model	NA3 (g)	DCD (g)	Ratio (NA3/DCD)
52.4*	9101	Oscillator	0.33	1.20	0.28
	9102	Oscillator	1.33	1.82	0.73
	9103	Oscillator	6.27	3.14	2.00
	9104	Oscillator	2.62	2.26	1.16
	9105	Oscillator	2.42	2.32	1.04
	9106	Oscillator	3.74	2.99	1.25
	9107	Oscillator	3.22	2.80	1.15
	9108	Oscillator	2.50	2.61	0.96
	9109	Oscillator	1.53	---	---
34.00	9091	Oscillator	1.61	1.29	1.25
	9092	Oscillator	1.61	1.06	1.52
	9093	Oscillator	1.12	---	---
27.00	9081	Oscillator	1.64	1.16	1.41
	9082	Oscillator	1.52	0.99	1.54
	9083	Oscillator	1.30	1.09	1.19
	9084	Oscillator	1.67	1.31	1.27
	9085	Oscillator	1.46	0.97	1.51
	9086	Oscillator	1.12	---	---
	9087	Oscillator	1.03	---	---
22.50	9071	Oscillator	1.15	1.60	0.72
	9072	Oscillator	1.79	1.31	1.37
	9073	Oscillator	4.47	2.03	2.20
	9074	Oscillator	1.67	1.31	1.27
	9075	Oscillator	1.51	1.16	1.30
	9076	Oscillator	1.65	---	---
17.50	9061	Oscillator	3.65	1.79	2.04
	9062	Oscillator	2.62	1.49	1.76
	9063	Oscillator	1.17	0.82	1.43
	9064	Oscillator	2.56	1.84	1.39
	9065	Oscillator	1.28	1.42	0.90
	99064	Oscillator	0.99	1.07	0.93
	9066	Oscillator	1.09	---	---
	9067	Oscillator	0.91	---	---

*The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.

Table A.1-4 Vertical Acceleration (Continued)

(e) Slab Oscillator

Elev. (m)	Node No.	Stick Model	NA3 (g)	DCD (g)	Ratio (NA3/DCD)
13.57	9051	Oscillator	1.11	0.81	1.37
	9052	Oscillator	1.25	1.46	0.86
	9053	Oscillator	0.99	---	---
	9054	Oscillator	0.83	---	---
9.06	9041	Oscillator	1.02	0.88	1.16
	9042	Oscillator	1.26	1.42	0.89
	9043	Oscillator	0.93	---	---
	9044	Oscillator	0.80	---	---
4.65	9031	Oscillator	1.62	1.17	1.38
	9032	Oscillator	0.89	0.97	0.92
	9033	Oscillator	1.12	1.02	1.10
	9034	Oscillator	1.81	1.51	1.20
	9035	Oscillator	1.09	1.38	0.79
	9036	Oscillator	0.94	---	---
	9037	Oscillator	0.82	---	---
-1.00	9021	Oscillator	0.97	1.12	0.87
	9022	Oscillator	2.07	1.45	1.43
	9023	Oscillator	0.98	1.01	0.97
	9024	Oscillator	1.12	0.89	1.26
	9025	Oscillator	1.21	1.34	0.90
	9026	Oscillator	1.63	1.57	1.04
	9027	Oscillator	0.93	0.88	1.06
	9028	Oscillator	0.96	---	---
	9029	Oscillator	1.30	---	---
	9030	Oscillator	0.87	---	---
-6.40	9011	Oscillator	0.84	0.92	0.91
	9012	Oscillator	1.17	0.92	1.27
	9013	Oscillator	1.52	1.35	1.13
	9014	Oscillator	1.19	---	---
	9015	Oscillator	1.03	---	---

Table A.1-5 Soil Pressure Due to an Earthquake

Elevation (m)	R1 and F3 Wall			RA and RG Wall			Note
	NA3 (MPa)	DCD (MPa)	Ratio (NA3/DCD)	NA3 (MPa)	DCD (MPa)	Ratio (NA3/DCD)	
4.65							Grade
	0.56	0.30	1.87	0.45	0.33	1.36	
-1							
	0.28	0.29	0.97	0.29	0.29	1.00	
-6.4							
	0.24	0.25	0.96	0.22	0.23	0.96	
-11.5							
	0.94	0.29	3.24	0.76	0.26	2.92	
-15.5							

Table A.1-6 Sloshing Loads for Spent Fuel Pool

(a) NS Motion

Wall				Floor			
Depth	Pressure			Distance	Pressure		
d/H	NA3 (kN/m^2)	DCD (kN/m^2)	Ratio (NA3/DCD)	x/(L/2)	NA3 (kN/m^2)	DCD (kN/m^2)	Ratio (NA3/DCD)
0.0	12.3	12.3	1.00	0.0	0.0	0.0	---
0.2	23.6	22.6	1.04	0.2	7.4	7.1	1.04
0.4	37.8	36.1	1.05	0.4	15.2	14.5	1.05
0.6	44.6	42.6	1.05	0.6	23.7	22.7	1.05
0.8	45.2	43.2	1.05	0.8	33.6	32.1	1.05
1.0	45.2	43.2	1.05	1.0	45.2	43.2	1.05

(b) EW Motion

Wall				Floor			
Depth	Pressure			Distance	Pressure		
d/H	NA3 (kN/m^2)	DCD (kN/m^2)	Ratio (NA3/DCD)	x/(L/2)	NA3 (kN/m^2)	DCD (kN/m^2)	Ratio (NA3/DCD)
0.0	11.8	11.8	1.00	0.0	0.0	0.0	---
0.2	24.2	23.2	1.04	0.2	8.5	8.2	1.04
0.4	40.0	38.2	1.05	0.4	17.5	16.7	1.05
0.6	49.4	47.2	1.05	0.6	27.4	26.2	1.05
0.8	52.2	49.8	1.05	0.8	38.7	37.0	1.05
1.0	52.2	49.8	1.05	1.0	52.2	49.8	1.05

(c) Vertical Motion

Wall				Floor		
Depth	Pressure					
d/H	NA3 (kN/m^2)	DCD (kN/m^2)	Ratio (NA3/DCD)	NA3 (kN/m^2)	DCD (kN/m^2)	Ratio (NA3/DCD)
0.0	0.0	0.0	---	98.5 for all floor area	98.5 for all floor area	1.00
0.2	19.7	19.7	1.00			
0.4	39.4	39.4	1.00			
0.6	59.1	59.1	1.00			
0.8	78.8	78.8	1.00			
1.0	98.5	98.5	1.00			

Table A.2-1 Maximum Stress Ratios for Flexure and Membrane Forces: FB

Location	Element ID	Concrete				
		NA3		DCD		Ratio (NA3/DCD)
		σ/σ_s	Load ID	σ/σ_s	Load ID	
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	0.246	7461	0.392	7301	0.63
	60219	0.481	8511	0.467	7482	1.03
	70201	0.448	6981	0.433	6981	1.03
	70204	0.551	8511	0.654	7482	0.84
	110718	0.719	7492	0.808	7492	0.89
2 Exterior Wall @ EL4.65 ~6.60m	62011	0.692	8514	0.579	7561	1.20
	62019	0.738	8514	0.449	7482	1.64
	72001	0.576	8511	0.520	7482	1.11
	72004	1.033	8512	0.550	7482	1.88
3 Exterior Wall @ EL22.50 ~24.60m	64011	0.778	8511	0.918	7561	0.85
	64019	0.505	7501	0.541	7501	0.93
	74001	0.306	8511	0.281	7581	1.09
	74004	0.460	8511	0.493	7201	0.93
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	0.343	8511	0.313	7482	1.10
	70801	0.700	7491	0.800	7492	0.88
	70804	0.472	8513	0.603	7561	0.78
	110748	0.547	8511	0.579	7492	0.94
5 Basemat	90306	0.247	8512	0.451	7241	0.55
	90310	0.150	7211	0.213	7211	0.71
	90410	0.282	7491	0.508	7601	0.55
5 Basemat @ Spent Fuel Pool	90486	0.347	8514	0.715	7201	0.49
	90490	0.356	8511	0.436	7481	0.82
	90526	0.239	7491	0.414	7201	0.58
6 Slab EL4.65m	93306	0.165	7211	0.212	7481	0.78
	93310	0.303	8514	0.314	7421	0.97
	93410	0.289	7561	0.226	7561	1.28

Note : Exceedance is highlighted. As shown in Figure 7.3.1.1-1, the exceedance is resolved by considering the moment capacity of wall according to the specifications of ACI 349-01.

Table A.2-1 Maximum Stress Ratios for Flexure and Membrane Forces: FB (Continued)

Location	Element ID	Primary Reinforcement																			
		Direction 1*										Direction 2*									
		In/Top					Out/Bottom					In/Top					Out/Bottom				
		NA3		DCD		Ratio	NA3		DCD		Ratio	NA3		DCD		Ratio	NA3		DCD		Ratio
		σ/σ_a	Load ID	σ/σ_a	Load ID	(NA3 /DCD)	σ/σ_a	Load ID	σ/σ_a	Load ID	(NA3 /DCD)	σ/σ_a	Load ID	σ/σ_a	Load ID	(NA3 /DCD)	σ/σ_a	Load ID	σ/σ_a	Load ID	(NA3 /DCD)
1 Exterior Wall	60011	0.159	7621	0.763	7601	0.21	0.250	8011	0.960	8011	0.26	0.112	9013	0.910	7982	0.12	0.164	7461	0.896	7992	0.18
and Pool Wall	60219	0.227	7601	0.824	7601	0.27	0.256	9011	0.821	7982	0.31	0.168	7701	0.833	7601	0.20	0.306	8511	0.827	7982	0.37
@ EL-11.50	70201	0.123	7751	0.254	7701	0.49	0.467	8512	0.666	7491	0.70	0.111	7751	0.394	7701	0.28	0.374	8514	0.816	7482	0.46
~-10.50m	70204	0.212	7601	0.581	7831	0.37	0.349	9011	0.561	7981	0.62	0.217	7701	0.986	7601	0.22	0.356	8514	0.779	7981	0.46
	110718	0.481	7701	0.692	8001	0.70	0.512	8511	0.515	8001	0.99	0.111	7751	0.278	7711	0.40	0.377	7492	0.596	8001	0.63
2 Exterior Wall	62011	0.383	9013	0.593	8081	0.65	0.632	7492	0.742	7492	0.85	0.729	9012	0.879	8021	0.83	0.801	7492	0.952	7492	0.84
@ EL4.65	62019	0.531	9014	0.551	7991	0.96	0.638	7471	0.678	7482	0.94	0.556	7991	0.666	8071	0.84	0.540	7482	0.570	7601	0.95
~6.60m	72001	0.766	7653	0.808	7481	0.95	0.863	8511	0.754	7121	1.14	0.761	7653	0.883	7931	0.86	0.710	7491	0.715	7491	0.99
	72004	0.839	7221	0.833	7491	1.01	0.948	8512	0.851	7482	1.11	0.979	7632	0.774	7811	1.27	0.946	8071	0.989	8071	0.96
3 Exterior Wall	64011	0.508	7961	0.579	7931	0.88	0.726	7521	0.823	7521	0.88	0.451	8071	0.639	8071	0.71	0.644	8511	0.744	7521	0.87
@ EL22.50	64019	0.630	8513	0.650	7581	0.97	0.798	8513	0.833	7421	0.96	0.277	8071	0.389	8071	0.71	0.686	7441	0.795	7421	0.86
~24.60m	74001	0.217	8511	0.298	7331	0.73	0.276	8511	0.278	7482	0.99	0.188	7581	0.210	7331	0.90	0.231	8511	0.241	7482	0.96
	74004	0.421	8514	0.405	8061	1.04	0.584	7471	0.587	7421	0.99	0.327	8061	0.386	8071	0.85	0.593	7471	0.613	7441	0.97
4 Spent Fuel	60819	0.277	7711	0.773	7711	0.36	0.239	7601	0.783	7601	0.30	0.086	7611	0.860	7612	0.10	0.120	7491	0.958	7601	0.12
Pool Wall	70801	0.300	7601	0.569	7601	0.53	0.534	7492	0.925	7492	0.58	0.220	7601	0.561	7601	0.39	0.336	7492	0.754	7492	0.45
@ EL-5.10	70804	0.434	7861	0.785	7841	0.55	0.377	7311	0.718	7711	0.53	0.290	7861	0.879	7991	0.33	0.253	8513	0.889	7711	0.28
~-3.30m	110748	0.517	8001	0.490	8001	1.06	0.387	8511	0.399	7981	0.97	0.273	8001	0.376	8001	0.73	0.278	8511	0.260	8001	1.07
5 Basemat	90306	0.181	7121	0.732	8071	0.25	0.063	8514	0.436	7601	0.14	0.176	7121	0.685	7601	0.26	0.017	7911	0.153	7941	0.11
	90310	0.042	2011	0.045	7431	0.92	0.039	7211	0.084	7931	0.46	0.040	2011	0.072	7601	0.55	0.044	7961	0.106	7931	0.42
	90410	0.061	8021	0.746	8021	0.08	0.057	7461	0.169	7411	0.33	0.128	8021	0.681	8021	0.19	0.199	7711	0.414	7911	0.48
5 Basemat	90486	0.158	7251	0.559	7201	0.28	0.212	7492	0.611	7601	0.35	0.059	7251	0.398	7991	0.15	0.165	8514	0.482	7601	0.34
@ Spent	90490	0.230	7601	0.640	7601	0.36	0.304	7492	0.349	8001	0.87	0.273	7621	0.867	7921	0.31	0.212	7992	0.548	7601	0.39
Fuel Pool	90526	0.300	7921	0.907	7982	0.33	0.088	7991	0.433	7601	0.20	0.141	7601	0.548	7921	0.26	0.145	8512	0.291	7492	0.50
6 Slab EL4.65m	93306	0.517	7201	0.641	7201	0.81	0.245	7301	0.425	7941	0.58	0.368	8514	0.351	7301	1.05	0.174	8001	0.242	7991	0.72
	93310	0.267	7431	0.339	7411	0.79	0.268	8514	0.363	7601	0.74	0.243	7411	0.328	7411	0.74	0.257	8514	0.327	7421	0.78
	93410	0.596	7491	0.436	7491	1.37	0.395	7701	0.248	7701	1.59	0.275	7501	0.267	7701	1.03	0.259	7701	0.257	7701	1.01

Note *: Exterior Wall, Pool Wall Direction1 : Horizontal, Direction2 : Vertical
Basemat, Slab Direction1 : N-S, Direction2 : E-W
σ and σ_a are calculated and allowable stress.

Table A.2-2 Maximum Stress Ratios for Membrane Compressive Forces: FB

Location	Element ID	Thickness h (m)	NA3					DCD					Ratio (NA3/DCD)			
			Load ID	Clculated Concrete Stress (MPa)				Load ID	Clculated Concrete Stress (MPa)							
				σ_x (MPa)	σ_y (MPa)	τ_{xy} (MPa)	σ_c (MPa)		σ_x (MPa)	σ_y (MPa)	τ_{xy} (MPa)	σ_c (MPa)	σ_x	σ_y	τ_{xy}	σ_c
1 Exterior Wall	60011	2.0	7251	-2.796	-1.711	-1.216	-3.585	7201	-3.406	-3.527	-3.384	-6.851	0.82	0.49	0.36	0.52
and Pool Wall	60219	3.6	7251	-1.766	-1.059	-0.552	-2.068	7201	-1.705	-3.165	-1.440	-4.049	1.04	0.33	0.38	0.51
@ EL-11.50	70201	2.0	7201	-0.629	-0.568	1.356	-1.955	7501	0.660	-1.724	-1.471	-2.425	-0.95	0.33	-0.92	0.81
~-10.50m	70204	2.0	7251	-1.624	-1.884	-2.077	-3.835	7201	-1.699	-4.839	-2.656	-6.354	0.96	0.39	0.78	0.60
	110718	1.5	8511	-5.081	-4.908	-4.098	-9.094	7482	-5.590	-7.281	-4.164	-10.684	0.91	0.67	0.98	0.85
2 Exterior Wall	62011	1.0	7491	-3.314	-1.939	3.178	-5.878	7301	-1.454	-2.815	-4.170	-6.360	2.28	0.69	-0.76	0.92
@ EL4.65	62019	1.0	7411	-2.386	-2.691	3.254	-5.796	7201	-1.365	-2.941	-3.465	-5.706	1.75	0.91	-0.94	1.02
~6.60m	72001	1.0	7501	-1.599	-3.269	4.578	-7.087	7441	1.224	-4.484	5.783	-8.079	-1.31	0.73	0.79	0.88
	72004	1.0	7501	-2.074	-3.215	5.045	-7.722	7501	-1.229	-3.807	4.709	-7.401	1.69	0.84	1.07	1.04
3 Exterior Wall	64011	1.0	7601	-3.251	0.052	1.609	-3.905	7601	-3.859	0.142	1.995	-4.683	0.84	0.36	0.81	0.83
@ EL22.50	64019	1.0	7101	-2.993	-0.873	-1.518	-3.785	7101	-3.098	-0.965	-1.693	-4.032	0.97	0.91	0.90	0.94
~24.60m	74001	1.0	8511	-0.253	-1.193	-2.891	-3.652	7482	-0.270	-1.159	-2.781	-3.531	0.94	1.03	1.04	1.03
	74004	1.0	8511	-1.788	-0.595	-3.522	-4.763	7101	-1.979	-0.674	1.992	-3.422	0.90	0.88	-1.77	1.39
4 Spent Fuel	60819	3.6	8511	-1.511	-1.565	-0.846	-2.385	7201	-1.338	-3.405	-1.538	-4.225	1.13	0.46	0.55	0.56
Pool Wall	70801	2.0	7251	-1.698	-1.023	-1.657	-3.052	7201	1.294	-1.749	2.286	-2.974	-1.31	0.58	-0.72	1.03
@ EL-5.10	70804	2.0	7251	-1.576	-1.314	-1.897	-3.347	7201	1.538	-3.401	2.629	-4.539	-1.02	0.39	-0.72	0.74
~-3.30m	110748	1.5	8511	-2.013	-4.397	-2.897	-6.337	7482	-2.156	-5.184	-2.909	-6.949	0.93	0.85	1.00	0.91
5 Basemat	90306	4.0	7251	-1.548	-0.786	0.912	-2.155	7201	-2.779	-1.199	1.583	-3.758	0.56	0.66	0.58	0.57
	90310	4.0	2001	-0.494	-0.509	0.050	-0.551	2001	-0.494	-0.508	0.049	-0.551	1.00	1.00	1.00	1.00
	90410	4.0	7251	-0.751	-2.318	0.686	-2.576	7201	-0.891	-3.394	1.419	-4.035	0.84	0.68	0.48	0.64
5 Basemat	90486	5.5	2001	-0.483	-0.812	-0.049	-0.819	7561	-0.904	-1.396	-0.465	-1.676	0.53	0.58	0.11	0.49
@ Spent	90490	5.5	7251	-0.541	-1.746	0.358	-1.844	7201	-0.686	-2.376	0.812	-2.702	0.79	0.73	0.44	0.68
Fuel Pool	90526	5.5	2001	-0.601	-0.914	-0.080	-0.933	7201	-1.620	-1.099	-1.131	-2.520	0.37	0.83	0.07	0.37
6 Slab EL4.65m	93306	1.3	8514	-2.180	-0.329	-2.011	-3.468	7211	-3.190	-0.464	-1.635	-3.956	0.68	0.71	1.23	0.88
	93310	1.3	2021	-1.698	-1.680	-1.854	-3.544	2021	-1.698	-1.680	-1.854	-3.544	1.00	1.00	1.00	1.00
	93410	1.3	7492	-0.637	-2.927	-1.525	-3.689	7492	-0.481	-3.287	-1.231	-3.750	1.32	0.89	1.24	0.98

Notes: Compressive forces are negative.

Table A.2-2 Maximum Stress Ratios for Membrane Compressive Forces: FB (Continued)

Location	Element ID	Thickness h (m)	NA3			DCD			Ratio (NA3/DCD)
			Load ID	Allowable Stress σ_a (MPa)	σ_c/σ_a	Load ID	Allowable Stress σ_a (MPa)	σ_c/σ_a	σ_c/σ_a
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	2.0	7251	-20.7	0.173	7201	-20.7	0.331	0.523
	60219	3.6	7251	-20.7	0.100	7201	-20.7	0.196	0.511
	70201	2.0	7201	-20.7	0.094	7501	-20.7	0.117	0.806
	70204	2.0	7251	-20.7	0.185	7201	-20.7	0.307	0.604
	110718	1.5	8511	-25.9	0.351	7482	-25.9	0.413	0.851
2 Exterior Wall @ EL4.65 ~6.60m	62011	1.0	7491	-25.9	0.227	7301	-20.7	0.307	0.739
	62019	1.0	7411	-25.9	0.224	7201	-20.7	0.276	0.813
	72001	1.0	7501	-20.7	0.342	7441	-25.9	0.312	1.097
	72004	1.0	7501	-20.7	0.373	7501	-20.7	0.358	1.043
3 Exterior Wall @ EL22.50 ~24.60m	64011	1.0	7601	-20.7	0.189	7601	-20.7	0.226	0.834
	64019	1.0	7101	-20.7	0.183	7101	-20.7	0.195	0.939
	74001	1.0	8511	-25.9	0.141	7482	-25.9	0.136	1.035
	74004	1.0	8511	-25.9	0.184	7101	-20.7	0.165	1.113
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	3.6	8511	-25.9	0.092	7201	-25.9	0.163	0.564
	70801	2.0	7251	-20.7	0.147	7201	-20.7	0.144	1.026
	70804	2.0	7251	-20.7	0.162	7201	-20.7	0.219	0.737
	110748	1.5	8511	-25.9	0.245	7482	-25.9	0.269	0.912
5 Basemat	90306	4.0	7251	-16.6	0.130	7201	-16.6	0.227	0.573
	90310	4.0	2001	-8.3	0.067	2001	-8.3	0.067	1.000
	90410	4.0	7251	-16.6	0.156	7201	-16.6	0.244	0.638
5 Basemat @ Spent Fuel Pool	90486	5.5	2001	-8.3	0.099	7561	-16.6	0.101	0.977
	90490	5.5	7251	-16.6	0.111	7201	-16.6	0.163	0.682
	90526	5.5	2001	-8.3	0.113	7201	-16.6	0.152	0.741
6 Slab EL4.65m	93306	1.3	8514	-25.9	0.134	7211	-25.9	0.153	0.877
	93310	1.3	2021	-15.5	0.228	2021	-15.5	0.228	1.000
	93410	1.3	7492	-25.9	0.143	7492	-25.9	0.145	0.984

Notes: Compressive forces are negative.

Table A.2-3 Calculation Results for Maximum Transverse Shear: FB

Location	Element ID	NA3			DCD			NA3					DCD					Ratio (NA3/DCD)				
		Load ID	d (m)	pv (%)	Load ID	d (m)	pv (%)	Shear Force (MN/m)				Vu/φVn	Shear Force (MN/m)				Vu/φVn	Shear Force (MN/m)				Vu/φVn
								Vu	Vc	Vs	φVn		Vu	Vc	Vs	φVn		Vu	Vc	Vs	φVn	
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	8511	1.70	0.710	7982	1.74	0.177	1.55	4.02	5.00	7.67	0.202	0.38	0.00	1.28	1.08	0.346	4.14	1.00	3.92	7.07	0.58
	60219	8511	3.05	0.710	7982	3.36	0.177	4.67	3.77	8.96	10.82	0.432	0.26	0.31	2.46	2.35	0.112	17.70	12.08	3.65	4.60	3.85
	70201	7481	1.65	0.710	7982	1.69	0.177	1.19	1.72	4.84	5.58	0.213	0.15	0.18	1.24	1.20	0.125	7.91	9.72	3.92	4.65	1.70
	70204	7481	1.59	0.710	4021	1.69	0.710	3.14	2.16	4.67	5.81	0.540	1.98	2.06	4.97	5.98	0.331	1.59	1.05	0.94	0.97	1.63
	110718	7492	1.12	0.355	7482	1.10	0.355	0.82	1.14	1.64	2.36	0.346	1.02	1.41	1.61	2.56	0.397	0.80	0.81	1.02	0.92	0.87
2 Exterior Wall @ EL4.65 ~6.60m	62011	7571	0.78	0.125	7982	0.78	0.125	0.49	0.84	0.40	1.06	0.463	0.27	0.23	0.40	0.54	0.499	1.81	3.61	1.00	1.96	0.93
	62019	7601	0.72	0.125	7982	0.72	0.125	0.18	0.13	0.37	0.43	0.407	0.11	0.13	0.37	0.42	0.256	1.62	1.06	1.00	1.02	1.59
	72001	7581	0.73	0.250	7982	0.72	0.250	0.47	0.00	0.76	0.64	0.728	0.45	0.10	0.75	0.72	0.620	1.05	0.00	1.02	0.89	1.17
	72004	7612	0.72	0.250	7982	0.72	0.125	0.46	0.00	0.74	0.63	0.732	0.23	0.00	0.37	0.32	0.734	1.99	1.00	2.00	2.00	1.00
3 Exterior Wall @ EL22.50 ~24.60m	64011	7492	0.72	0.125	7482	0.72	0.125	0.31	0.71	0.37	0.92	0.336	0.29	0.72	0.37	0.92	0.310	1.08	0.99	1.00	0.99	1.08
	64019	8511	0.80	0.125	7482	0.80	0.125	0.22	0.00	0.41	0.35	0.635	0.24	0.00	0.41	0.35	0.680	0.93	1.00	1.00	1.00	0.93
	74001	7492	0.73	0.125	4021	0.72	0.125	0.15	0.18	0.38	0.47	0.321	0.10	0.12	0.37	0.42	0.249	1.45	1.44	1.02	1.13	1.29
	74004	8513	0.72	0.125	4021	0.72	0.125	0.30	0.40	0.37	0.66	0.462	0.06	0.08	0.37	0.38	0.168	4.75	5.34	1.00	1.73	2.75
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	8511	3.05	0.710	7982	3.33	0.177	2.44	4.35	8.97	11.32	0.216	0.37	0.43	2.44	2.44	0.151	6.63	10.04	3.67	4.63	1.43
	70801	8514	1.71	0.710	7482	1.69	0.710	4.03	2.03	5.02	5.99	0.672	3.99	1.84	4.97	5.79	0.690	1.01	1.10	1.01	1.04	0.97
	70804	7571	1.62	0.710	7982	1.59	0.177	1.11	0.69	4.75	4.62	0.240	0.11	0.13	1.17	1.10	0.098	10.25	5.37	4.07	4.20	2.44
	110748	8511	1.22	0.177	7482	1.22	0.177	1.06	1.32	0.89	1.88	0.563	1.09	1.38	0.89	1.93	0.563	0.97	0.96	1.00	0.97	1.00
5 Basemat	90306	8514	3.53	0.629	7982	3.49	0.629	4.82	6.96	9.18	13.73	0.351	6.11	1.70	9.07	9.15	0.667	0.79	4.10	1.01	1.50	0.53
	90310	7511	3.52	0.629	7482	3.48	0.629	2.82	5.95	9.15	12.84	0.220	3.70	5.75	9.06	12.59	0.294	0.76	1.04	1.01	1.02	0.75
	90410	7471	3.53	0.629	7982	3.50	0.629	3.47	6.91	9.19	13.68	0.254	3.90	1.76	9.09	9.23	0.423	0.89	3.92	1.01	1.48	0.60
5 Basemat @ Spent Fuel Pool	90486	7492	5.04	0.419	7982	3.92	0.419	1.86	4.63	8.74	11.36	0.164	2.91	3.66	6.79	8.89	0.327	0.64	1.26	1.29	1.28	0.50
	90490	8514	5.04	0.629	7482	5.05	0.629	5.65	5.53	13.11	15.85	0.356	11.99	6.04	13.13	16.29	0.736	0.47	0.92	1.00	0.97	0.48
	90526	7221	5.03	0.629	7982	3.94	0.629	4.48	9.27	13.07	18.99	0.236	6.45	3.16	10.25	11.40	0.566	0.69	2.93	1.28	1.67	0.42
6 Slab EL4.65m	93306	7482	1.10	0.500	6483	1.10	0.500	0.41	0.79	2.27	2.60	0.158	0.22	0.26	2.27	2.15	0.101	1.89	3.08	1.00	1.21	1.56
	93310	7571	1.10	0.500	7482	1.10	0.500	0.93	2.47	2.27	4.03	0.231	1.08	2.95	2.27	4.44	0.244	0.86	0.84	1.00	0.91	0.94
	93410	7501	1.10	0.500	7482	1.10	0.500	0.46	0.99	2.27	2.77	0.168	0.46	2.15	2.27	3.75	0.121	1.02	0.46	1.00	0.74	1.38

APPENDIX B

IN-PLANE SHEAR CHECK FOR FB ACCORDING TO ACI349-01

Table of Contents

List of Tables

List of Figures

B.1 SCOPE

This appendix describes In-plane Shear Check for FB according to ACI349-01.

B.2 IN-PLANE SHEAR CHECK

According to ACI 394-01 Section 21.6.5.2, the maximum shear strength of a horizontal wall segment per unit length is calculated as follows.

$$Vn = \left(2\sqrt{f_c^{'}} + \rho_n f_y\right)h \qquad \text{(lb/in)}$$

Where, *h* is wall thickness.

Shear strength calculated above shall not be taken greater than the following equation specified in ACI 394-01 Section 21.6.5.7.

$$Vn_{max} = 10\sqrt{f_c^{'}}h \qquad \text{(lb/in)}$$

The reduction of thermal stresses due to the decreased stiffness of a cracked concrete section is considered.

B.3 CONCLUSIONS

The results of in-plane shear check for the selected elements are shown in Table B-1. For elements at the exterior wall at EL 4,650 to EL 6,600, it is confirmed that the combined forces Nxy are larger than the allowable shear forces evaluated above.

Since ACI 349-01 in-plane shear stress check for walls is developed for the entire wall and not meant for local checks, the stress check by looking at the entire wall at EL 4,650 to EL 6,600 as highlighted in Figure B-1 is performed instead of the stress check on one element.

The results of in-plane shear check on the entire wall at EL 4,650 to EL 6,600 are shown in Table B-2 and in-plane shear stress is confirmed to be lower than the allowable stress.

Table B-1 Maximum Stress Ratios for In-Plane Shear Check

Location	Element ID	Load Case	Nxy (MN/m)	Thickness *t* (m)	Primary Reinforce -ment Ratio	Allowalbe Shear Strength $\phi Vn=\phi 10tf'_c{}^{0.5}$ (MN/m)	Total In-Plane Shear Nxy(MN/m)	*Nxy/φVn*
1 Exterior Wall	60011	8514	-2.887	2.0	2.013 %	8.288	2.887	0.348
and Pool Wall	60219	7461	-2.172	3.6	2.097 %	14.918	2.172	0.146
@ EL-11.50	70201	8514	-3.303	2.0	3.522 %	8.288	3.303	0.399
~-10.50m	70204	8514	-4.731	2.0	3.522 %	8.288	4.731	0.571
	110718	8511	-6.148	1.5	1.342 %	6.216	6.148	0.989
2 Exterior Wall	62011	7481	3.182	1.0	2.516 %	4.144	3.182	0.768
@ EL 4.65	62019	7482	-3.327	1.0	2.516 %	4.144	3.327	0.803
~6.60m	72001	8511	6.381	1.0	3.020 %	4.144	6.381	1.540
	72004	8512	5.803	1.0	3.020 %	4.144	5.803	1.400
3 Exterior Wall	64011	7491	1.758	1.0	2.516 %	4.144	1.758	0.424
@ EL22.50	64019	8513	1.641	1.0	2.012 %	4.144	1.641	0.396
~24.60m	74001	8511	-2.891	1.0	2.516 %	4.144	2.891	0.698
	74004	8511	-3.522	1.0	2.516 %	4.144	3.522	0.850
4 Spent Fuel	60819	8511	-3.045	3.6	2.097 %	14.918	3.045	0.204
Pool Wall	70801	7492	-3.571	2.0	3.522 %	8.288	3.571	0.431
@ EL-5.10	70804	7441	3.956	2.0	3.522 %	8.288	3.956	0.477
~-3.30m	110748	8511	-4.345	1.5	1.342 %	6.216	4.345	0.699

Note: Exceedance is highlighted.

Table B-2 In-Plane Shear Check for Entire Wall (FB Exterior Wall at EL 4.65 m to 6.60 m)

Critical Load Case	Location	Element	Element Length Li (m)	Element Thick-ness Ti (m)	Shear Area of Element Ai (m^2)	Shear Area of Wall As (m^2)	Element Shear Force in Unit Length Qi (MN/m)	Element Shear Force Q (MN)	Total Shear Force Qt (MN)	Total Shear Stress τ (MN/m^2)	Allowable Shear Stress ta (MN/m^2)	τ / τa
8514	Exterior Wall @EL 4.65 ~6.60m	72001	2.10	1.00	2.10		6.220	13.06				
		72002	2.10	1.00	2.10		6.233	13.09				
		72003	2.10	1.00	2.10		5.838	12.26				
		72004	1.80	1.00	1.80		5.663	10.19				
		72005	2.40	1.00	2.40		5.504	13.21				
		72006	2.40	1.00	2.40		5.490	13.18				
		72007	1.80	1.00	1.80		5.375	9.68				
		72008	2.10	1.00	2.10		5.318	11.17				
		72009	2.10	1.00	2.10		5.614	11.79				
		72010	2.10	1.00	2.10		5.881	12.35				
		32001	2.50	1.50	3.75		6.272	15.68				
		32002	2.16	1.50	3.24		7.223	15.62				
		32003	2.14	1.50	3.21		6.016	12.86				
		32004	1.85	1.50	2.78		4.839	8.95				
		32005	1.80	1.50	2.70		4.049	7.29				
		32006	2.20	1.50	3.30		3.829	8.42				
		32007	1.85	1.50	2.78		3.563	6.59				
		32008	3.60	1.50	5.40		3.402	12.25				
		32009	2.60	1.50	3.90		3.242	8.43				
		32010	2.80	1.50	4.20		3.095	8.67				
		32011	2.80	1.50	4.20		2.972	8.32				
		32012	2.60	1.50	3.90		2.865	7.45				
		32013	3.60	1.50	5.40		2.764	9.95				
		32014	1.85	1.50	2.78		2.781	5.14				
		32015	2.20	1.50	3.30		2.858	6.29				
		32016	1.80	1.50	2.70		3.086	5.55				
		32017	1.85	1.50	2.78		3.514	6.50				
		32018	2.14	1.50	3.21		4.093	8.75				
		32019	2.16	1.50	3.24		4.287	9.27				
		32020	2.50	1.50	3.75	91.5	2.999	7.50	299.46	3.27	4.14	0.79

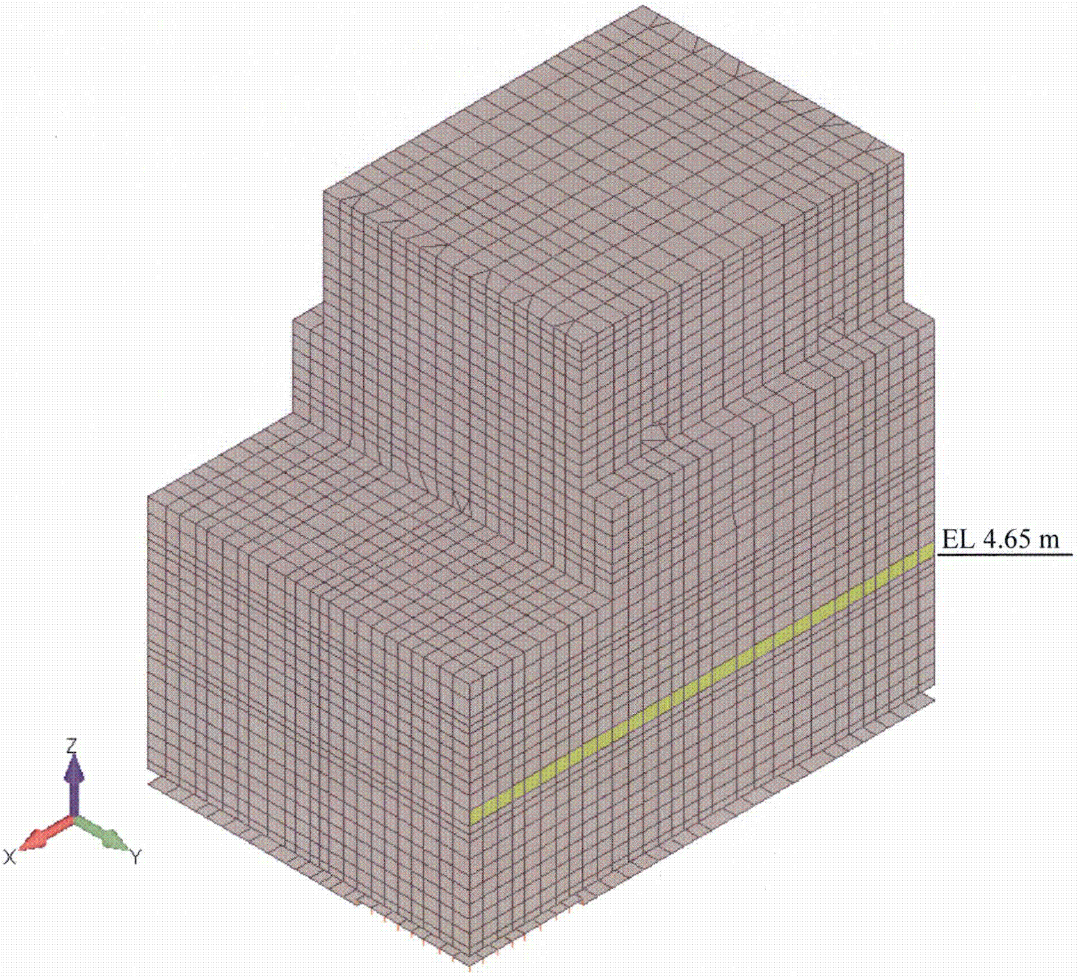


Figure B-1 Selected Elements for In-plane Shear Check on Entire Wall

APPENDIX C

COMPRESSION LIMIT CHECK FOR FB ACCORDING TO ACI349-01

Table of Contents

List of Tables

List of Figures

None

C.1 SCOPE

This appendix describes Membrane Compressive Force Check for FB according to ACI349-01.

C.2 MEMBRANE COMPRESSIVE FORCE CHECK

According to ACI 394-01 Section 10.3.5.2, design axial load strength of compression members shall not be taken greater than the following:

$$\phi Pn(\max) = 0.80\phi\left[0.85 f_c'\left(A_g - A_{st}\right) + f_y A_{st}\right]$$

Where, *Ag and Ast* are gross area and total cross-sectional area of reinforcement of section.

C.3 CONCLUSION

The results of compression force check are shown in Table C-1. It is confirmed that the calculated compression force are less than the allowable compression force evaluated based on the above strength.

Table C-1 Membrane Compressive Stress Check According to ACI349-01

Location	Element ID	Load ID	Section Forces (MN/m)			Thickness h (m)	Clculated Concrete Stress (MPa)				Allowable Stress σ_a (MPa)	σ_c/σ_a
			Nx	Ny	Nxy		σ_x	σ_y	τ_{xy}	σ_c		
1 Exterior Wall	60011	8511	-7.014	-2.936	-2.745	2.0	-3.507	-1.468	-1.372	-4.197	-20.8	0.202
and Pool Wall	60219	7481	-6.893	-4.879	-1.991	3.6	-1.915	-1.355	-0.553	-2.255	-20.9	0.108
@ EL-11.50	70201	7201	-1.257	-1.136	2.712	2.0	-0.629	-0.568	1.356	-1.955	-24.0	0.081
~-10.50m	70204	8514	-3.260	-2.863	-4.731	2.0	-1.630	-1.432	-2.366	-3.899	-24.0	0.162
	110718	8511	-7.621	-7.362	-6.148	1.5	-5.081	-4.908	-4.098	-9.094	-19.3	0.471
2 Exterior Wall	62011	7491	-3.314	-1.939	3.178	1.0	-3.314	-1.939	3.178	-5.878	-21.8	0.269
@ EL4.65	62019	7411	-2.386	-2.691	3.254	1.0	-2.386	-2.691	3.254	-5.796	-21.8	0.265
~6.60m	72001	7471	2.043	-4.952	6.044	1.0	2.043	-4.952	6.044	-8.438	-22.9	0.368
	72004	7571	-2.933	-2.886	5.044	1.0	-2.933	-2.886	5.044	-7.954	-22.9	0.347
3 Exterior Wall	64011	7491	-3.706	-0.703	1.758	1.0	-3.706	-0.703	1.758	-4.516	-21.8	0.207
@ EL22.50	64019	7491	-3.544	-0.976	-1.548	1.0	-3.544	-0.976	-1.548	-4.271	-20.8	0.206
~24.60m	74001	8511	-0.253	-1.193	-2.891	1.0	-0.253	-1.193	-2.891	-3.652	-21.8	0.167
	74004	8511	-1.788	-0.595	-3.522	1.0	-1.788	-0.595	-3.522	-4.763	-21.8	0.218
4 Spent Fuel	60819	8511	-5.441	-5.636	-3.045	3.6	-1.511	-1.565	-0.846	-2.385	-20.9	0.114
Pool Wall	70801	7481	-3.440	-2.402	-3.412	2.0	-1.720	-1.201	-1.706	-3.186	-24.0	0.133
@ EL-5.10	70804	8514	-4.648	-1.903	-3.849	2.0	-2.324	-0.951	-1.924	-3.681	-24.0	0.153
~-3.30m	110748	8511	-3.019	-6.596	-4.345	1.5	-2.013	-4.397	-2.897	-6.337	-19.3	0.328
5 Basemat	90306	7481	-7.988	-2.992	3.858	4.0	-1.997	-0.748	0.965	-2.522	-15.6	0.162
	90310	7491	-3.356	-3.772	0.488	4.0	-0.839	-0.943	0.122	-1.024	-15.6	0.066
	90410	8511	-3.199	-10.517	3.097	4.0	-0.800	-2.629	0.774	-2.913	-15.6	0.187
5 Basemat	90486	7471	-5.741	-7.153	1.489	5.5	-1.044	-1.300	0.271	-1.472	-15.3	0.096
@ Spent	90490	7491	-4.851	-11.890	2.350	5.5	-0.882	-2.162	0.427	-2.291	-15.3	0.149
Fuel Pool	90526	7571	-7.134	-5.515	-4.154	5.5	-1.297	-1.003	-0.755	-1.919	-15.3	0.125
6 Slab EL4.65m	93306	8514	-2.833	-0.427	-2.614	1.3	-2.180	-0.329	-2.011	-3.468	-19.8	0.176
	93310	8514	-2.937	-2.507	-3.390	1.3	-2.259	-1.928	-2.608	-4.707	-19.8	0.238
	93410	7492	-0.828	-3.805	-1.983	1.3	-0.637	-2.927	-1.525	-3.689	-19.8	0.187