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**
Application Section:	**19.1**
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Question No. 19-46

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)."

The staff reviewed DCD, Tier 2, Figure 9.5A-3, and found that the large emergency diesel engine fuel oil system storage tanks appear to be located in or adjacent to the auxiliary building. The staff is not clear if these fuel oil storage tanks have been evaluated as potential combustible sources that can significantly exacerbate a potential fire scenario occurring in their vicinity. Therefore, in order for the staff to reach a reasonable assurance finding, please address the following items:

a) Include in the DCD, an assessment of the potential combustible source's impact to the APR1400 internal fire risk

b) Justify the exclusion of the potential for an ignition source to cause a secondary ignition of oil that might leak from the tank, either randomly or as a result of the tank being heated and possibly breached

c) Identify any communication paths between the rooms housing the fuel oil storage tanks and other rooms housing important equipment

d) Clarify the possibility of fire, smoke, gas, etc., to affect nearby compartments, including the remote shutdown panel and the main control room

e) Describe the potential consequence of such a scenario, irrespective of the likelihood of such scenario involving the large fuel oil storage tank.

Response

Each diesel fuel oil storage tank (DFOST) is designed for a 7-day supply to its associated EDG, without relying on the associated fuel oil day tank inventory, plus a margin for periodic testing of the associated EDG. The diesel fuel oil storage tanks are designed and fabricated in accordance with ASME Section III. Fittings are provided for tank level instrumentation, venting, sampling, and water removal. Flanged openings are provided as manholes for access to the tank interior. Each diesel fuel oil storage tank is located inside a concrete structure to contain oil spills, and it is equipped with a vent line with a flame arrester and a level transmitter. The vent line flame arresters protect the tanks from an external open fire. A sufficient space around each diesel fuel oil storage tank is provided for inspection, maintenance, and repair of the system. (DCD Section 9.5.4.2.2.1).

The DFOSTs are not considered as ignition sources in NUREG/CR-6850 (see NUREG/CR-6850 Table 6-1 “Fire Frequency Bins and Generic Frequencies”). Since the fire frequency bins are based on operating experience, one can surmise that there have been no DFOST fires during the period covered in the fire events database, and the authors assumed that these are not credible fire sources. This has been consistent in many iterations of fire data analysis (e.g., EPRI TR-1003111, NUREG/CR-6850, EPRI 1016735, NUREG-2169, etc.)

The only ignition source in these fire compartments (F065-A01C and F065-A01D) is one (1) ventilation fan in each room (which by examination of plant general arrangement drawings are about 10-15 feet from the tank), and transient sources (including welding and cutting fires) which can occur anywhere in these rooms. There are other small pumps (diesel oil transfer pumps and DFOST room sump pumps) in the room which are too small (< 5 hp) to be considered as an ignition source (Section 6.2.2 of EPRI 1019259 / NUREG/CR-6850, Supplement 1).

There are pre-action sprinkler systems in these two rooms covering the DG fuel oil storage tanks and fuel oil transfer pumps areas; additional fire suppression capability is provided by portable extinguishers (DCD Sections 9.5A.3.2.18 and 9.5A.3.3.18). Fire suppression is currently not credited in these rooms in the APR1400 fire PRA due to low screening CDF.

All flammable liquid tanks in buildings containing safe shutdown equipment were considered as potential ignition sources in the seismic-fire interaction assessment, APR1400-K-P-NR-013455-P. The tanks and their associated piping were all deemed seismically rugged based on their seismic Category, and therefore deemed unlikely to fail and release their contents during a seismic event; based on this, they were judged to be not significant to seismic-fire risk.

The following specifically addresses the NRC questions regarding the DFOSTs impact:

a) The DCD is revised to include an assessment of the potential combustible source's impact to the APR1400 internal fire risk (see Attachment 1)

b) The PRA does not exclude the potential for any ignition source to cause a secondary ignition of oil that might leak from the tank or any other intervening combustible. Rather, any fire in any compartment, regardless of the size or location, is assumed to result in a "full room burnout scenario" (DCD Section 19.1.5.2.1.3 for Full Power fire analysis, and DCD Section 19.1.6.3.1.1 item c. for LPSD fire analysis.) where every fire PRA credited component in the room is assumed to fail. This inherently assumes that either the ignition sources are sufficiently large, or that there is some intervening combustible (e.g., spilled oil, etc.) which contributes to fire failure of all equipment in the room.

Hence, for fires in the DFOST fire compartments (F065-A01C and F065-A01D), all equipment is assumed failed regardless of whether or not any oil is leaked from the tanks. Based on the assumption of full room burnout, and taking no credit for automatic or manual suppression, the fire induced single compartment CDF for each of these rooms is still only about ~1E-11.

c) The potential for fire spread to adjacent compartments was considered in the multi-compartment analysis which includes the identification of the barriers and communication paths between adjacent fire compartments.

Spread to adjacent compartments requires either an unextinguished fire of sufficient magnitude to result in a hot gas layer which can travel through failed/unavailable fire barriers, or spread of flammable fluids (e.g., diesel fuel oil) through failed/unavailable barriers. Per DCD Section 9.5.4.2.2.1, each DFOST is located inside a concrete structure to contain oil spills, and per DCD Sections 9.5A.3.2.18 and 9.5A.3.3.18, the DFOST rooms have substantial concrete walls that are designed to seismic Category I criteria, and may provide more than 3-hour fire resistance. Review of the Fire Barrier DBD drawings, specifically 1-322-A108-030, Rev. 0 shows that the DFOST room's floors are also 3-hour rated. Additionally, although not specifically labeled on the general arrangement drawings, the wall and floor thickness between the DFOST rooms and adjacent Auxiliary Building rooms can be estimated at about 4 feet thick by scaling known dimensions on these drawings. Further review of plant general arrangement drawings show no access into the DFOST rooms except through the ceiling (a ladder up to roofs of the DFOST rooms which is at ground elevation), and stairwells up into the DFOST room entrance areas (fire compartments F100-A43C and F100-A43C from DFOST rooms F065-A01C and F065-A01D, respectively). Hence, there is no flow path for any spilled oil, and the only credible mechanism for fire spread is via hot gas layer spread through failed/unavailable barriers. A failed barrier in either DFOST room would either vent any hot gas layer to the outside atmosphere (if the ladder opening to the DFOST roof opens/fails), or into F100-A43C or F100-A43D. There are no known penetrations in the DFOST room's walls of floor, and the only known penetrations are on the roof.

The potential for fire spread from fire compartment F065-A01C to F100-A43C, and from fire compartment F065-A01D to F100-A43D were evaluated within the APR1400 fire PRA multi-compartment analysis. Both of these scenarios were screened using the qualitative screening criteria identified in Section 11.5.4.2 of NUREG/CR-6850. Specifically, a scenario may be screened if the fire PRA components and cables of the exposed compartment(s) are identical (or less than) those in the exposing compartment. In these cases, the fire spread does not result in the failure of any additional fire PRA cables or components. In addition, note that barrier failures leading to the roof were not considered as these would be beneficial failures (i.e., failure would vent the hot gas layer to the atmosphere).

d) As described in the response to c), above, the multi-compartment analysis addressed the impact of the potential spread of fire impacts to adjacent compartments. Like the single compartment analysis, the multi-compartment analysis considers all equipment in the exposed room to be damaged by the impacts of the fire (i.e., full room burnout scenarios). In addition, the impact of the fires and the products of combustion on local manual operator actions is addressed in the fire PRA (i.e., local manual operator actions are assumed to fail if impacted by the impacts of the fire).

   Specifically regarding smoke, it is assumed that smoke impact on equipment in either single compartment analysis or multi-compartment propagation is negligible. This is consistent with short term smoke damage guidance provided in NUREG/CR-6850, Appendix T, Section T.3.1., which states, “Short-term smoke damage will only result from a severe smoke exposure condition. For general compartment scenarios: Smoke exposures arising from a general compartment fire (e.g., general smoke spread within the room of fire origin or in an adjacent compartment) will not lead to short-term smoke damage, even for potentially vulnerable components.”

   Note that there is no credible communication path between the DFOST rooms (ceiling at about Elevation 100’) and the main control room (Elevation 157’) or remote shutdown room (Elevation 137’-6”). Fire spread to these areas would require failure of multiple 3 hour fire barriers, and failure of multiple automatic fire suppression systems.

e) Assuming that a fire in one of the DFOST rooms ignites a sufficient amount of spilled diesel fuel oil to form a hot gas layer capable of spreading to adjacent compartments, fire spread to an adjacent compartment is only possible if both the pre-action sprinkler system in the DFOST room failed, and there was a barrier failure. The most likely scenario would include failure of a fire door, fire damper, or penetration seal vs. failure of the ~4 foot thick 3 hour rated walls of floors. This would result in fire spread to either the outside (via the ceiling opening to the roof), or to the DFOST entrance rooms (F100-A43C and F100-A43D). In the case of fire spread to the outside, there is no additional plant impact beyond what is already evaluated with the single compartment scenario. In the case of fire spread to the entrance rooms, prior multi-compartment analysis already identified that there is no additional impact beyond what is already evaluated with the single compartment scenario (i.e., there is no additional fire PRA credited equipment damaged as a result of the fire spread).

   As previously stated in the answer to c), the DFOST rooms have substantial (~ 4 ft. thick) concrete walls and floors that may provide more than 3-hour fire resistance. Assuming failure of these substantial 3-hour rated barriers, the worst case scenario would involve fire wall or floor failure resulting in damage to equipment in the same division. So, even if this unlikely scenario happened, it would not result in damage to opposite division equipment, and as discussed above, neither the main control room nor the remote shutdown room should be directly affected by this fire.

Note that the above assessments are based on the reference plant (Shin Kori 3 & 4) cable database, and penetration information. When the APR1400 design information becomes available, the multi-compartment fire analysis will be revisited to update any information which has changed.

Impact on DCD

The DCD will be revised as shown in Attachment 1. In addition, COL 19.1(4) will be revised to ensure that fire barriers and fire barrier penetrations will be verified via review of as-designed and as-built information and/or walkdowns 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

The fire PRA report will be revised in the next PRA update to more fully describe fires in the DFOST rooms.

etc.). Potential MCA compartments are screened if the exposed compartment has no PRA-credited equipment since the resulting cutsets will be non-minimal to the exposing single-compartment scenario. In addition, potential scenarios involving either the main turbine building (F000-TB) or the containment building (F000-C01) are screened due to the size and geometry, which preclude the formation of a hot gas layer or oil fire spread. In total, 1,055 unscreened MCA scenarios are identified and evaluated. MCA scenarios account for about 14 percent of the CDF and 13 percent of the LRF.

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19.1.5.2.2 Results from the Internal Fire Risk Evaluation

The internal fire risk evaluation is performed using the design-specific fire protection features in Chapter 9, Appendix 9A and the internal events PRA model of Subsection 19.1.4.

The fire CDF and LRF for the APR1400 are as follows:

a. Fire CDF: 1.9×10^{-6}/year

   1) Single-compartment fire CDF: 1.6×10^{-6}/year

   2) Multi-compartment fire CDF: 2.6×10^{-7}/year

b. Fire LRF: 1.7×10^{-7}/year

   1) Single-compartment fire LRF: 1.5×10^{-7}/year

   2) Multi-compartment fire LRF: 2.2×10^{-8}/year

c. Conditional large release probability: 0.09

It should be noted that units for CDF and LRF are expressed in terms of “reactor calendar year” (shortened to “/year” when displayed in the text in this section).

19.1.5.2.2.1 Fire-Induced Initiating Events

Table 19.1-46 shows the percentages of fires resulting in each identified fire-induced internal event initiator, ranked highest to lowest. Table 19.1-47 and Table 19.1-48 present the CDF and LRF, respectively, for each fire-induced initiator ranked from highest to lowest. The results show that the vast majority of the plant fire frequencies result in

A

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COL 19.1(3) The COL applicant is to describe the uses of PRA in support of licensee programs, and identify and describe risk-informed applications being implemented during the operational phase. See Subsection 19.1.1.4.

fire barrier and fire barrier penetrations,

COL 19.1(4) The COL applicant is to review as-designed and as-built information and conduct walkdowns as necessary to confirm that the assumptions used in the PRA (including PRA inputs to RAP and SAMDA) remain valid with respect to internal events, internal flood and fire events (routings and locations of pipe, cable, and conduit), and HRA analyses (development of operating procedures, emergency operating procedures, and severe accident management guidelines and training), external events including PRA-based seismic margins and HCLPF fragilities, and LPSD procedures. See Subsection 19.1.2.2.

COL 19.1(5) The COL applicant is to conduct a peer review of the PRA relative to the industry PRA Standard prior to use of the PRA to support risk-informed applications, as applicable. See Subsection 19.1.2.3.

COL 19.1(6) The COL applicant is to describe the PRA maintenance and upgrade program. See Subsection 19.1.2.4.

COL 19.1(7) The COL applicant is to confirm that the PRA-based seismic margin assessment is bounding for the selected site, and to update the assessment to include site-specific SSC and soil effects (including sliding, overturning liquefaction, and slope failure). The COL applicant is to confirm that the as-built plant has adequate seismic margin. See Subsection 19.1.5.1.2.

COL 19.1(8) The COL applicant is address following issues with a site-specific risk assessment, as applicable:

- Dam failure
- External flooding
- Extreme winds and tornadoes
- Industrial or military facility