REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**129-8085**
SRP Section:	**03.08.01 – Concrete Containment**
Application Section:	**3.8.1**
Date of RAI Issue:	**08/05/2015**

Question No. 03.08.01-1

Appendix A to 10 CFR Part 50, General Design Criteria1, 2, 4, 16 and 50, provide the regulatory requirements for the design of the concrete containment. Standard Review Plan (SRP) 3.8.1, Section II.3 discusses the loads and load combinations normally applicable to concrete containments with emphasis on the extent of compliance with Article CC-3230 of Section III, Division 2, of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, with additional guidance provided in Regulatory Guide 1.136, "Design Limits, Loading Combinations, Materials, Construction, and Testing of Concrete Containments."

APR1400 DCD Tier 2, Section 3.8.1.3, "Loads and Load Combinations," states that the containment is designed to resist the loads given in the ASME Code and RG 1.136 with some exceptions. The staff reviewed the information pertaining to the applicable design loads and various combinations provided by the applicant and noticed that additional information is needed in order for the staff to complete its evaluation. In accordance with SRP 3.8.1, and Appendix A to 10 CFR Part 50, General Design Criteria 1, 2, 4, 16 and 50, the applicant is requested to address the following and include this information in the DCD:

a. Provide a description for other loads which are included in the load combinations presented in DCD Table 3.8-2, but are not defined in DCD Section 3.8.1.3.2, i.e., G, H, H_s, and P_s, as well as D_d, L_h, and C which are identified in the footnotes to the table.

b. In DCD Section 3.8.1.3.2, the seismic load (E_s) is defined as loads generated by the safe shutdown earthquake (SSE) in which only the actual dead loads and live loads are considered in evaluating seismic response forces. Since it is not clear whether full live load or a portion of the live load is considered when evaluating the seismic response forces in design, provide this information and the basis for that approach. This seismic inertial live load would be in addition to the separate live load used in the applicable load combinations.

c. DCD Section 3.8.1.3, item b, describes the load combination associated with the combustible hydrogen generation due to fuel clad metal-water reaction. Identify what is the pressure calculated for this loading condition and if it is greater than 45 psig, what pressure is used in the design.

d. In DCD Table 3.8-2, "Seismic Category I Structure Load Combination for the Reactor Containment Building," it is not clear why both load combinations (LCs) 13 and 14 were provided with the only difference being that in LC 13, W is included and in LC 14, W is omitted. KHNP is requested to explain whether they followed the approach that if any load reduces the effects of other loads, then that load is omitted. The use of LC 13 and 14 suggests that this approach may not have been followed.

e. Explain where in DCD Sections 3.8.1.3 and 3.8.3.3 the load descriptions and load combinations for consideration of safety/relief valve actuation loads on the containment and containment internal structures are described and whether or not the safety/relief valve actuation loads include potential direct loads on the structures and potential building dynamic response loads.

f. DCD Section 3.8.1.3 does not describe the safety/relief valve actuation load, if applicable, and the method used for combining dynamic loads that include SSE, LOCA and safety/relief valve actuation. Provide this information and indicate if it is in accordance with SRP 3.8.1 (including Appendix A) and Regulatory Guide (RG) 1.136, "Materials, Construction, and Testing of Concrete Containments," Revision 3.

Response – Rev.1

a. Loads G, H, H_s, P_s, D_d, L_h, and C are defined as follows;

- Valve actuation load (G)

  Loads resulting from relief valve or other high energy device actuation

- Design flood/precipitation load (H)

  Flood loads on seismic Category I structures are determined based on the maximum site flood levels specified in DCD Tier 2, Chapter 2.

- Probable maximum flood/precipitation (H_s)

  H_s is the forces, due to the probable maximum precipitation as well as the maximum flood level, which includes the effects of seiches, surges, waves, and tsunamis.

- Combustible gas load (P_s)

  The pressure loads during an accident that releases hydrogen generated from 100 percent fuel clad metal-water reaction accompanied by hydrogen burning are combined together. The combustible gas load is described in Subsection 19.2.4.2.1 in detail.

1) Fuel clad metal-water reaction pressure – P_{g1}

Pressure loads from 100 percent fuel clad metal-water reaction

2) Hydrogen combustion pressure – P_{g2}

Pressure loads from hydrogen combustion

- Self-weight of structure (D_d)

  D_d is the load from the self-weight of the structure, including waterproofing, siding, and insulation.

- Hydrostatic load (L_h)

  Hydrostatic loads are due to weight and pressures of fluids with well-defined densities and controllable maximum heights.

- Crane and Trolley Loads (C)

  This load is the crane and trolley lifted load, including impact load, longitudinal load, and lateral load. All of these loads shall be considered as acting simultaneously. This load is described in detail in DCD Tier 2, Subsection 3.8.4.3.1.

Loads G, H, H_s, P_s, and C will be described in DCD Tier 2, Subsection 3.8.1.3.2. Loads D_d and L_h are currently defined in Table 3.8-8; pointers will be added to the applicable notes of Table 3.8-2. DCD Tier 2, Subsection 3.8.1.3.2 and Table 3.8-2 will be revised as shown in the attachment associated with this response.

b. When evaluating seismic response forces, only 75 percent of design snow load is applied to the containment dome, in accordance with SRP 3.7.2, Section II.3.D.

However, there is no live load assigned to the RCB slabs as a floor load when evaluating seismic response forces. No live load is assigned to the RCB slab because the design floor live load inside the containment is generated by any movable equipment during construction and maintenance of the plant. During normal operation, the live load is negligible since movement of equipment within the containment building is not allowed. In addition, the seismic load is not considered to occur during the construction and maintenance of the plant. Therefore, the seismic inertial floor live load is not applied to the seismic analysis of the RCB.

To clarify the design floor live load in the containment, DCD Tier 2, Subsection 3.8.1.3.2 and 3.8A.1.4.3.1.3 will be revised as shown in the attachment associated with this response.

c. The pressure of P_s (P_{g1}+P_{g2}) is determined by using the adiabatic, isochoric, complete combustion (AICC) pressure evaluation. Based on the results of this evaluation, the upper-bound value for the pressure load as a result of slow deflagrations of hydrogen produced from 100 percent metal-water reaction is 109 psig.

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DCD Tier 2, Subsection 3.8.1.3 and 3.8.1.3.2 will be revised as indicated in the attachment associated with this response.

d. If any load reduces the effects of other loads, that load is omitted in the design. Load combination (LC) 13 in Table 3.8-2 will be omitted as indicated in the attachment associated with this response since LC 13 is less severe than LC 14. The load combinations in Table 3.8-2 are in accordance with ASME CC Table 3230-1. However, OBE seismic load E_o was omitted per DCD Tier 2, Subsection 3.7.1.

e. DCD Tier 2, Subsection 3.8.1.3 does not describe pilot-operated safety relief valve (POSRV) actuation load since POSRV actuation loads are not applied on the containment wall. The IRWST is separated from the containment wall by a gap of 2 inches, as shown in Figure 1 below. Thus, there is no connection to transfer POSRV actuation loads to the containment wall. Therefore, POSRV actuation loads are not applied to the containment basemat through the containment wall. DCD Tier 2, Subsection 3.8.3.1.8 will be revised, indicated in the attachment associated with this response.

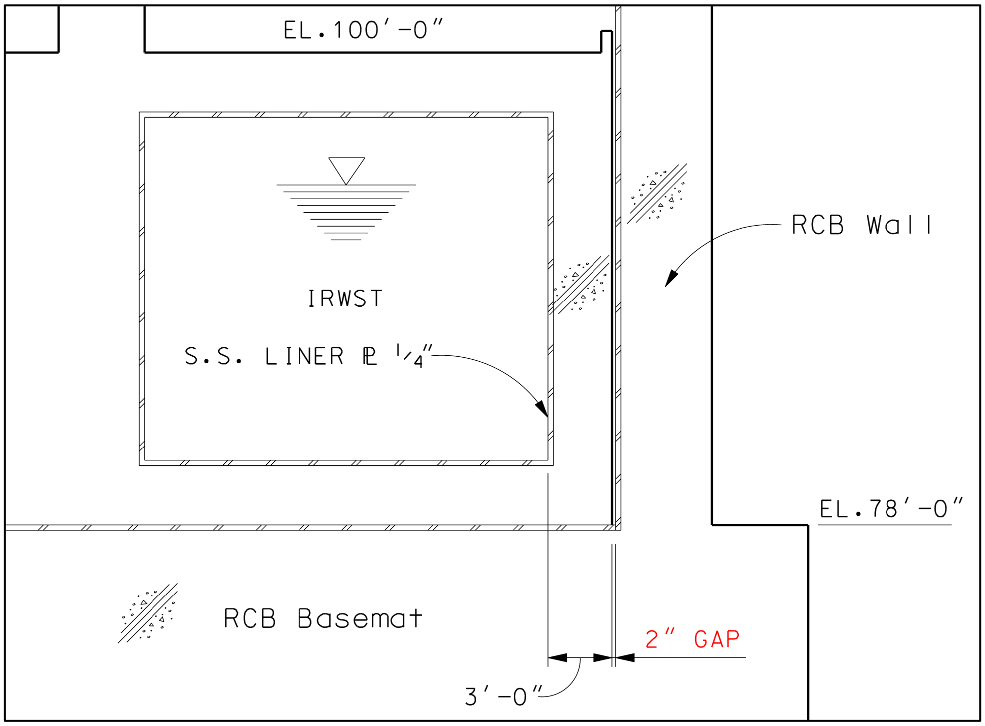

Figure 1 Section of Containment around IRWST

For the containment internal structures, POSRV actuation loads are transmitted through the pressurizer (DCD Tier 2, Subsection 3.8.3.1.4 and 3.8A.1.4.3.1.3). Therefore, the loads are treated as a kind of reactor coolant system (RCS) support load. For RCS support loads, the governing load, either POSRV actuation or branch line pipe break (BLPB) load, has been applied on the pressurizer enclosure room wall and slab.

For POSRV discharge load, a hydrodynamic pressure which is generated by the explosion of air during POSRV discharge, is applied to the wall and bottom slab of the IRWST through the 12 spargers (DCD Tier 2, Subsection 3.8A.1.4.3.1.3). This hydrodynamic pressure load is a short transient pressure time history during the expansion and collapse of the air bubble. The air bubble transient pressure time history is directly applied to the wall and bottom slab of the IRWST using the normalized factor which is considered for the distance between the spargers and structures.

For the ARP 1400 IRWST design, the hydrodynamic pressure load generated by the spargers due to POSRV actuation is determined to be 21.2 psi, which is added the approximately 40% margin. The hydrodynamic load considering the dynamic impact factor is applied as an equivalent static pressure loading to the submerged IRWST wall and bottom boundaries. Details of the hydrodynamic pressure load generated by the spargers are described in the response to Question 03.08.03-1 of RAI No. 208-8245.

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f. DCD Tier 2, Subsection 3.8.1.3 does not the describe POSRV actuation load since this load is not applied on the containment wall. The POSRV load is only applied to the IRWST, as mentioned above. The IRWST is not pressure boundary structure. Therefore, the approach described in Appendix A to SRP Section 3.8.1 is not applicable to the APR1400 plant.

   The definition and description of the POSRV load on the IRWST, which includes the load in the applicable load combinations, and method for combining the POSRV load with other loads, is described in DCD Tier 2 Subsection 3.8A.1.4.3.1.3, 3.8A.1.4.3.2.2 and 3.8A.1.4.3.2.3.

Impact on DCD

DCD Tier 2, Subsection 3.8.1.3, 3.8.1.3.2, 3.8.3.1.8, Table 3.8-2, 3.8A.1.4.3.1.3, and 3.8A.1.4.3.2.3 will be revised, as indicated in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

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3.8.1.2.1 Design Codes, Standards, Specifications, and Regulations

The design codes, standards, specifications, and regulations are listed in Table 3.8-1. The primary design code for concrete containment is ASME Section III, Division 2, Subsection CC (Reference 3).

3.8.1.2.2 NRC Regulatory Guides

Conformance to each NRC Regulatory Guide (RG) is described in Section 1.9. The NRC RGs applicable to the design of the concrete containment are NRC RG 1.35 (Reference 4), NRC RG 1.35.1 (Reference 5), NRC RG 1.136 (Reference 6), and NRC RG 1.7 (Reference 7).

3.8.1.2.3 Industry Standards

Internationally recognized industry standards published by ASTM are used whenever possible to define material properties, testing procedures, and fabrication and construction methods.

3.8.1.3 Loads and Load Combinations

The containment is designed to resist the loads given in Article CC-3000 of the ASME Code and NRC RG 1.136 with the exceptions listed below.

a. The post-LOCA flooding combined with the safe shutdown earthquake (SSE) is more severe than the post-LOCA flooding combined with the operating basis earthquake (OBE) set at one third or less of the SSE for the plant. Therefore, only the post-LOCA flooding SSE combination is considered in the design.

b. Subarticle CC-3720 of the ASME Code is satisfied when the containment structure is exposed to the load combination listed below. As a minimum design condition, the pressure ($P_{g1} + P_{g2}$) is not less than 310 kPa (45 psig).

$D + F$ ~~+ T~~ $+ P_{g1} + P_{g2}$

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Where:

D = Dead load

F = Prestress

~~T = Temperature load~~

P_{g1} = Pressure resulting from an accident that releases hydrogen generated from 100 percent fuel clad metal-water reaction

P_{g2} = Pressure resulting from uncontrolled hydrogen burning

A description of load categories and definition of loads are given in Subsections 3.8.1.3.1 and 3.8.1.3.2.

3.8.1.3.1 Load Category

The load categories include any condition encountered during construction and testing, and in the normal operation of a nuclear power plant, as well as the conditions resulting from extreme environmental conditions postulated during the life of the facility and certain combinations thereof.

The design loads are defined as service load category and factored load category depending on the frequency of their occurrence.

3.8.1.3.1.1 Service Loads

Service loads are any loads encountered during construction and in the normal operation of a nuclear power plant and include loads such as any anticipated transient or test loads during normal and emergency startup and shutdown of the nuclear steam supply, safety and auxiliary systems, and the severe environmental loads that may be anticipated during the life of the facility.

Construction

The construction condition considers events and loads during construction, including the various stages of prestressing but excluding those during testing. Contraction loads for buildings and other structures are developed in accordance with Table 3.8-2 and with SEI/ASCE 37-02 (Reference 8).

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reactions due to postulated pipe breaks for design basis accidents. This loading condition also includes plant-related non-environmental missiles. The loads from each postulated accident event are considered to be mutually exclusive of other postulated accidents.

Abnormal/Severe Environmental

The abnormal/extreme condition includes a consideration of the loads due to the highly improbable simultaneous occurrence of abnormal and severe environmental loading conditions. Only the specified combinations of these conditions are considered.

Abnormal/Extreme Environmental

The abnormal/extreme condition includes a consideration of the loads due to the extremely improbable simultaneous occurrence of abnormal and extreme environmental loading conditions. Only the specified combinations of these conditions are considered.

3.8.1.3.2 Design Loads

The design loads pertaining to the design of containment are as follows:

a. Dead load (D)

   Dead loads, including hydrostatic and permanent equipment loads

b. Live load (L)

   Live loads generated by any movable equipment during construction and maintenance of plant

   ~~Live loads, including any movable equipment loads and other loads that vary with intensity during each occurrence such as soil pressures~~

c. Prestress (F)

   Loads resulting from the application of prestress, including effects resulting from the construction sequence used to post-tension the tendon

75 percent of snow

k. Seismic load (E_s)

Loads generated by the SSE; only the actual dead loads and live loads are considered in evaluating seismic response forces.

l. Tornado load (W_t)

Tornado or hurricane loading including the effects of missile impact

m. Internal flooding (H_a)

Load resulting from internal flooding other than from pipe breaks

n. Accident pressure (P_a)

Design pressure load within the containment generated by the design basis accident, based on the calculated peak pressure with an appropriate margin

o. Accident temperature (T_a)

Thermal effects and loads generated by the design basis accident including operating temperature (T_o)

p. Pipe reaction (R_a)

Pipe reaction from thermal conditions generated by the design basis accident including pipe reaction at normal operating or shutdown conditions (R_o)

q. Pipe break load (R_r)

Local effects due to the design basis accident normally include all postulated high-energy system ruptures. These loads include an appropriate dynamic load factor to account for the dynamic nature of the load. This load category includes:

1) Pipe break reaction load (Y_r)

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2) ~~Combustible gas (P_{g1}, P_{g2})~~ Combustible gas load (P_s)

Combustible gas (P_{g1}) loads are pressure loads that result from a fuel-clad metal-water reaction followed by an uncontrolled hydrogen burn (P_{g2}) during a post-accident condition in the containment inerted by carbon dioxide. NRC RG 1.136, Regulatory Position C.5 provides the loads and load combinations acceptable for analysis and design of containment when exposed to the loading conditions associated with combustible gas. The loads and load combinations for combustible gas are provided in Subsection 3.8.1.3.

t. Missile loads other than hurricane generated or tornado-generated missiles

There are no missile loads on the containment resulting from activities of nearby military installations, turbine failures, or other causes.

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3.8.1.~~3~~.3 Design Load Combinations

The applicable load combinations and load factors for the design of a concrete containment conform with the requirements of Article CC-3000 of the ASME Section III, Division 2. Table 3.8-2 lists the load combinations used in the design of the containment.

3.8.1.3.4 Liner Plate Loads and Load Combinations

The load combinations shown in Table CC-3230-1 of the ASME Code are applicable to the liner, except that load factors for all load cases are taken as equal to 1.0. Strains associated with construction-related liner deformations are excluded when calculating liner strains for the service and factored load combinations.

3.8.1.4 Design and Analysis Procedures

3.8.1.4.1 General

The design and analysis procedures are in conformance with the requirements of Article CC-3000 of the ASME Section III, Division 2.

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u. Valve actuation load (G)
   Loads resulting from relief valve or other high energy device actuation
v. Design flood/precipitation load (H)
   Flood loads on seismic Category I structures are determined based on the maximum site flood levels specified in Chapter 2.
w. Probable maximum flood/precipitation (H_S)
   H_S is the forces, due to the probable maximum precipitation as well as the maximum flood level, which includes the effects of seiches, surges, waves, and tsunamis.
x. Crane and trolley loads (C)
   This load is the crane and trolley lifted load, including impact load, longitudinal load, and lateral load. All of these loads shall be considered as acting simultaneously. This load is detailed in Subsection 3.8.4.3.1.

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3.8.3.1.8 In-Containment Refueling Water Storage Tank

The in-containment refueling water storage tank (IRWST) provides storage of refueling water, a single source of water for the safety injection and containment spray pumps, and a heat sink for the safety depressurization system. The IRWST is annular and uses the lower section of the internal structure as its outer boundary. The IRWST is lined with a stainless steel liner plate to prevent leakage. The IRWST consists of the top and bottom slab and the exterior wall. The bottom slab of IRWST rests on the reactor containment building basemat, and the top and bottom slabs are rigidly connected to the secondary shield wall. The IRWST is separated from the containment wall by a gap of 50 mm (2 in). The design of the IRWST considers pressurization as a result of the reactor containment building systems design basis accident. Refer to Section 6.8 for a description of the IRWST.

3.8.3.1.9 Holdup Volume Tank

The holdup volume tank (HVT) is a rectangular structural tank located between the primary shield wall and the IRWST inner wall. A screen is provided at the top of the HVT to prevent debris from getting into the tank. The HVT has a sump with pumps to measure the leakage rate and route the liquid to the liquid waste management system. During an accident, the water from breaks and the reactor containment building spray is collected in the HVT and overflows into the IRWST. Refer to Section 6.8 for a description of the HVT.

3.8.3.1.10 Operating and Intermediate Floors

The operating floor provides access for operating personnel functions and biological shielding. Intermediate floors provide access to equipment and components. The operating floor is located at elevation 156 ft 0 in, and intermediate floors are located at elevations 114 ft 0 in and 136 ft 6 in. These floors consist of reinforced concrete or steel grating supported by structural steel framing that spans between the containment wall and the secondary shield wall. The steel framing has a horizontally sliding connection at the containment wall side to allow axial displacement of framing due to seismic displacement and thermal expansion. Openings are provided in the floor for equipment removal.

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Table 3.8-2

Seismic Category I Structure Load Combination for the Reactor Containment Building

Category	Loading Condition	No	D(1)	L(2)	F	P_t	G	Pa	T_t	T_o	T_a	E_s	W	Wt	R_o	R_a	Y_r	Y_j	Y_m	Y_f	H	H_s	P_v	H_a	P_s
Serv	Test	1	1.0	1.0	1.0	1.0	-	-	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Serv	Construction	2	1.0	1.0	1.0	-	-	-	-	1.0	-	-	1.0	-	-	-	-	-	-	-	-	-	-	-	-
Serv	Normal	3	1.0	1.0	1.0	-	1.0	-	-	1.0	-	-	-	-	1.0	-	-	-	-	-	-	-	1.0	-	-
Factored	Severe environmental	4	1.0	1.3	1.0	-	1.0	-	-	1.0	-	-	1.5	-	1.0	-	-	-	-	-	-	-	1.0	-	-
		5	1.0	1.3	1.0	-	1.0	-	-	1.0	-	-	-	-	1.0	-	-	-	-	-	1.5	-	1.0	-	-
	Extreme environmental	6	1.0	1.0	1.0	-	1.0	-	-	1.0	-	1.0	-	-	1.0	-	-	-	-	-	-	-	1.0	-	-
		7	1.0	1.0	1.0	-	1.0	-	-	1.0	-	-	-	1.0	1.0	-	-	-	-	-	-	-	1.0	-	-
		8	1.0	1.0	1.0	-	1.0	-	-	1.0	-	-	-	-	1.0	-	-	-	-	-	-	1.0	1.0	-	-
	Abnormal	9	1.0	1.0	1.0	-	1.0	1.5	-	-	1.0	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-
		10	1.0	1.0	1.0	-	1.0	1.0	-	-	1.0	-	-	-	-	1.25	-	-	-	-	-	-	-	-	-
		11	1.0	1.0	1.0	-	1.25	1.25	-	-	1.0	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-
	Abnormal/severe environmental	12	1.0	1.0	1.0	-	1.0	1.25	-	-	1.0	-	1.25	-	-	1.0	-	-	-	-	-	-	-	-	-
		~~13~~	~~1.0~~	~~1.0~~	~~1.0~~	~~-~~	~~1.0~~	~~-~~	~~-~~	~~1.0~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~	~~1.0~~	~~-~~
		~~14~~ 13	1.0	1.0	1.0	-	1.0	-		1.0	-	-	1.0	-	-	-	-	-	-	-	-	-	-	1.0	-
	Abnormal/extreme environmental	~~15~~ 14	1.0	1.0	1.0	-	1.0	1.0	-	-	1.0	1.0	-	-	-	1.0	1.0	1.0	1.0	1.0	-	-	-	-	-
	~~Severe Accident~~(3) Combustible Gas Control inside Containment	~~16~~ 15	1.0		1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0

(1) D_d is included in D. (in Table 3.8-8)

(2) Includes all temporary construction loads during and after construction of the containment; also includes Lh and C. (in Table 3.8-8)

(3) The strain does not exceed the values given in ASME Section III, Division 2, Table CC-3720-1.

Frame Elements

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a. RCP lateral support beam

b. RCS model

Figure 3.8A-23 shows the full FEM for the containment internal structure. The solid element model (PSW, IRWST, and fill concrete), shell element model (SSW), and beam element model (RCS) are shown in Figure 3.8A-24.

Structure dead load consists of self-weight for PSW, SSW, RV, additional weight of floor and equipment, and dead load of RCS. Fifty percent of the weights and equipment weights on the floor between the containment shell and the SSW are assumed to be distributed to the containment shell and the SSW, respectively. The large equipment weights are applied as nodal forces at the location of equipment loads.

~~The live load is applied as follows:~~ Live load which is generated by any movable equipment during construction and maintenance of plant is applied as follows:

a. Concrete slabs at El.100 ft 0 in and El.156 ft 0 in: 1.0 ksf

b. Other slabs: 0.2 ksf

Hydrostatic loads are divided by the surface pressure loads in the refueling pool and IRWST walls and bottom slabs.

An equivalent uniform temperature gradient is input directly in the ANSYS model at the appropriate nodes. The temperature profiles during normal operating condition are more severe than those of the accident condition, thus represent the limiting temperature for all the plant conditions.

Compartment pressures on RCB internal structures are result of a pipe break inside containment. The types of compartment pressures are as follows:

a. SG compartment – feedwater economizer nozzle

b. SG compartment – feedwater downcomer nozzle

c. SG compartment – SG blowdown nozzle

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d. PZR compartment – PZR spray nozzle

e. PZR compartment – POSRV nozzle

f. PZR spray valve room – PZR spray line

Branch line pipe break (BLPB) loads are dynamic reactions caused by the combined effects of branch line nozzle reactions or thrust due to pipe break, jet impingement on RCS equipment, or subcompartment pressure effects on RCS equipment. The RCS support reactions due to BLPB are applied as nodal forces at the support locations.

The hydrodynamic pressure load, which is generated by the expulsion of air in the pilot-operated safety relief valve (POSRV) discharge, is applied to the wall and bottom slab of the IRWST through the ~~two~~ twelve spargers. For the hydrodynamic pressure load, by multiplying the dynamic impact factor (DIF), the maximum pressure is conservatively considered as the static load in the analysis. In addition, the normalized factor is considered for the spatial distribution due to the location of spargers.

The seismic analysis for structures is performed using response spectrum analysis. A 7 percent damping ratio for reinforced concrete structures (SSE) and 3 percent damping ratio for the RCS model are used. In addition, the damping ratio for water in the IRWST or refueling pool is the same as that for reinforced concrete structures: the seismic response of water is only considered as impulsive (rigid) mode for structural analysis. Figure 3.8A-5 (a) and (c) show the in-structure response spectrum (ISRS) of the SSE level at El. 78 ft 0 in with 3 percent and 7 percent damping.

Three sections are selected in the PSW as critical sections. Each section is thinnest in the directions of north, south, and east. The design forces and moments for PSW critical sections are presented in the Table 3.8A-18. Table 3.8A-22 presents the margins of safety of rebar stress in the primary shield wall. The margin of safety is the ratio of allowable stress and actual stress.

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3.8A.1.4.3.2.2 Load Combinations Considered

The following loading combinations are critical for the analysis and design of the IRWST wall:

a. Normal: $1.4D + 1.4L_h + 1.7L$ or $1.1D + 1.1L_h + 1.3L + 1.2T_o$ and
$1.4D + 1.4L_h + 1.7L + 1.4P_s + 1.2T_o$

b. Abnormal: $1.0D + 1.0L_h + 1.0L + 1.4P_s + 1.2T_a$

c. Extreme environmental: $1.0D + 1.0L_h + 1.0L + 1.0T_o + 1.0E_s$

d. Abnormal/extreme environmental: $1.0D + 1.0L_h + 1.0L + 1.0P_s + 1.0T_a + 1.0E_s$

P_s is the air-clearing load, which is the hydrodynamic load generated by the expulsion of air in POSRV discharge lines during the POSRV discharge following the water clearing phenomena in the sparger.

3.8A.1.4.3.2.3 Analysis Methods and Results

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The IRWST FEM is part of the containment internal structure full model. See Subsection 3.8A.1.4.3.1.3. The governing load to the IRWST outer wall and upper slab is the sparger discharge load. Hydrodynamic loads occur at ~~two~~ twelve sparger locations (north and west). Therefore, stresses on the portions of outer wall and upper slab are investigated and critical sections are selected where the largest stress takes place. The design forces and moments for IRWST critical sections are presented in Table 3.8A-19.

The typical rebar arrangements for the IRWST are presented in the Table 3.8A-23.

3.8A.1.4.3.2.4 Conclusion

The IRWST wall/slab concrete section strengths determined from the criteria in ACI 349 are sufficient to resist the design basis loads. It is feasible to design and construct the structural components considered. The assumptions envelop the given parameters so the design is adequate for any site-specific conditions within the parameters.

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Because the IRWST is separated from the containment wall by a seismic gap and there is no connection to transfer POSRV load to the containment wall, the POSRV load is not directly applied on the containment wall. The primary and secondary shield wall (PSW and SSW) may be directly influenced by the POSRV load because this load is applied to the IRWST which is integrally connected with the PSW and SSW. However, the transient displacements of PSW and SSW due to POSRV load are comparatively small enough to be ignored. In addition, the spectral acceleration of POSRV is obtained from FRS curves which are generated from time-history analysis. The results comparing with seismic load show that the spectral acceleration by POSRV is less enough to be ignored for PSW and SSW. For reference, the developed FRS is used by other disciplines for qualification of systems and components (e.g., pipes and equipment).