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.:	**158-7997**
SRP Section:	**06.03 – Emergency Core Cooling System**
Application Section:	**06.03**
Date of RAI Issue:	**08/20/2015**

Question No. 06.03-9

The applicant stated in DCD Tier 2, Section 6.3.1.4 that "for breaks larger than 0.0462 m^2 (0.5 ft^2), two diagonal SI pumps, in conjunction with the SITs, provide 100 percent of the minimum injection flow rate required to satisfy the LOCA performance requirements in Subsection 6.3.1.1. For breaks equal to or smaller than 0.0462 m^2 (0.5 ft^2), each SI pump, in conjunction with the SITs, has 100 percent of the capacity to satisfy the LOCA performance requirements." Following the guidance provided in SRP 6.3, the staff identified that the applicant's design of the SIS must conform to GDC 35, which ensures emergency core cooling under the assumption of a single failure.

According to the quoted statement above, from DCD Tier 2, Section 6.3.1.4, the staff also notes that the minimum injection flow rate required to satisfy the LOCA performance requirements relies on two **diagonal** SIPs. The staff needs the applicant to justify how it ensures that the credited safety flow from the 2 SIPs is indeed from 2 **diagonal** SIPs during any given break where only 2 SIPs are capable of providing safety injection flow. For example, in a DVI-line-break scenario, the single failure SIP could occur beside the SIP that is feeding the break, thus resulting in two **non-diagonal** SIPs injecting. Two non-diagonal SIPs injecting in this scenario does not seem to meet the minimum injection flow rate requirements, as stated in DCD Tier 2, Section 6.3.1.4. Also, please clarify the applicant's definition of **diagonal** and update the DCD as appropriate.

Response – (Rev. 1)

The most limiting case for LOCA in APR1400 is loss of one SI train (e.g., failure of one EDG, failure of one SIP, failure of valve opening in discharge line). Therefore, three SI trains are operable at any time of LOCA. However, APR1400 LOCA analysis conservatively assumes that only two diagonal SI trains are available. The DVI line break is the small break LOCA.

APR1400 DCD Tier 2, Section 15.6.5.3.2 which will be revised as response to Ch. 6.3 Phone

Call Clarification Item No.3 describes the assumption for large break LOCA (the break size is larger than 0.0462 m^2 (0.5 ft^2)) analysis;

> "The most limiting single failure for a large break LOCA is the loss of one SIP train. However, two of the four SIPs are conservatively assumed to be available for the large break LOCA analysis. The available SIP injection located near the broken cold leg with another available injection located on the opposite side of broken cold leg is used for the large break analysis."

APR1400 DCD Tier 2, Section 15.6.5.3.2 describes the assumption for small break LOCA (the break size is smaller than 0.0462 m^2 (0.5 ft^2)) analysis;

> "An analysis of the possible single failures that can occur within the SIS shows that the worst single failure for the small break spectrum is the failure of one SI pump train. This failure causes a loss of two of the four SIPs with additional conservativeness, thereby minimizing the safety injection available to cool the core.
>
> Based on the above assumptions, the following safety injection flows are credited for the small break analysis:
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> a. For a break in the pump discharge leg, the SI flow credited is full flow from two SIPs and four SITs.
>
> b. For a break in a DVI line, the SI flow credited is full flow from one SIP and three SITs. The flow from the remaining active SIP and from one SIT is assumed to spill out of the break."

To clarify the SI flow capacity assumption, DCD Tier 2, Section 6.3.1.4 will be revised as attachment.

Impact on DCD

The description of Tier 2, Section 6.3.1.4 and Section 15.6.5.3.2 will be revised as indicated in the attachment to this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on any Technical Specifications.

Impact on Technical/Topical/Environmental Reports

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

Conformance with the GDC is addressed in Section 3.1, and 10 CFR 50.46 is addressed in Subsection 6.3.1.1.

Conformance with the relevant items of the Three Mile Island Action Plan is addressed in Table 6.3.1-1 and Subsection 1.9.3.

The SIS design incorporates the resolution of the relevant unresolved safety issues and medium-priority and high-priority generic safety issues that are specified in NUREG-0933, as described in Table 6.3.1-2 and Section 1.9.3.

Conformance with the generic safety issue (GSI)-191 and NRC RG 1.82 is described in Subsection 6.8.4.5.

The SIS design incorporates operating experience insights from generic letters and bulletins, as described in Table 6.3.1-3 and Subsection 1.9.4.

6.3.1.4 Functional Design Bases

The SIS is designed to inject the borated water into the RCS through DVI nozzle. The discharge of each SI pump and tank is piped directly to a DVI nozzle. The flow is directed into the reactor vessel downcomer region through the DVI nozzle.

The SIS is designed so that for breaks larger than 0.0462 m^2 (0.5 ft^2), two diagonal SI pumps, in conjunction with the SITs, provide ~~100 percent of the minimum injection~~ sufficient flow rate required to satisfy the LOCA performance requirements in Subsection 6.3.1.1. For breaks equal to or smaller than 0.0462 m^2 (0.5 ft^2), ~~each SI pump,~~ the SI pumps, in conjunction with the SITs, ~~has 100 percent of the~~ have sufficient capacity to satisfy the LOCA performance requirements.

The shutoff head and flow rate of the SI pumps are selected to provide reasonable assurance that adequate flow is delivered to the reactor vessel to accomplish the functional requirements in Subsections 6.3.1.1 and 6.3.1.2. Table 6.3.2-4 presents the minimum and maximum flow delivery.

Storage of water for the SIS is accomplished by the IRWST, which contains a sufficient amount of borated water to accomplish the requirements in Subsections 6.3.1.1 and 6.3.1.2.

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SIP injection located near the broken cold leg with another available injection located on the opposite side of broken cold leg is ~~the limiting condition~~ for the large break analysis.

The operating parameters and ranges for the plant uncertainty evaluation determined in large break LOCA analysis are listed in Table 15.6.5-1. Core and system parameters are prepared by using measurement uncertainty ranges or determined to cover the minimum and maximum ranges of the design data or the limit of the Technical Specifications.

The large break analysis accounts for 10 percent tube plugging of the steam generator tubes that may occur during the life of the plant.

The accidents are assumed to occur at the initial burnup for the large break analysis. The stored energy is the maximum value because the fuel elements show the most densification at the initial burnup (BOC), and the burnup yields the highest cladding temperature in the large break LOCA.

Subsection 6.2.1.5 presents the minimum containment pressure analysis that is performed in the analysis of ECCS performance. The analysis identifies the containment parameters used in the large break analysis. The values for the containment parameters are chosen to minimize containment pressure to minimize the core reflood rate.

The worst break in the large break analysis is the double-ended guillotine at the RCP discharge leg (Reference 63). To determine the limiting break size, a guillotine break spectrum of 100 percent, 80 percent, and 60 percent break areas are analyzed, and the limiting break size is applied for 124 cases of SRS calculation.

Small Break Loss-of-Coolant Accident

The safety injection system (SIS) consists of four direct vessel injection lines, each supplying flow from one SIT and one SIP. Offsite power is conservatively assumed to be lost upon reactor trip, and the SIPs therefore await diesel startup and load sequencing before they can start. The total time delay assumed is 40 seconds from when the SIAS setpoint is reached to when the full SI flow is delivered to the RCS. For breaks in the DVI line, all safety injection flow delivered to the broken line is assumed to spill out of the break.