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.:	**268-8308**
SRP Section:	**SRP 19**
Application Section:	**19**
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Question No. 19-12

10 CFR 52.47(27) requires that a standard design certification applicant provide a description of the design specific probabilistic risk assessment (PRA) and the results. Standard Review Plan (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.” The Shutdown Evaluation Report, Section 2.8.3.2.1, Level, states, “Four unique sets of instruments are provided for the measurement of level during RCS drain down and reduced inventory operations. These instruments make up the refueling water level indication system (RWLIS).” The first set of instruments is a pair of wide-range, pressure differential (dP)-based level sensors. These sensors are provided to measure the level between the pressurizer (PZR) and the bottom of the hot leg during drain-down operations. Another pair of dP-based level sensors is used to determine reactor coolant system (RCS) water level once it is within the reactor vessel (RV). These narrow-range level sensors function to measure level between the direct vessel injection (DVI) nozzle and the bottom of the hot leg. The Ultrasonic level measurement system measures from twenty percent to one hundred percent of the hotleg level. During a loss of shutdown cooling at reduced inventory conditions, it is not clear whether the operator reviews all three level indicators. If the RCS is vented via the pressurizer manway, and decay heat removal (DHR) is lost, RCS heatup and re-pressurization could result in hot leg inventory being swept into the pressurizer. For the wide-range level indication that is tapped into the pressurizer, in this condition, level indication could read erroneously high. However, the other two sets of narrow range indication should still be accurate. The staff requests additional information in the design control document (DCD) on how this condition has been accounted for in the post-initiator, human error probabilities (HEPs).

Response – (Rev.1)

The normal and emergency procedures are written to utilize the best available indications for safe plant operation. According the normal operating procedures for the APR1400, the operators will use the narrow range instruments during draindown and mid-loop operations.

The APR1400 HRA credits primary system level indication in several recovery actions, during draindown or mid-loop operations, with the Reactor Coolant System vented (i.e., not intact). Since the operating procedures specify that the narrow range instruments are the primary indicators during these plant operating states, the operators will implicitly continue to use these indications during any accident recovery. The HRA does not specify the narrow range level transmitters, but implicitly credits procedural compliance in instrument use.

In addition, the APR1400 Emergency Operating Guideline DIAGNOSTIC ACTIONS, Section 6.0 states that

> "All available indications should be used to aid in evaluating plant conditions since the accident may cause irregularities in a particular instrument reading. Instrumentation readings must be corroborated when one or more confirmatory indications are available."

This requirement ensures that the operators will utilize the narrow range indications during any event that could potentially have an erroneously high wide range level indication. The wide range indicators will be used only in a confirmatory role but will not override the narrow range as the primary indicators.

Impact on DCD

DCD 5.4.7.2.6 will be revised as shown in Attachment 1.
DCD Table 19.1-4 will be revised as shown in Attachment 2.

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 Technical/Topical/Environmental Report.

Operator actions for responses to events that occur in TS Modes 4, 5, or 6 are summarized in the following groups:

a. Actions to restore SCS

b. Actions to provide reasonable assurance of secondary cooling

c. Actions to initiate feed and bleed cooling

d. Actions to isolate RCS leakage and restore inventory

e. Actions to align the AAC power source

The time available to perform each of these categories of actions varies with POS. As a result, the HEPs for each event also vary with POS. Some actions are not applicable to all initiators and timing can be affected by specific initiating events. For example, actions to isolate RCS leakage and restore inventory are not applicable to loss of SCS initiating events.

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19.1.6.1.1.7 Systems Analysis

The following summarizes differences in LPSD PRA system models versus at-power PRA modeling:

a. Safety Injection System

1) The SITs are isolated in the late POS 2 (TS Mode 3) and below. They are considered unavailable during all of POS 3 through POS 13.

2) Manual actuation of the SIPs is assumed to be required in Mode 4 (POS 3) and below. Automatic actuation is not credited.

b. Shutdown Cooling System

1) The system is modeled as aligned for shutdown with one train in operation and one train on standby.

2) No maintenance is performed on the SCS when operation of the system is required.

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As another example, the normal operating procedures direct the operators to utilize the narrow range primary system level indicators during draindown and mid-loop operations. The operators will therefore use these same indications to recover from a loss of decay heat removal, which will minimize the impact of potentially erroneous wide range indications that occur following an unplanned heatup of the primary system. The APR1400 HRA does not specify the specific instrument channels but it does reflect the primary indicators used in the procedures for each credited action.

below the pressure that corresponds to the relief valve blowdown pressure, the operator confirms that the LTOP relief valves have been reseated by monitoring RCS pressure and level and IRWST. If an LTOP relief valve is stuck open, the operator takes actions to provide adequate RCS makeup inventory and core cooling.

f. Operation with reduced RCS inventory

Reduced inventory including mid-loop operation is necessary for increasing the plant availability. During this operation, the RCS water level is lowered to below the reactor vessel flange. When the RCS water level abnormally decreases, air may be ingested into the shutdown cooling system with the possibility of affecting the SCS. The RCS level is maintained higher than the RCS low water level of 8.3 cm (3.28 inch) above the loop center, and a SCS flow rate of 14,385 to 15,710 L/min (3,800 to 4,150 gpm) is maintained for decay heat removal and prevention of an air ingestion.

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The performance of the SCS operation is verified at the RCS mid-loop level during preoperational testing. For the air ingestion RCS cooldown rate, the shutdown cooling flow rate, SCP motor current, and SCP suction/discharge pressure are monitored.

The APR1400 design includes the features listed below to facilitate continued SCS operations during reduced RCS inventory in conformance with Generic Letter (GL) 88-17. The Shutdown Evaluation Report (Reference 22) provides an assessment of shutdown operation risk in conformance with GL 88-17.

1) Two independent instrumentation systems are provided for RCS level measurement. These instruments function to monitor the RCS level in order to preclude SCS suction line vortexing and subsequent air entrainment. Level instrument types and corresponding instrumentation ranges are optimized to encompass all reduced RCS inventory conditions.

2) Two independent thermocouples are provided to measure core exit temperature.

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Reactor coolant level is monitored during the reduced inventory condition by the Refueling Water Level Indication System (RWLIS). The RWLIS consists of the Permanent Refueling Water Level Indication System (PRWLIS), the Local Refueling Water Level Indication System (LRWLIS), and the Ultrasonic Level Measurement System (ULMS).

The PRWLIS (Wide Range) monitors coolant level between 10 % level of the PZR and the bottom of the hot leg. The level indication of the PRWLIS (WR) is provided in the MCR. Upper level taps are connected with the PZR pressure instrument sensing lines. Lower level taps are connected with the SCS suction lines located on the bottom of the hot legs. Two level instrumentations are provided for monitoring coolant level.

The PRWLIS (Narrow Range) monitors coolant level between the top of the hot leg and 2 inch above the bottom of the hot leg. Level indication and high, low and low-low alarms are provided in the MCR. Upper level taps are connected with piping to the DVI nozzles. Lower level taps are connected with the SCS suction lines located on the bottom of the hot legs. Two level instrumentations are provided for monitoring coolant level for Loop1 and Loop 2, separately.

The LRWLIS (Sight Glass) has a minimum visible span of 150 inches (3.81 m) above the bottom of the hot leg. The local level indicator is located outside the secondary shield. High, low and low-low alarms are provided in the MCR. Upper level taps are connected with the PZR pressure instrument sensing lines. Lower level taps are connected with the SCS suction lines located on the bottom of the hot legs. Two level instrumentations are provided for monitoring coolant level.

Two ULMS are installed temporarily on the bottom of both hot legs to monitor coolant level of hot legs during mid-loop operation. The ULMS monitors coolant level between 8.4 inch above the hot leg bottom to the hot leg top. High, low and low-low alarms are provided in the MCR.

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No.	Insight	Disposition
	Risk Insights from PRA Models	
58	The fire PRA assumes that the fire barrier management procedures used during LPSD will include directions to provide reasonable assurance that breached risk-significant fire barriers can be closed in sufficient time to prevent the spread of fire across the barrier. The procedural direction is to include the use of a fire watch whose duties are commensurate with the risk associated with the barrier. For example, for fire barriers that separate two fire compartments that both contain no equipment or cables necessary to prevent core damage or large early release during LPSD conditions, or have been demonstrated to have low risk significance, there will at least be a roving fire watch to check the barrier during rounds. For fire barriers separating fire compartments that contain equipment or cables necessary to prevent core damage or large early release during LPSD conditions, and have been demonstrated to be risk significant with respect to fire, a permanent fire watch will be established until the barrier is reclosed. In the latter case, the fire barrier management procedure is to direct that hoses or cables that pass through a fire barrier use isolation devices on both sides of a quick-disconnect mechanism that allow for reclosure of the barrier in a timely fashion to re-establish the barrier prior to fire spread across the barrier.	Subsection 19.1.6.3.1.2 COL 19.1(11)
##	The core exit thermocouples (CETs) provide representative indications of the core exit temperature when shutdown cooling system (SCS) is operational, including reduced inventory operations. Continuous, redundant narrow range RCS water level indication is operational during reduced inventory operations.	Subsection 19.1.6.1.1.5