
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

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Question No. 19.03-24

NRC Commission paper SECY-12-0025 (February 17, 2012), “Proposed Orders and Requests for Information in Response to Lessons Learned from Japan’s March 11, 2011, Great Tohoku Earthquake and Tsunami,” stated that the NRC staff expected new reactor design certification or license applications (e.g., construction permit, operating license, and combined license) not yet then-submitted to address the Commission-approved Fukushima actions in their applications, prior to submittal, to the fullest extent practicable. In SECY-12-0025, the NRC staff outlined a three-phase approach regarding mitigation strategies to respond to beyond-design-basis external events (BDBEEs). The initial phase involved the use of installed equipment and resources to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling without alternating current power. The transition phase involved providing sufficient, portable, onsite equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from offsite. The final phase involved obtaining sufficient offsite resources to sustain those functions indefinitely.

The NRC staff provided guidance for satisfying the Commission directives regarding BDBEE mitigation strategies in Japan Lesson-Learned Project Directorate (JLD)-ISG-2012-01, Revision 0, “Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,” (ADAMS Accession No. ML12229A174). JLD-ISG-2012-01 endorsed with clarification the methodologies described in the industry guidance document Nuclear Energy Institute (NEI) 12–06, Revision 0, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide,” (ADAMS Accession No. ML12242A378). The guidance in JLD-ISG-2012-01 describes one acceptable approach for satisfying the Commission directives regarding BDBEE mitigation strategies.

NEI 12-06 Revision 0, Section 3.2.1.8 “Effects of Loss of Ventilations,” states that “The effects of loss of HVAC in an extended loss of ac power event can be addressed consistent with NUMARC 87-00 [Ref. 8] or by plant-specific thermal hydraulic calculations, e.g., GOTHIC calculations.” In Technical Report APR1400-E-P-NR-14005-P Table 5-9 “Conformance with NEI

12-06, Rev. 0,” the applicant states that the APR1400 FLEX strategy complies with NEI 12-06, Section 3.2.1.8.

APR1400-E-P-NR-14005-P, Section 5.1.2.3.1.1.2, “Phase 1-b (1 to 8 hours),” states that during phase 1 of full-power operation, up to 8 hours, additional cooling in MCR, electrical and I&C equipment rooms, TDAFWP rooms is not required based on heat-up calculations. Also, APR1400-E-P-NR-14005-P, Section 5.1.2.3.1.2.1, “Basic Operational Strategy,” states that during phase 2 of full-power operation, 8 to 72 hours, additional cooling in MCR, electrical and I&C equipment rooms, TDAFWP rooms, and ACP room is not required based on heat-up calculations. Additionally Table 5-7, “APR1400 Flex Capability Summary,” discusses HVAC as a support function and states that “no cooling is necessary for MCR, electrical and I&C equipment room, ACP room and the TDAFWP room as the heatup temperature does not exceed the design temperature of the room during BDBEE.”

This RAI is to request clarification on the acceptance criteria used to assess the effects of a loss of heating, ventilation, and air conditioning to satisfy equipment functionality, control room operator habitability, and personnel accessibility. As part of the response, discuss if opening doors to an affected cabinet or area (e.g., pump room) is included as part of the strategy to ensure that equipment failure does not occur as a result of a loss of forced ventilation/cooling or that an area is habitable or accessible for required operator actions.

Response

Acceptance Criteria

The purposes of the room heatup calculations are to 1) determine the maximum temperatures in the main control room (MCR), technical support center (TSC), essential electrical and I&C equipment rooms housing post-Fukushima event mitigation equipment, turbine-driven auxiliary feedwater pump (TDAFWP) rooms, and auxiliary charging pump (ACP) room, and 2) demonstrate that the maximum temperature of the each room does not exceed the maximum allowable temperature during 72 hours assuming a loss of HVAC system.

NEI 12-06, Revision 0, Section 3.2.1.8 “Effects of Loss of Ventilation,” states that the effects of loss of HVAC in an extended loss of ac power event can be addressed consistent with NUMARC 87-00. Therefore, the acceptance criteria for the APR1400 are set with reference to NUMARC 87-00, Revision 1.

In NUMARC 87-00, the dominant areas are separated into three distinct conditions.

Equipment located in Condition 1 rooms is considered to be of low concern with respect to elevated temperature effects and will likely require no special actions to assure operability.

Condition 1 is defined by a steady state temperature of 120°F. For most mechanical and electrical equipment and instrumentation in Condition 1 dominant areas, temperature rises up to 120°F would likely not adversely affect operability.

Equipment located in Condition 2 rooms generally requires no forced cooling to assure operability. Condition 2 is defined by a steady-state temperature of 150°F, which is more typical

of rooms containing steam-driven makeup pumps, such as RCICS and AFWS, which are generally qualified or designed to operate in elevated temperatures.

Equipment located in Condition 3 rooms requires plant-specific treatment of the potential for thermal-induced failure.

NUMARC 87-00 also states that it is not expected that operator actions would be impacted significantly by projected temperature and humidity conditions, and further, that a dry bulb temperature of 110°F appears to be a conservative limit for control room habitability.

In APR1400, the maximum allowable temperature of each room is decided based on the steady-state temperature of Conditions mentioned in NUMARC 87-00.

The essential electrical and I&C equipment rooms are classified into Condition 1 of NUMARC 87-00. The maximum allowable temperature of the essential electrical and I&C equipment rooms is decided as the Condition 1 temperature, 120°F.

The ACP room and the TDAFWP rooms are classified into Condition 2 of NUMARC 87-00. The maximum allowable temperature of the ACP room and the TDAFWP rooms is decided as the Condition 2 temperature, 150°F.

The maximum allowable temperatures of the MCR and TSC are decided as 110°F for habitability.

The maximum allowable temperatures of each room being analyzed are listed as follows:

Room	Maximum Allowable Temperature (APR1400)	Condition/Temperature (NUMARC 87-00)
MCR and TSC	110°F	110°F for habitability
ACP Room	150°F	Condition 2 / 150°F
TDAFWP Rooms	150°F	Condition 2 / 150°F
Essential electrical and I&C equipment rooms housing post-Fukushima event mitigation equipment	120°F	Condition 1 / 120°F

Heatup Calculation Procedure

The GOTHIC (Generation of Thermal-Hydraulic Information for Containments) program is used to perform heatup calculations. The heatup calculation procedure for rooms housing post-Fukushima event mitigation equipment is as follows:

1. Perform heatup calculation on rooms with their doors closed and no operator taking actions such as opening doors, in the perspective of conservative design.
2. Compare the heatup calculated temperatures of rooms with the maximum allowable temperature.
3. A) If the heatup calculated temperatures of rooms with their doors closed are lower than the maximum allowable temperatures, those calculated temperatures are considered as the maximum temperatures of the rooms during 72 hours assuming a loss of HVAC system. In this case, additional cooling in the room is not required.

B) If the heatup calculated temperatures of rooms with their doors closed exceed the maximum allowable temperatures, a second heatup calculation is performed on those rooms with their doors opened. The second resultant temperatures are considered as the maximum temperatures of the rooms during 72 hours assuming a loss of HVAC system, and if those secondary temperatures do not exceed the maximum allowable temperatures, additional cooling is not required as long as operators open the doors.

C) If the maximum temperatures that are derived with the room doors opened also exceed the maximum allowable temperatures of the rooms, additional cooling shall be considered.

Result and Conclusion

The heatup calculation result showed that all rooms, except for the electrical equipment room (120-P20), did not exceed the maximum allowable temperatures with their doors closed. Thus, it was decided that additional cooling for these rooms was not required based on the heatup calculation.

The temperature of the electrical equipment room (120-P20), 123.2°F, exceeded the maximum allowable temperature of 120°F with the door closed. In the second calculation, with its door opened according to the above procedure, the resultant temperature was below the maximum allowable temperature. Therefore, it was decided that additional cooling for this room is not required, either. If an operator opens a door of this room during 0 to 8 hours because this room houses equipment required to operate during phase II, 8 to 72 hours, the maximum temperature of this room during 72 hours assuming a loss of HVAC system does not exceed the maximum allowable temperature.

KHNP concludes that additional cooling in the MCR, TSC, essential electrical and I&C equipment rooms, ACP room, and TDAFWP rooms is not required based on the results of the heatup calculations.

The operator will open doors of rooms housing post-Fukushima event mitigation equipment to decrease the maximum temperature. The operator will also open cabinet doors containing instrumentation in the MCR to maintain internal cabinet temperatures in equilibrium with the MCR temperature in accordance with NUMARC 87-00.

Room heat-up calculation for rooms housing post-Fukushima event mitigation equipment of APR1400 DC was uploaded in the Electric Reading Room (ERR) as described below.

- -1 Calculation BOP Design / 14 Room heatup calculation
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Impact on DCD

There is no impact on the DCD.

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 Environmental Report.