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.:	**232-7864**
SRP Section:	**19 - Probabilistic Risk Assessment and Severe Accident Evaluation**
Application Section:	**19**
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Question No. 19-7

10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design specific PRA and the results. To review the LPSD large release frequencies (LRFs), the staff reviewed the assumptions in DCD Section 19.1.6.2.2.5, "Key Assumptions." One of the assumptions states, “B. Failure of hydrogen control from PARs and/or igniters is assumed to yield a conditional probability of containment rupture due to hydrogen detonation of 0.1, plus another conditional probability of containment rupture due to hydrogen burn of 0.1 or 0.01. These probabilities are believed to be conservative, but additional calculations are needed for confirmation.” The staff is requesting that the applicant provide in the DCD the results of the additional calculations documenting the conditional containment failure probability due to hydrogen which impact the total LRF. The staff needs to compare total LRF against the Commission goals for new reactors as directed in the SRP for Chapter 19.

Response – (Rev. 2)

The key assumption in the DCD was not worded properly. The LPSD Level 2 notebook documents that the late containment failure (LCF) decomposition event tree (DET) was developed with the assumption that for sequences in which detonable levels of hydrogen are credible, failure of PARS yielded a guaranteed rupture of containment (conditional probability of 1.0). Assumption B in DCD Section 19.1.6.2.2.5 should read that for sequences with success of PARS, the probability of containment rupture would be 0.1 due to hydrogen burns, and then another conditional probability of 0.1 given that a burn did not rupture containment. Since the time of the original DCD writing, detailed calculations have been performed on the potential for hydrogen accumulation in LPSD scenarios. The analysis considered various LPSD accident sequences with and without cavity flooding, containment sprays, hydrogen igniters and PARS. Deflagration was considered occur early and/or late, depending on conditions in containment, but was found not to have any significant contribution to containment failure probability. The analysis determined that with either the igniters or PARS available, neither global nor local hydrogen concentrations exceed 10%. Without igniters or PARS, some scenarios yield higher

hydrogen concentrations and the potential for detonation or deflagration to detonation (DDT), though in most cases the pressure transient is not large.

Therefore, the LPSD Level 2 approach to containment failure due to hydrogen effects has been demonstrated to be conservative. For sequences with failure of PARS and a credible potential for hydrogen/steam concentrations to yield hydrogen detonation, the conditional probability of containment rupture is 1.0 in DET LCF. For sequences with success of PARS and low steam concentrations, a detailed analysis demonstrated that detonatable levels of hydrogen would not occur, but the LPSD Level 2 conservatively assigned a conditional probability of 0.1 for containment rupture due to hydrogen burns or detonation.

The LPSD Level 2 notebook (APR1400-K-P-NR-013762-P, Rev.0) will be revised (See Attachment 3). COL 19.2(2) will be deleted in the Attachment 2 because it has no relation.

Impact on DCD

Item B in DCD 19.1.6.2.2.5 and Table 19.1-4 will be revised as shown in the Attachment 1 and 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 any Technical/Topical/Environmental Report.

An importance analysis of the LPSD key CCF basic events with respect to LRF sorted by RAW is presented in Table 19.1-143. The same list sorted by Fussell-Vesely is presented in Table 19.1-144.

An importance analysis of the LPSD key operator action basic events with respect to LRF sorted by RAW is presented in Table 19.1-145. The same list sorted by Fussell-Vesely is presented in Table 19.1-146.

The source term category contributors to the internal events LPSD LRF are presented in Table 19.1-147.

19.1.6.2.2.5 Key Assumptions

A. The LPSD internal events Level 1 analysis did not credit offsite power recovery for LOOP sequences that did not result in SBO (offsite power recovery was credited for the SBO sequences). In the Level 1 analysis, the impact on CDF was not large, but it had a greater impact on LRF. Therefore, the Level 2 analysis did credit offsite power recovery in non-SBO LOOP sequences in order to present a more realistic LRF.

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B. ~~Failure of hydrogen control from PARs and/or igniters is assumed to yield a conditional probability of containment rupture due to hydrogen detonation of 0.1, plus another conditional probability of containment rupture due to hydrogen burn of 0.1 or 0.01. These probabilities are believed to be conservative, but additional calculations are needed for confirmaton.~~

C. No credit was taken for the external reactor vessel cooling (ERVC) system. This is conservative, especially for LPSD, since RCS pressure would be low at the time of core damage and the decay heat levels are low. Crediting ERVC system would reduce the LPSD LRF.

D. The containment equipment hatch can be secured in LPSD POS with four bolts, but this provides a lower containment ultimate pressure capacity than is credited in the at-power Level 2 analysis. The LPSD analysis assumed that the LPSD hatch configuration can withstand a containment pressure of 80 psia (65.3 psig). In MAAP calculations to determine if ECSBS could be credited, the containment

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For sequences with low steam concentrations and a significant generation of hydrogen, failure of hydrogen control from PARs and/or igniters is conservatively assumed to yield a conditional probability of containment rupture due to hydrogen detonation of 1.0 in the late containment failure (LCF) decomposition event tree. For similar sequences with success of PARS, a detailed evaluation has shown that hydrogen accumulation does not reach appreciable levels. However, for conservatism, the LPSD Level 2 analysis assumes such sequences have a 10% probability of containment rupture due to hydrogen burns, plus an additional 10% probability of containment rupture due to hydrogen detonation, given no failure due to burns. These probabilities have been demonstrated to be conservative.

Table 19.1-4 (26 of 26)

No.	Insight	Disposition
	Risk Insights from PRA Models	
66	The COL applicant is to demonstrate that HCLPF capacity is equal to or exceed 1.67 times the GMRS for site-specific structures (ESWIS and CCW Hx Building) and HCLPF capacity is equal to or exceeds 1.67 times the CSDRS for BOP components, and is to complete the SEL. At the design certification phase, specific design data for the BOP components such as material properties, analysis results, qualification test information, etc. are not available. Appendix E of EPRI-NP-1002988 (Reference 58) presents example calculations showing that the equipment designed for 0.25g SSE can have 0.5g or higher HCLPF considering the conservatism in the design process. The EPRI-NP-6041 (Reference 39) indicates that Seismic Category I concrete structure and BOP equipment can have 0.5g HCLPF as long as the structure and the equipment are designed in accordance with the current code and standard and the anchorage is rugged. The generic fragility data provided by the Electric Power Research Institute (EPRI) Utility Requirements Document (Reference 37) show the BOP components have HCLPF capacities higher than 0.5g. The COL applicant is to demonstrate that failure of buildings that are not seismic Category I (e.g., turbine building and compound building) does not impact SSCs designed to be seismic Category I.	COL 19.1(8) COL 19.1(22)
67	The flood PRA assumes that maintenance-induced flooding events is an insignificant contributors to overall flood risk.	Subsection 19.1.5.3.1.5 Subsection 19.1.6.4.1.2 COL 19.1(17)
68	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
69 ##	The HG design is composed of 30 PARs and 8 igniters. The LPSD Level 2 PRA assumes that the 25% of the PARs are unavailable due to test and maintenance. The remaining 75% of the PARs and all of the igniters are available during LPSD conditions.	Subsection 19.1.6.1.1.5 COL 13.5(7) ~~COL 19.2(2)~~

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