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.:	**134-8033**
SRP Section:	**08.03.01 – AC Power Systems (Onsite)**
Application Section:	**08.03.01**
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Question No. 08.03.01-12

DCD, Tier 2, Table 8.1-2 (page 2 of 8) refers to applicable sections of Rule 10 CFR 50.34 (f) related to TMI Action Items. The Table also shows that it is also applicable for 8.3.2. However, in Section 8.3.1.1.2, Class 1E Onsite AC Power System, it is noted that except for TMI Item II.E.3.1, other TMI Action Items (TMI Item I.D.3, and TMI Item II.G.1) are not discussed. Please clarify and confirm that these TMI Action Items are considered as the basis for Analysis Sections 8.3.1.2, and 8.3.2.2 as applicable.

Response

KHNP confirms that TMI Items I.D.3 and II.G.1, as well as II.E.3.1, are considered in the design of the Class 1E onsite ac and dc power systems. KHNP will add Subsections 8.3.1.2.3 and 8.3.2.2.3 to include discussion on the above mentioned TMI items.

Impact on DCD

DCD Tier 2, Table 1.9-4, Subsections 8.3.1.1.2, 8.3.1.2, and 8.3.2.2 will be revised 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 Environmental Report.

Table 1.9-4 (3 of 11)

10 CFR 50.34(f) Item / Issue No.	Requirements	Conformance Discussion	DCD Tier 2 Section
(2)(i) / I.A.4.2	Provide simulator capability that correctly models the control room and includes the capability to simulate small-break LOCAs.	Not applicable (COL)	N/A
(2)(ii) / I.C.9	Establish a program, to begin during construction and follow into operation, for integrating and expanding current efforts to improve plant procedures. The scope of the program shall include emergency procedures, reliability analyses, human factors engineering, crisis management, operator training, and coordination with Institute of Nuclear Power Operations (INPO) and other industry efforts.	Not applicable (COL)	N/A
(2)(iii) / I.D.1	Provide, for Commission review, a control room design that reflects state-of-the-art human factors principles prior to committing to fabrication or revision of fabricated control room panels and layouts.	The APR1400 conforms with this TMI-related requirement.	18.7
(2)(iv) / I.D.2	Provide a plant safety parameter display console that displays to operators a minimum set of parameters defining the safety status of the plant, capable of displaying a full range of important plant parameters and data trends on demand, and capable of indicating when process limits are being approached or exceeded.	The APR1400 conforms with this TMI-related requirement.	7.5.2.5 18.7
(2)(v) / I.D.3	Provide for automatic indication of the bypassed and operable status of safety systems.	The APR1400 conforms with this TMI-related requirement.	7.1.2.5, 7.5.2.3, 7.6.2.1, ~~8.3.1~~
(2)(vi) / II.B.1	Provide the capability of high-point venting of noncondensable gases from the RCS, and other systems that may be required to maintain adequate core cooling. Systems to achieve this capability shall be capable of being operated from the control room, and their operation shall not lead to an unacceptable increase in the probability of LOCA or an unacceptable challenge to containment integrity.	The high-point vent system is installed to meet this requirement.	5.4.12.1 8.3.1.1.3, 8.3.1.2.3, 8.3.2.2.3

Table 1.9-4 (6 of 11)

10 CFR 50.34(f) Item / Issue No.	Requirements	Conformance Discussion	DCD Tier 2 Section
(2)(x) / II.D.1	Provide a test program and associated model development and conduct tests to qualify reactor coolant system relief and safety valves and, for PWRs, PORV block valves, for all fluid conditions expected under operating conditions, transients and accidents. Consideration of anticipated transients without scram (ATWS) conditions shall be included in the test program. Actual testing under ATWS conditions need not be carried out until subsequent phases of the test program are developed.	Performance testing for the POSRV is performed on both normal and accident conditions, excluding anticipated transient without scram (ATWS), to provide the stable valve operation.	5.2.2.10
(2)(xi) / II.D.3	Provide direct indication of relief and safety valve position (open or closed) in the control room.	The APR1400 conforms with this TMI-related requirement.	5.2.2.1.1, 5.2.2.8, 7.1.2.6
(2)(xii) / II.E.1.2	Provide automatic and manual auxiliary feedwater (AFW) system initiation, and provide auxiliary feedwater system flow indication in the control room. (PWRs only)	The APR1400 conforms with this TMI-related requirement.	7.1.2.7, 7.2, Table 15.0-11
(2)(xiii) / II.E.3.1	Provide pressurizer heater power supply and associated motive and control power interfaces sufficient to establish and maintain natural circulation in hot standby conditions with only onsite power available. (PWRs only)	The APR1400 conforms with this TMI-related requirement.	8.3.1.1.2 add , 8.3.1.2.3
(2)(xiv) / II.E.4.2	Provide containment isolation systems that: a. Ensure all non-essential systems are isolated automatically by the containment isolation system b. For each non-essential penetration (except instrument) c. Do not result in reopening of the containment isolation d. Utilize a containment setpoint pressure for initiating containment isolation as low as is compatible with normal e. Include automatic closing on a high radiation signal for all systems that provide a path to the environs	The APR1400 conforms with this TMI-related requirement.	6.2.4.2, 7.1.2.8, 7.2, 7.5

Table 1.9-4 (8 of 11)

10 CFR 50.34(f) Item / Issue No.	Requirements	Conformance Discussion	DCD Tier 2 Section
(2)(xviii) / II.F.2	Provide instruments that provide in the control room an unambiguous indication of inadequate core cooling, such as primary coolant saturation meters in PWRs, and a suitable combination of signals from indicators of coolant level in the reactor vessel and in-core thermocouples in PWRs and BWRs.	The APR1400 conforms with this TMI-related requirement based on NUREG-0737.	7.1.1.5, 7.1.2.10, 7.5.1.2, Table 15.0-11
(2)(xix) / II.F.3	Provide instrumentation adequate for monitoring plant conditions following an accident that includes core damage.	The APR1400 conforms with this TMI-related requirement based on NRC RG 1.97 Rev. 4.	7.1.2.11 Table 15.0-11
(2)(xx) / II.G.1	Provide power supplies for pressurizer relief valves, block valves, and level indicators such that (A) level indicators are powered from vital buses; (B) motive and control power connections to the emergency power sources are through devices qualified in accordance with requirements applicable to systems important to safety, and (C) electric power is provided from emergency power sources. (PWRs only)	The APR1400 conforms with this TMI-related requirement.	7.1.2.12, 7.4.2, ~~8.3.1~~, 8.3.1.2.3
(2)(xxv) / III.A.1.2	Provide an onsite Technical Support Center, an onsite Operational Support Center, and for construction permit applications only, a near-site Emergency Operations Facility.	The APR1400 conforms with this TMI-related requirement.	9.5.2.1

The Class 1E 4.16 kV switchgears are connected to offsite power sources through the UAT and SAT. Each Class 1E 4.16 kV switchgear is also powered by an EDG during a LOOP condition. The dedicated Class 1E 4.16 kV switchgear (train A or train B) has access to the non-Class 1E AAC source for an SBO event. Each 4.16 kV bus supplies power to the motor loads and 4.16 kV/480V load center transformers.

The Class 1E 4.16 kV switchgears are located in the auxiliary building. Each switchgear is arranged as an independent distribution system, located in separate fire zones in a seismic Category I room. The switchgear is a metal-clad, three-phase lineup with draw-out, stored-energy operating mechanism type circuit breakers. Each switchgear is provided with potential transformers, relays, and current transformers. The switchgear ratings are shown in Table 8.3.1-6.

Three Mile Island (TMI)

Class 1E 4.16 kV switchgears A and B supply power to the non-Class 1E load of the pressurizer heaters back-up group in their division as required by the ~~TMI~~ Action Item Plan in NUREG-0737, Item II.E.3.1 (Reference 2). These non-Class 1E loads are connected to the Class 1E buses by Class 1E circuit breakers, which serve as isolation devices.

The 480V Class 1E load centers and MCCs are located indoors in seismic Category I buildings. Each load center and MCC is provided with potential transformers, relays, and current transformers. The Class 1E load center transformer rating is shown in Table 8.3.1-6.

Load center transformers connected to the Class 1E 4.16 kV buses provide power to Class 1E 480V load center buses. The Class 1E 480V MCC buses are connected to the Class 1E load center buses.

The load center (LC02) located at the train B area of auxiliary building is used as a swing bus for the auxiliary charging pump. LC02 is connected to the train A load center (LC01A) during normal operation. In case of a loss of power from LC01A, LC02 is manually transferred to the train B load center (LC01B) through a dummy breaker. The auxiliary charging pump is manually controlled by the train A or train B hand switches in the main control room (MCR) and remote shutdown room (RSR).

d. Control

e. Instrumentation

If the trays are stacked, the order from top to bottom is as shown above.

Cables of each train run in separate raceways are physically separated from cables of the other trains. Separation of trains is in accordance with IEEE Std. 384, as endorsed by NRC RG 1.75. Raceways for non-Class 1E are separated from each Class 1E train A, B, C, and D in accordance with IEEE Std. 384. The raceway in the cable spreading area, main control room, and other congested areas is designed in accordance with IEEE Std. 384. The power and control wiring in control boards or panels is separated in accordance with IEEE Std. 420 (Reference 40).

Medium-voltage power cables are routed in an open-top ladder-type cable tray in a single layer with maintained spacing. The distance between adjacent cables within a tray is one-quarter the diameter of the larger cable. The cable tray fill criterion for low-voltage power cables does not exceed 30 percent of the cross-sectional area of the open-top ladder-type tray. The cable tray fill criterion for control cable does not exceed 50 percent of the cross-sectional area of the open-top ladder-type tray. Solid-bottom and solid-cover type cable trays are used for routing instrumentation cables, with an allowable fill of 50 percent of tray cross-sectional area. Cable splicing in a raceway is prohibited.

add

1.204, 1.218, and 10 CFR 50.34.

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8.3.1.2 Analysis

The APR1400 Class 1E ac power system is designed to meet the requirements of GDCs 2, 4, 5, 17, 18, 33, 34, 35, 38, 41, 44, 50, and the intent of NRC RGs 1.6, 1.9, 1.32, 1.47, 1.53, 1.63, 1.75, 1.81, 1.106, 1.118, 1.153, 1.155, 1.160, ~~and 1.204.~~ The criteria and guidelines are shown in Table 8.1-2 and include their applicability in the electrical system design.

8.3.1.1.11 Cathodic Protection

The Cathodic protection system disturbs the electrochemical reaction that causes corrosion of metal structures and piping of which protection is decided as per the site conditions. Basically, two methods of cathodic protection are applied. One is the sacrificial system, which is a passive method, and the other is impressed current system, which is an active method.

The COL applicant is to provide the detailed design of the cathodic protection (GP) system as appicable to the site conditions. (COL 8.3 (9))

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NRC RG 1.160 endorses Revision 4A of NUMARC 93-01 (Reference 45), which provides methods for complying with the provisions of 10 CFR 50.65 with some provisions and clarifications. Conformance with NRC RG 1.160 is addressed in Section 1.9.

NRC Regulatory Guide 1.204

NRC RG 1.204 is related to the guidelines for lightning protection of nuclear power plants.

The APR1400 onsite ac power system is designed to meet the requirements of IEEE Std. 665, IEEE Std. 666, IEEE Std. 1050, and IEEE Std. C62.23 (Reference 46), which are related to the lightning protection of nuclear power plants.

NRC Regulatory Guide 1.218

NRC RG 1.218 provides the cable design and maintenance criteria for the performance of periodic testing as part of the condition-monitoring techniques for the electric cables that are used in nuclear power plants. The inaccessible cable condition-monitoring techniques related to NRC RG 1.218 are addressed in Subsection 8.3.1.1.10.

add

8.3.1.3 Electrical Power System Calculations and Distribution System Studies for AC System

The analysis of load flow, voltage regulation, and short-circuit studies is performed by

8.3.1.2.3 Conformance with 10 CFR 50.34 Related to TMI Action Plan Requirements

10 CFR 50.34(f)(2)(v) (TMI Item I.D.3) requires the applicant to provide for automatic indication of the bypassed and operable status of safety systems. Information regarding bypassed and inoperable status indication of the Class 1E onsite ac and dc power system and the Class 1E EDG system is described in Subsection 7.5.1.3. Conformance with the requirement of 10 CFR 50.34(f)(2)(v) is addressed in Subsection 7.5.2.3.

10 CFR 50.34(f)(2)(xiii) (TMI Item II.E.3.1) is related to providing pressurizer heater power supply and conformance with the requirement of 10 CFR 50.34(f)(2)(xiii) is addressed in Subsection 8.3.1.1.2.

10 CFR 50.34(f)(2)(xx) (TMI Item II.G.1) is related to providing power supplies for pressurizer relief valves, block valves, and level indicators. For the APR1400, there is no power-operated relief valve (PORV) or block valve which requires any electrical power. The Class 1E 120Vac I&C power system, backed up by EDGs and batteries, supplies power for pressurizer level indication instruments as described in Subsection 7.1.2.12. Thus, it conforms with 10 CFR 50.34(f)(2)(xx).

The inverters that provide reliable I&C power have sufficient capacity and capability to perform their intended function. The Class 1E 120 Vac I&C power system loads are listed in Table 8.3.2-3 and the inverter rating is shown in Table 8.3.2-4.

A 125 Vdc control center is provided for each of the 125 Vdc power system load groups. Each control center supplies power to its assigned bus and equipment and is powered directly from its associated 125 Vdc battery and battery chargers irrespective of the condition of other control centers. The Class 1E dc control center supplies power to one dc distribution panel and one static inverter.

8.3.2.1.2.7 Class 1E 125 Vdc Power System and 120 Vac Instrumentation and Control Power System Status Information

The parameters or status that are monitored in the MCR for the 125 Vdc power system and 120 Vac I&C power system are listed in Table 8.3.2-5.

Ammeters provided to monitor battery current have the capability to monitor both charge and discharge currents. Voltmeters are supplied to monitor dc and ac voltage of the buses and inverter distribution panels. The indications and alarms in the dc control center, battery charger control panel, and inverter distribution panel are listed in Table 8.3.2-5.

Ground fault detectors and their corresponding ground monitoring alarms are provided with sufficient sensitivity.

8.3.2.2 Analysis

The APR1400 Class 1E 125 Vdc power system is designed to meet the requirements of GDCs 2, 4, 5, 17, 18, 33, 34, 35, 38, 41, 44, and 50 and the intent of NRC RGs 1.6, 1.32, 1.47, 1.53, 1.63, 1.75, 1.81, 1.106, 1.118, 1.128, 1.129, 1.153, 1.155, 1.160, ~~and 1.212.~~ 1.212, and 10 CFR 50.34. Table 8.1-2 includes their applicability of the GDC and NRC RGs to the electrical system design.

NRC Regulatory Guide 1.212

NRC RG 1.212 is related to sizing of lead-acid storage batteries. IEEE Std. 485, endorsed by NRC RG 1.212, provides recommended practice for sizing lead-acid batteries for stationary applications.

The Class 1E dc batteries are designed to conform with the requirements of NRC RG 1.212 and IEEE Std. 485.

add

8.3.2.3 Electrical Power System Calculations and Distribution System Studies for DC System

Analysis of load flow, voltage regulation, and short-circuit studies is performed by using ETAP, which is qualified for nuclear power plants in accordance with 10 CFR Part 21 (Reference 60), 10 CFR Part 50 Appendix B, and ASME NQA-1.

8.3.2.3.1 Load Flow and Under/Overvoltage Protection

Load flow studies are implemented to check whether the equipment terminal voltage is maintained within the acceptable voltage range under the most severe loading condition. Voltage drops at equipment terminals are also derived from the largest discharge current conditions. Consequently, terminal voltages of equipment meet the voltage range that is recommended in IEEE Std. 946.

8.3.2.3.2 Short-Circuit Studies

Short-circuit studies are implemented to calculate the magnitudes of the expected currents in the power system during the most severe fault condition. In case of Class 1E dc bus short-circuit calculations, the contributing short-circuit current sources are the batteries and battery chargers because there are no dc motors directly connected to the Class 1E dc buses. The maximum short-circuit current in the calculation is used to select the circuit breaker rating based on IEEE Std. C37.16 (Reference 61). The COL applicant is to provide the short-circuit analysis of onsite dc power system with actual data (COL 8.3(7)).

8.3.2.3.3 Conformance with 10 CFR 50.34 Related to TMI Action Plan Requirements

See Subsection 8.3.1.2.3.