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.:	**418-8348**
SRP Section:	**SRP 19**
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Question No. 19-50

10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design specific PRA.

SRP Chapter 19.0, Revision 3 (Draft), Section “II. Acceptance Criteria,” states that the staff determines whether, “…the technical adequacy of the PRA is sufficient to justify the specific results and risk insights that are used to support the DC or COL application. Toward this end, the applicant’s PRA submittal should be consistent with prevailing PRA standards, guidance, and good practices as needed to support its uses and applications and as endorsed by the NRC (e.g., RG 1.200).”

According to the DCD, in cases where there is a potential for more than one fire-induced initiator to occur in a given fire compartment, the applicant established a hierarchy of initiating events “wherein perceived worst-case initiators were given preference over lesser initiators.” Please provide additional basis in the DCD for establishing this hierarchy and how this assumption may impact the PRA.

Response – (Rev.1)

DCD 19.1.6.3.1.3 will be revised to include additional information on the selection of fire-induced initiators.

In addition, the reason why the loss of DC bus is not a LPSD Fire initiating event is provided below.

First, note that LPSD Fire is only analyzed in POS 3 - 6 and 10 - 13. POS 1, 2, 7, 8, 9, 14 and 15 are screened from the analysis (refer to DCD Section 19.1.6.3.1.2, paragraphs o. and p.)

During POS 3 - 6 or 10 - 13, a loss of any DC bus for any reason (i.e., either random failure or by fire) has no impact on the continued operation of the running SC train or its supporting systems as there are no DC power requirements on these operating systems. Loss of DC could impact the ability to align and/or start the opposite; however, since there is no initiating event, there is no need to align/start the opposite train.

Regarding the potential impact of loss of DC on overdrain during POS 5 and 11, note that the draindown is accomplished through the letdown line, and the air operated valves (AOVs) controlling the flow (parallel path AOVs CV-201P and CV-201Q) fail closed upon loss of control power. In fact, the following additional letdown line AOVs also fail closed upon loss of control power: letdown AOVs CV-515 and CV-516, letdown line containment isolation valves CV-522 and CV-523. Hence, loss of DC power can interrupt the draindown, but cannot prevent failure to isolate. Therefore, a loss (either random or fire-induced) of DC power either has no impact on draindown, or actually prevent an overdrain event by closing one or more of the letdown line AOVs. Premature interruption of the draindown is not an initiating event.

In conclusion, a loss of DC during POS 3 - 6 or POS 10 - 13 neither results in the interruption of SC, nor causes an overdrain event; hence, it is not an initiating event. This is consistent with the LPSD internal events analysis.

Impact on DCD

DCD 19.1.6.3.1.3 will be revised as stated in the response as shown in the 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 Environment Report.

SO – Overdrain events (POS 5 and 11 only)

JL – CVCS letdown line diversion LOCA

CC – Loss of operating component cooling train

KV – Loss of 4 kV bus on operating shutdown cooling train

LP – Loss of offsite power impacting operating shutdown cooling train

AS – Fire-induced main control room evacuation (alternate shutdown)

LPSD initiator fault tree models have been created for all systemic initiators, and any new equipment added to support these initiator fault trees has been included in Task 2. The flag files used during quantification to fail fire-damaged equipment in each fire compartment were updated to include any new equipment identified in Task 2 (included events added for LPSD initiator fault tree models), and any new cables added in Task 3.

During the development of the systemic initiator fault trees, it was identified that the spurious operations that could cause an SL event are the same that could cause an SO event. These two initiators are only applicable to POS 5 and 11, and are functionally the same initiator for fire scenarios since: 1) the flow diversion pathway is the same, 2) the mitigation scheme is identical, and 3) operator action timing is the same. For this analysis, the SL event is used to represent these failures.

Then,

for each POS

f

~~B~~ased on the potential for equipment damage in each fire compartment, ~~a list of potential fire-induced initiating events in each fire compartment has been developed~~. ~~F~~or each fire compartment, a single initiator is chosen based on the most likely fire~~, or engineering judgment~~. If there is the potential for more than one fire-induced initiator solely due to fire damage, engineering judgment is used to determine the representative initiator. A hierarchy was established wherein perceived worst-case initiators were given preference over lesser initiators. The hierarchy used is:

during a POS

b

in that compartment during that POS

~~AS >~~ SL > LP > KV > S2 or CC ~~> JL~~ with JL included as described below

~~Note that AS is only applicable to fires involving the MCR and SL is only applicable to POS 5 and 11. Also, note that S2 and CC are functionally equivalent, since CC's only~~

Concerning MCR fires, all scenarios resulting in MCR evacuation are assumed to result in an AS event; no other event is applicable to fires involving MCR evacuation.
For all other fire scenarios, a list of potential fire-induced initiating events in each fire compartment has been developed

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~~modeled function during LPSD is cooling the shutdown cooling heat exchangers, and direct fire-induced loss of shutdown cooling is functionally the same as fire-induced loss of CC (or SX).~~

new text is added as shown in A

Task 6, fire ignition frequency development, was accomplished in a two-step process. Step 1 involved updating the fire ignition frequency spreadsheet used in the FP-FPRA with the LPSD generic frequencies from Table 2 of NUREG/CR-7114. Step 2 involved updating the maintenance, occupancy, and storage transient fire influencing factors, using engineering judgment to identify fire compartments where these influencing factors will likely increase during the outage. The result of these two steps is a recalculation of the fire compartment initiating event frequencies for LPSD conditions. All assumptions or deviations from the NUREG/CR-6850 methodology for determining fire ignition frequencies taken in the FP-FPRA (see Subsection 19.1.5.2.1.3) are assumed applicable to the LPSD FPRA.

Task 7 screens fire compartments from further detailed analysis. Risk-significant fire compartments have been identified by inspection of preliminary CDF calculations, and resulted in the main turbine building area, fire compartment F000-TB, being the only fire compartment chosen for detailed analysis. Note that the MCR, fire compartment F157-AMCR analysis is performed in accordance with the NUREG/CR-6850, Task 11 methodology.

The Task 10 failure mode likelihood analysis conservatively sets all potential spurious operations have assumed to occur.

Task 8 fire scoping modeling and Task 11 detailed fire modeling have not been performed due to lack of sufficient data related to the relational location of the ignition sources and their targets (including intervening combustibles). Therefore, for single-compartment fire analyses, all unsuppressed fires are assumed to propagate throughout the entire compartment (damaging all PRA-credited equipment within the compartment). For multi-compartment scenarios, in addition to propagating throughout the exposing compartment (i.e., compartment in which the fire initiated), fire spread is assumed to propagate through barriers at the probabilities associated with the respective barriers under consideration. Generic barrier failure probabilities from NUREG/CR-6850 were used to calculate barrier failure probabilities between adjacent compartments.

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A(1/2)

The basis for the hierarchy starts with the fact that the LP, KV, S2 and CC events all result in failure of the running SC train which do not impact the RCS or reactor cavity water levels, whereas SL and JL also result in a decrease of the water level.

The SL event is only applicable by definition in reduced inventory POSs 5 and 11. In addition to restoration of SC, inventory make-up and isolation of the flow diversion is required, or else feed and bleed is required. The perceived relative severity of the SL event is due to the initial low RCS level in POS 5 and 11 resulting in relatively shorter operator action times. Hence, SL is deemed to be more severe than LP, KV, S2 or CC events during POS 5 and 11.

LP, KV, S2 and CC all deal with the failure of the operating train of SC, where S2 and CC are functionally equivalent. Since CC's only modeled function during LPSD is cooling the shutdown cooling heat exchangers, direct fire-induced loss of shutdown cooling is functionally the same as fire-induced loss of CC (or SX). The selection of CC or S2 is based on engineering judgement considering the failed equipment. For example, if CC fails due to direct fire damage to the CC pump and S2 fails due to spurious operation, then CC is selected since the fire damage is "guaranteed" whereas the S2 spurious operation is not a guaranteed failure (i.e., fire-induced spurious operation is usually represented as a probability).

Regarding KV, the 4 kV bus which fails the operating SC train, also fails other equipment powered by that bus; hence, the KV event would be more challenging than the S2 or CC events. Likewise, with LP, offsite power is lost to at least the entire division supporting the operating SC train (not just a single train), requiring the DGs to supply 4 kV power to the division. Additionally, if the LP event fails both divisions of offsite power, conditional failure of the DGs results in an SBO requiring power from the AAC. Therefore, LP is considered to be more challenging than the KV event. Finally, note that these four events are only applicable during the POSs in which the affected train is operating. Based on the LPSD assumed operating schedule, SC train A is operating during POS 3 – 7, and SC train B is operating during POS 9 – 13. Hence, if the fire only impacts SC train B during POS 5, there is no initiating event since SC train A is unaffected.

Regarding JL, there is many similarities with the SL event, except that the JL event can occur during any POS. Since SL is restricted to POS 5 and 11, for fire scenarios when both SL and JL are possible, the SL event is selected during POS 5 and 11, and the JL event is selected for all other POSs. Note that both the event tree structure and HRA of the SL and JL events is identical in POS 5 and 11 (Reference 7); hence, there is no CDF or LRF impact due to this use of engineering judgement, and the only impact is on the distribution of CDF and LRF between JL and SL.

A(2/2)

The application of the JL event in POSs other than 5 and 11 is based on the fact that the JL event can occur in any POS while the LP, KV, S2 and CC events only occur when the operating train is damaged. In addition, the JL event assumes an unrecoverable loss of RCS water outside containment. For fires, since fire-induced pipe break is not credible, the JL event can only be caused by equipment damage diverting the water from the RCS; hence, for POSs with higher initial water levels (i.e., POSs other than POS 5 and 11), the JL event may actually be recoverable if the operators re-route the water back to the RCS, and/or isolate the spurious operation causing the diversion; however, this is not credited. Additionally, although not credited, in reality, natural clearing of the hot short may isolate the JL event.

Hence, for fire scenarios when both JL and either LP, KV, S2 or CC occur, JL is assumed for the POSs where the LP, KV, S2 or CC event would not occur. For example, if a fire scenario results in damaging equipment which could both result in a JL event and fail the SC A train, the S2 event would be assumed during POS 3A – 6 (because the A train of SC is assumed to be the operating train in these POSs), and JL is modeled for POS 10 – 13.