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## 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.:** 417-8359  
**SRP Section:** SRP 19  
**Application Section:** 19.1  
**Date of RAI Issue:** 02/23/2016

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### **Question No. 19-42**

Item 11 of Section II, "Acceptance Criteria," of the (Draft) Revision 3 SRP, states, "The PRAs that meet the applicable supporting requirements for Capability Category I and meet the high-level requirements as defined in the ASME PRA Standard (ASME/ANS RA-S-2008 and addenda ASME/ANS RA-Sa-2009) should generally be acceptable for DC and COL applications. Alternatively, the applicant may identify, and justify the acceptability of, alternative measures for addressing PRA quality and technical adequacy. The staff should specifically review the acceptability of these alternative measures in the context of the specific uses and applications of the PRA."

The staff reviewed the APR1400 design control document (DCD) Section 19.1.4.1.1, "Description of Level 1 Internal Events PRA for Operations at Power," and found insufficient information describing the success criteria analysis performed. Specifically, the applicant did not describe the reasonableness and acceptability of success criteria developed which were different from design basis analysis and success criteria analysis notebook referenced in the PRA summary report, APR1400-E-P-NR-14001-P. As an example, the large loss of coolant accident (LLOCA) PRA success criteria for safety injection pumps requires more pumps than the design basis requirement (ASME PRA Standard – SC-B5). Therefore, in order for the staff to reach an assurance finding on the conformance to SRP Chapter 19.0 regarding PRA technical adequacy, please provide an explanation for the differences and revise the DCD accordingly.

### **Response – (Rev. 3)**

The LLOCA success criterion is that "3 out of 4 Safety Injection Pumps (SIPs) inject borated water into the reactor vessel" based on the result of conservative thermal-hydraulic analysis. The PRA sensitivity analysis for changing the LLOCA success criterion from 3 out of 4 SIPs to 2 out of 4 SIPs shows that the core damage frequency is estimated to be 1.29E-06/yr (a decrease of 0.8%), thus the changed success criteria does not affect the results significantly.

During a consistency review of the DCD, it was identified that several items in DCD Table 19.1-8 were not up to date with respect to the APR1400 DC PRA latest success criteria analysis. These success criteria changes and clarifications were identified during both internal review of the PRA model, and the RAI process.

- o The first change had to do with the losses of the ultimate heat sink (UHS) initiators (PLOCCW, PLOESW, TLOCCW and TLOESW). The initial APR1400 PRA model, based on the reference plant PRA, only included SI pump room cooling via the cubicle coolers which are ultimately cooled via the UHS; hence, UHS failures directly impacted the SI pumps in the initial PRA model. However, for the APR1400 PRA updated model, SI pump room cooling can be adequately supplied by either the cubicle coolers, or the Auxiliary Building Controlled Area HVAC System (VK) which is independent of the UHS, and only requires electric power. Therefore, the PLOCCW, PLOESW, TLOCCW and TLOESW initiating events do not impact the SI pump success criteria. This is reflected in DCD Table 19.1-8 which adds PLOCCW, PLOESW, TLOCCW and TLOESW in the “Event Tree” column of the “1 of 4 SI pumps” success criteria row, and removes PLOCCW, PLOESW from the “Event Tree” column of the “1 of 2 SI pumps” success criteria row since all 4 SIPs are available for these initiators, so the success criteria is 1 of 4 SIPs. In addition, the original Note 1 which discussed this issue was removed.

- o A new Note 1 was added to clarify that DVI LLOCAs affect the SIT and SIP LLOCA success criteria since these both inject via the DVI lines. Hence, if the LLOCA is in the DVI line, then 1 SIT and 1 SIP associated with the broken DVI line is lost out of the break, and the success criteria effectively changes to 2 of 3 available SITs and 2 of 3 available SIPs.

- o Another change had to do with the design change modeled in the PRA update wherein the alternate AC (AAC) gas turbine generator can only supply power to either 1E 4kV SWGR SW01A or SW01B. Therefore, during SBO events (SBO or GRID-SBO) where offsite power is not yet recovered, and the AAC is the only AC power source, only the “A” and “B” SI pumps (which can be powered from the AAC) are available since the “C” and “D” SI pumps have no AC power source (until offsite power is returned). Upon an SBO with successful AAC start, the operators must manually align the AAC to either SW01A or SW01B. If failures occur on the initially aligned train which prevents shutdown using that train, the operators would need to manually align the other 4kV SWGR and continue the shutdown using that train. So, even though the AAC can only be aligned to SW01A or SW01B, there are still 2 SI pumps available for use; however, they can only be used one at a time. This is reflected in DCD Table 19.1-8 which adds SBO and GRID-SBO in the “Event Tree” column of the “1 of 2 SI pumps” success criteria row, and also in the edited version of Note 2 which provides this clarification.

- o Finally, to keep the table notes in order from top to bottom of the table, the new “Note 2” described above was added to the table. This resulted in the DCD Table 19.1-8 notes 2 and 3, being changed to notes 3 and 4. Notes 3 and 4 were also slightly edited to provide consistency in wording in the four notes (i.e., Condition A impacts component B. Therefore, the success criteria is effectively X of Y available components). Finally, Note 4 was also edited to provide clarification with respect to the conservative hot leg injection criteria used in the PRA.

**Impact on DCD**

The DCD Tier 2, Table 19.1-8 and Table 19.1-12 will be marked up as shown in the Attachment 1 and Attachment 2.

**Impact on PRA**

There is an impact on the PRA. But it is very small and will not impact risk insights. This response will be reflected in the next revision of 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 Environment Report.

APR1400 DCD TIER 2

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Table 19.1-8 (4 of 6)

, PLOCCW, PLOESW, TLOCCW, TLOESW

Top Event	Top Event Description	Success Criteria	Event Trees
RCS Heat Removal			
SIT	Safety Injection Tanks inject borated water	2 of 4 SITs inject borated water ← (1)	LLOCA
SIS	SI pumps provides high pressure injection to make up lost RCS inventory	1 of 4 SI pumps provides DVI injection	FWLB, LSSB-D, LSSB-U, MLOCA, SGTR, SLOCA, PR-SL
		1 of 2 SI pumps provide DVI injection <sup>(+)</sup> ← (2)	PLOCCW, PLOESW ← SBO, GRID-SBO
		2 of 4 SI pumps provide DVI injection ← (1)	LLOCA
SCSI	SC pump injection to RCS	1 of 2 SCS pumps provides injection from IRWST	SGTR, SLOCA
RF	IRWST refill during SGTR	Refill IRWST with borated water using CVCS	LSSB-D, SGTR
	SI pump injection for feed and feed decay heat removal	1 of 4 SI pumps provides DVI injection	FWLB, GRID-LOOP, GTRN, LOCV, LOFW, LOIA, LSSB-D, LSSB-U LOOP, SBO, PLOCCW, PLOESW ←
FEED		1 of 3 SI pumps provides DVI injection <sup>(+)</sup> ← (3)	LODCA, LODCB
		1 of 2 SI pumps provides hot leg injection <sup>(+)</sup> ← (4)	LLOCA
SDC	Shutdown cooling for long-term heat removal	1 of 2 SCS pumps provides injection from hot leg	LSSB-D, SGTR

~~LODCA<sup>(2)</sup>, LODCB<sup>(2)</sup>~~

- ~~(1) The division 1 of SI pumps are unavailable because PLOCCW or PLOESW causes the HVAC failure for division 1 of SI pumps. Therefore, the success criterion is 1 of 2 SI pumps on PLOCCW or PLOESW.~~
- ~~(2) One train of SI pumps is unavailable because LODCA or LODCB causes the starting failure of one train of SI pump. Therefore, the success criterion is 1 of 3 SI pumps on LODCA or LODCB.~~
- ~~(3) Two trains of SI pumps are used for Hot Leg Injection. Therefore, the success criterion is 1 of 2 SI pumps for Hot Leg Injection.~~

replace "A" in the next page

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- (1) For DVI line LLOCA, the SI Tank and Pump associated with the broken DVI line is assumed lost out of the break. ~~For cold leg LLOCA, the SI Tank and Pump which injects nearest the broken cold leg is assumed lost out of the break.~~ Hence, for these two LLOCAs, the success criteria is effectively 2 of 3 available SI Tanks and 2 of 3 available SI pumps.
- (2) The AAC can only power the A or B SI pump. Hence, for SBOs with the AAC available, ~~the~~ criteria is effectively 1 of 2 DVI available SI pumps.
- (3) LODCA or B causes fail to start of SI pump A or B. Therefore, for LODCA or B, the success criterion is effectively 1 of 3 available SI pumps.
- (4) For hot leg LLOCA, the SI Pump associated with the broken hot leg is assumed lost out of the break. Hence, for hot leg LLOCA, the success criterion is effectively 1 of 1 available SI pump.

APR1400 DCD TIER 2

Table 19.1-12

RELAP Thermal-Hydraulic Run Summaries

Two

Case	LOCA Size	Available Components	Other Initial and Boundary Conditions	Peak Fuel Temperature	Results	ASC Initiation
Large Break Loss of Coolant Accident – Safety Injection						
1(a)	Double-ended rupture (30 inch diameter)	Three Safety Injection pumps Two Injection tanks	No Charging pumps No Auxiliary Feedwater pumps No Containment Spray pumps No Shutdown Cooling pumps (Sensitivity analysis with location is performed )	< 1400 K ( < 2060°F)	Core damage prevented	N/A
Small Break Loss of Coolant Accident – ASC Timing						
1(b)	2 inch (0.02 ft2)	One Safety Injection tank	One AFW pump One SC pump One Atmospheric Dump Valve No Safety Injection pumps No Charging pumps No Containment Spray pumps	< 998.4 K	Core damage prevented	40 min
Double Ended Steam Generator Tube Rupture – ASC Timing						
1(c)	0.75 inch (one U-tube)	MSSVs	One AFW pump One SC pump	< 640 K	Core damage prevented	23 hrs
1(d)	double-ended rupture)	One ADV opens on the ruptured SG	One Atmospheric Dump Valve No Safety Injection pumps No Charging pumps No Containment Spray pumps No Safety Injection Tanks	< 640 K	Core damage prevented	5 hrs