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.:	**446-8535**
SRP Section:	**19 - Probabilistic Risk Assessment and Severe Accident Evaluation Application Section**
Application Section:	**19.1**
Date of RAI Issue:	**03/16/2016**

Question No. 19-98

The staff reviewed KHNP's revised response to RAI Question 19-4 dated September 30, 2015. In response to RAI Question 19-4, KHNP proposed that a new table be added to the DCD, Table 19.1-93, Summary of Analysis Results for Plant Operating States (POSs). This table shows:

1. The anticipated decay heat level and the associated time post shutdown
2. The size and locations of any RCS vents
3. The assumed RCS water level
4. The time to RCS boiling given a loss of the decay heat removal function
5. The time to core uncovery
6. The thermal-hydraulic code used to assess the POS and a discussion of the acceptability of the code to assess that POS.

In addition, based on staff review of: (1) proposed DCD Table 19.1-93, (2) the staff's confirmatory midloop MELCOR calculation, and (3) the midloop loss of core cooling calculation referenced in Fukushima Technical Report, Section A.5.3 Shutdown Condition with SGs not Available, the staff is requesting the following additional information to be added to the proposed DCD Table 19.1-93:

a. RCP seal leakage rate for each POS. Please confirm if this leakage rate is the same rate referenced in the Fukushima Technical Report (25 gpm/pump).

b. Leakage rate from temporary seals used for the Incore Instrumentation for each applicable POS.

c. The definition of hot leg top level (for POS 4 only).

d. The definition of midloop operation level (for POS 5 only). Please confirm if this level is the same midloop vessel level referenced in Section A.5.3 of the Fukushima Technical Report.

e. Clarification in POS 4A, with the RCS closed except for the open Reactor Coolant System Gas Vent System (RCGVS), whether the RCS is being drained with a cover gas.

f. Clarification in each POS where reflux cooling is being credited, the assumed initial SG secondary side level and the number of SGs with secondary inventory.

g. Clarification in each POS whether the vessel head is installed.

Response

The responses are as follows;

a. RCS pump seal leakage is not considered for POS 3 through 13 (Mode 4 and 5), because RCS pressure is low since SCS is in-service or RCS is not intact (pressurizer manway is open).

b. The temporary seal is not used during refueling, since the BM-ICI system uses a fixed ICI system.

c. The definition of hot leg top level (for POS 4 only) is the upper end level of hot leg inside diameter (Hotleg Top Level: 119’ 1”), and it will be added in Table 19.1-93.

d. The definition of midloop operation level (for POS 5 only) is as follows;

   - High Level: 117’ 11”,
   - Low Level: 117’ 7.28”,
   - Low-Low Level: 117’ 6”

   These are the same midloop vessel level referenced in Section A.5.3 of the Fukushima Technical Report. And it will be added in Table 19.1-93.

e. Instrument air is ported to the RCS through the pressurizer vent path before the pressurizer manway is opened. This alignment prevents the RCS from drawing a vacuum and speeds draining.

f. POS 3 and POS 13 have two (2) SGs and POS 4A has one (1) SG. And it will be added in Table 19.1-93.

g. Vessel head is removed in POS 6 and installed in POS 10. And it will be added in Table 19.1-93.

Impact on DCD

Table 19.1-93 will be revised as shown in 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.

Added

RAI 42-7945_Question 19-4

RAI 446-8535_Question 19-98

Table 19.1-93 (1 of 4)

Summary of Analysis Results for Plant Operating States

POS	Description	Anticipated Decay Heat Level (MWt)	Associated Time Post Shutdown (hrs)	Size and Locations of any RCS Vents	Minimum RCS Water Level During POS	Number of SGs and SG Water Level	Cases	Time to RCS Boiling	Time to Core Uncovery
03A	Cooldown with Shutdown Cooling System to 212°F	24.6	32.9	RCS is intact and LTOP valves are in auto protection mode	Normal operation level	Two of SGs and Wet Lay-up water level	Base	16801 sec (4.67 hrs)	19943 sec (5.54 hrs)
							LTOP B Stuck-open at t=0	190 sec (0.05 hrs)	3061 sec (0.85 hrs)
							LOCA through CVCS Letdown line	13103 sec (3.64 hrs)	19837 sec (5.51 hrs)
03B	Cooldown with Shutdown Cooling System to 140°F	24.6	37.5	RCS is intact and LTOP valves are in auto protection mode	Normal operation level	Two of SGs and Wet Lay-up water level	N/A	N/A	N/A
04A	Reactor Coolant System drain-down (pressurizer manway closed) (3)	18.6	75.1	RCGVS (Reactor Coolant System Gas Vent System) is open and LTOP valves are in auto protection mode	Normal operation level	One of SG and Wet Lay-up water level	Base	10728 sec (2.98 hrs)	48146 sec (13.37 hrs)
							LOCA through CVCS Letdown line	9724 sec (2.70 hrs)	47646 sec (13.24 hrs)

Added

RAI 42-7945_Question 19-4

RAI 446-8535_Question 19-98

Table 19.1-93 (2 of 4)

POS	Description	Anticipated Decay Heat Level (MWt)	Associated Time Post Shutdown (hrs)	Size and Locations of any RCS Vents	Minimum RCS Water Level During POS	Number of SGs and SG Water Level	Cases	Time to RCS Boiling	Time to Core Uncovery
04B	Reactor Coolant System drain-down (pressurizer manway open)	18.5	76.4	Pressurizer manway open. RCGS (Reactor Coolant System Gas Vent System) open and LTOP valves are in auto protection mode	Hot leg top level (1)	-	Base	134 sec (0.04 hrs)	5599 sec (1.56 hrs)
							LOCA through CVCS Letdown line	38 sec (0.01 hrs)	5502 sec (1.53 hrs)
05	Reduced Inventory operation and nozzle dam installation	16.8	96.7	Pressurizer manway open. Steam generators manway open. RCGVS (Reactor Coolant System Gas Vent System) open and LTOP valves are in auto protection mode	Mid-loop Operation level (2)	-	Base	400 sec (0.11 hrs)	4582 sec (1.27 hrs)
							LOCA through CVCS Letdown line	398 sec (0.11 hrs)	4161 sec (1.16 hrs)
06	Fill for refueling	15.7	113.5	Pressurizer manway open. ICI tubes open. RCGVS (Reactor Coolant System Gas Vent System) open and LTOP valves are in auto protection mode. Nozzle dam installed Vessel head is removed.	Reactor vessel flange level	-	Base	364 sec (0.10 hrs)	6020 sec (1.67 hrs)
							LOCA through CVCS Letdown line	362 sec (0.10 hrs)	5924 sec (1.65 hrs)

Added

RAI 42-7945_Question 19-4

RAI 446-8535_Question 19-98

Table 19.1-93 (3 of 4)

POS	Description	Anticipated Decay Heat Level (MWt)	Associated Time Post Shutdown (hrs)	Size and Locations of any RCS Vents	Minimum RCS Water Level During POS	Number of SGs and SG Water Level	Cases	Time to RCS Boiling	Time to Core Uncovery
10	Reactor Coolant System drain-down to Reduced Inventory after refueling	9.3	435.9	Pressurizer manway open. ICI tubes open. RCGVS (Reactor Coolant System Gas Vent System) open and LTOP valves are in auto protection mode. Nozzle dam installed Vessel head is installed.	Reactor vessel flange level	-	Base	861 sec (0.24 hrs)	10248 sec (2.85 hrs)
							LOCA through CVCS Letdown line	850 sec (0.24 hrs)	10133 sec (2.81 hrs)
11	Reduced Inventory operation with steam generator manway closed	8.7	521.7	Pressurizer manway open. Steam generators manway open. RCGVS (Reactor Coolant System Gas Vent System) open and LTOP valves are in auto protection mode.	Mid-loop operation level (2)	-	Base	1258 sec (0.35 hrs)	9874 sec (2.74 hrs)
							LOCA through CVCS Letdown line	1233 sec (0.34 hrs)	9914 sec (2.75 hrs)
12A	Refill Reactor Coolant System (pressurizer manway open)	8.6	534.9	Pressurizer manway open. LTOP valves are in auto protection mode	Hot leg center +13" level	-	Base	455 sec (0.13 hrs)	20094 sec (5.58 hrs)
							LOCA through CVCS Letdown line	451 sec (0.13 hrs)	19579 sec (5.44 hrs)

Added

RAI 42-7945_Question 19-4

RAI 446-8535_Question 19-98

Table 19.1-93 (4 of 4)

POS	Description	Anticipated Decay Heat Level (MWt)	Associated Time Post Shutdown (hrs)	Size and Locations of any RCS Vents	Minimum RCS Water Level During POS	Number of SGs and SG Water Level	Cases	Time to RCS Boiling	Time to Core Uncovery
12B	Refill Reactor Coolant System (manway closed)	8.6	539.1	RCGVS (Reactor Coolant System Gas Vent System) open and LTOP valves are in auto protection mode.	28.2% Pressurizer level	-	Base	37176 sec (10.33 hrs)	No core uncovery (simulation time 25.0 hrs)
							LOCA through CVCS Letdown line	16713 sec (4.64 hrs)	85395 sec (23.72 hrs)
13	Reactor Coolant System heat-up with Shutdown Cooling System isolation at 350°F	8.4	562.3	RCS is intact and LTOP valves are in auto protection mode.	Normal operation level	Two of SGs and Wet Lay-up water level	Base	53063 sec (14.74 hrs)	60661 sec (16.85 hrs)
							LOCA through CVCS Letdown line	13703 sec (3.81 hrs)	59294 sec (16.47 hrs)

(1) The upper end Level of Hot leg inside diameter (Hot leg Top Level: 119’ 1”)

(2) The midloop operation level are High Level : 117’ 11”, Low Level : 117’ 7.28”, and Low-Low Level : 117’ 6”. These are the same with the level in the Fukushima Technical Report

(3) Instrument air is ported to the RCS through the pressurizer vent path before the pressurizer manway is opened. This alignment prevents the RCS from drawing a vacuum and speeds draining.

- RCS pump seal leakage is not considered for POS 3 through 13 which are Mode 4 and 5 because RCS pressure is low since SCS is in-service or RCS is not intact (pressurizer manway is open).
- ICI seal leaks of ICI system is not considered because it is a fixed ICI system of "U" type BM-ICI system preventing seal leaks.