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.:	**409-8325**
SRP Section:	**SRP 19**
Application Section:	**19.1**
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Question No. 19-26

10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design specific PRA and the results. SRP Chapter 19, Revision 3 (Draft), “Design-Specific PRA (PRA for Non-Power Modes of Operation)” states that, “Given that shutdown risk may be highly outage-specific, the staff reviews the shutdown PRA insights to confirm that operational assumptions used to develop an average shutdown model (e.g., use of nozzle dams, outage schedule, containment status, procedural requirements) have been clearly documented in the FSAR.” During the evaluation of containment performance during low power and shutdown conditions, the staff noticed different containment ultimate pressure capacities were referenced in Section 19.3 of the design control document (DCD) (184 psig), Section 19.2 of the DCD (123 psig), and 19.1 of the DCD (163 psig). The staff is requesting the applicant to resolve these inconsistencies in the DCD or justify in the DCD why different containment ultimate pressure capacities were used.

Response – (Rev. 1)

The responses are as follows;

The containment ultimate pressure in DCD Section 19.1 (probabilistic risk assessement) is the containment pressure from the containment fragility analysis (DCD Section 19.1.4.2.1.2.2). This provides information on the likehood of containment failure to provide an effective barrier against the release of fission products to the environment.

The total containment failure probabilities are obtained by integration process given the rupture mode and the leak mode. PTOTAL_FAIL = 1 – (1-PRUPTURE) * (1-PLEAK)

Figure 19.1-47 in DCD 19.1 shows the total containment fragility curve. The containment failure probability becomes 0.5 (i.e., 50 percentile) when the containment pressure is set to be 162.68 psig. The containment ultimate pressure evaluation was documented in DCD Section 19.1.4.2.1.2.2 and PRA notebook (APR1400-K-P-NR-013605-P, Rev.0).

The 123.7 psia containment pressure in DCD Section 19.2 (severe accident evaluation) is the containment pressure generated by hydrogen burning with a 100% fuel clad metal –water reaction (19.2.4.2.1 Combustible Gas Control inside Containment, RG 1.216, position 2). For Section 19.2, this is utilized as an acceptable upper limit of containment pressure. As seen in comparison with Sections 19.1 and 19.3, this limit is well below the actual calculated containment pressure limits, and therefore is a conservative bound. Section 19.2.4.2.2 also showed that 123.7 psia is not reached for the containment pressure for a large-break LOCA that results in the highest containment pressure at 24 hours following the onset of core damage (RG 1.216, position 3).

The containment ultimate pressure in DCD Section 19.3 (Beyond Design Basis External Event) is the containment pressure which is estimated based on the design of the containment structure in DCD 3.8.1.4.11 (Ultimate Pressure Capacity). It was used to perform the evaluation of containment capability by using ECSBS in loss of RHR during mid-loop operation in Mode 5 (DCD Section 19.3.2.3.3). The GOTHIC analysis showed that the containment pressure can be controlled within the ultimate pressure capacity (UPC) of APR1400 with the ECSBS operation following the loss of RHR in mode 5.

The brief comparison of containment pressure between both19.1, 19.2, and 19.3 is summarized in the table below.

Chapter	19.1 (PRA)	19.2 (Severe Accident Evaluation)	19.3 (Beyond Design Basis External Event)
Containment Pressure	162.7 psig (median pressure)	123.7 psia	12.9 kg/cm^2 (184 psia)
Requirement	-	RG 1.216 Position 2	RG 1.216 Position 1
Definition	Containment Pressure evaluated by Containment Fragility Analysis in PRA (Probabilistic Containment Pressure)	Containment pressure resulting from severe accident	Ultimate Pressure Capacity of containment (Deterministic/Design Containment Pressure)
Detailed Information	The total probability of containment failure can be obtained by integration process given the rupture mode and the leak mode. $P_{TOTAL\_FAIL} = 1 – (1-P_{RUPTURE}) * (1-P_{LEAK})$ Figure 19.1-47 shows the total fragility curve. The containment failure probability becomes 0.5 (i.e., 50 percent) when the containment pressure is 162.68 psig.	Factored Load Category (FLC)	Deterministic evaluation of the design of the structure. 184 psia was calculated to be the pressure at which the maximum strain of the liner plate and horizontal tendon is 0.8 percent.
Reference	19.1.4.2.1.2.2	19.2.4	3.8.1.4.11 Ultimate Pressure Capacity

Impact on DCD

DCD 19.1.4.2.1.2.2 will be revised and Table 19.1-28a will be added in DCD 19.1 as shown in the Attachment.

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.

A plant-specific containment structural analysis was performed to determine the ultimate pressure capacity of the APR1400 containment building, and to identify the failure modes. Potential modes considered include:

a. Membrane failure

b. Cylindrical wall at the basemat

c. Failure of the basemat

d. Failure of the equipment hatch

e. Failure of the personnel access airlock

f. Failure of the personnel emergency exit airlock

g. Failure of the fuel transfer tube

In this analysis, the several failure modes that are identified in the containment structural analysis can be classified by their failure sizes into two groups, which are defined in NUREG-1150 and NUREG/CR-6906 (Reference 35).

a. A leak is defined as a containment breach that would arrest a gradual pressure buildup, but would not result in containment depressurization in less than 2 hours. The typical leak size is evaluated to be on the order of 9.29×10^{-3} m^2 (0.1 ft^2).

b. A rupture is defined as a containment breach that would arrest a gradual pressure buildup and would depressurize the containment within 2 hours. The typical rupture size is evaluated to be on the order of approximately 9.29×10^{-2} m^2 (1.0 ft^2).

The failure modes and their results are as presented in Table 19.1-28.

A probability density function was calculated for each potential failure mode, and summed together to estimate a total fragility curve. The results of this analysis are presented in Figure 19.1-47. These results were used in the Level 2 phenomenological evaluations for leak and rupture failure pressures of the containment.

The comparison of containment pressure between 19.1, 19.2, and 19.3 is summarized in Table 19.1-28a.

Table 19.1-28

Containment Failure Modes and Results

Failure Mode		Force	Median Pressure (psi)	Logarithmic Standard Deviation	Failure Size Category
Cylinder Wall	Hoop Direction	Membrane	204.79	0.20	Rupture
	Meridional Dire.	Membrane	257.66	0.19	Rupture
Dome	Hoop Dire. (above 45 deg.)	Membrane	221.90	0.23	Rupture
	Meridional Dire. (under 45deg.)	Membrane	237.31	0.18	Rupture
Basemat -Cylinder Wall Junction	Radial Dire.	Shear	214.80	0.29	Rupture
	Meridional Dire.	Moment	224.28	0.16	Rupture
Basemat	Screen out	-	-	-	Rupture
Equipment Hatch	Spherical Hatch Cover	Buckling	225.71	0.15	Rupture
	Welded Stud	Shear	251.69	0.11	Rupture
	Wall-Hatch Junction	Shear	459.10	0.29	Rupture
Personnel Air lock	Spherical Hatch Cover (Bulkhead plate)	Buckling	222.18	0.15	Rupture
	Welded Stud	Shear	253.03	0.11	Rupture
	Wall-Hatch Junction	Shear	443.92	0.24	Rupture
Fuel Transfer Tube	Blind Flange	-	223.08	0.15	Rupture
	Sleeve	-	281.03	0.15	Rupture
Fuel Transfer Tube	Welded Stud	Shear	420.55	0.15	Rupture
	Wall-Hatch Junction	Shear	752.43	0.24	Rupture
Liner Tearing of Equipment Hatch	-	-	188.0	0.15	Leak

Table added (Table 19.1-28a)

Table 19.1-28a

Comparison of Containment Pressure Between 19.1, 19.2 and 19.3

	19.1 (Probabilistic Risk Assessment)	19.2 (Severe Accident Evaluation)	19.3 (Beyond Design Basis External Event)
Containment Pressure	162.7 psig (median pressure)	123.7 psia	12.9 kg/cm^2 (184 psia)
Requirement	-	RG 1.216 Position 2	RG 1.216 Position 1
Definition	Containment pressure evaluated by containment fragility analysis (Probabilistic Containment Pressure)	Containment pressure resulting from severe accident	Ultimate pressure capacity of containment (Deterministic Containment Pressure)
Detailed Information	The total probability of containment failure can be obtained by integration process given the rupture mode and the leak mode. $P_{TOTAL\_FAIL} = 1 - (1-P_{RUPTURE}) * (1-P_{LEAK})$ The containment failure probability becomes 0.5 (i.e., 50 percent) when the containment pressure is 162.7 psig.	Factored Load Category (FLC)	Deterministic evaluation of the design of the structure. 184 psia was calculated to be the pressure at which the maximum strain of the liner plate and horizontal tendon is 0.8 percent.
Reference	19.1.4.2.1.2.2	19.2.4	3.8.1.4.11