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.:	**539-8730**
SRP Section:	**08.01 – Electric Power – Introduction**
Application Section:	**8.1**
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Question No. 08.01-21

Compliance with 10 CFR Part 50, GDC 17 requires that onsite and offsite electrical power be provided to support functioning of systems, structures, and components (SSCs) important to safety. Standard Review Plan (SRP) 8.2 and 8.3 explains that the GDC 17 requirements for the interface between the onsite and offsite electric power system in evolutionary advance light water reactor (ALWRs) designs are documented in SECY-91-078. In SECY-91-078, “Chapter 11 of the Electric Power Research Institute’s (EPRI’s) Requirements Document and Additional Evolutionary Light Water Reactor (LWR) Certification Issues,” the staff concluded that feeding the safety buses from the offsite power sources through non-safety buses or from a common transformer winding with non-safety loads increases the difficulty in properly regulating voltage at the safety buses, subjects the safety loads to transients caused by the non-safety loads, and adds additional failure points between the offsite power sources and safety loads.

The APR1400 design includes non-safety and safety buses being fed from a common 4.16kV transformer winding of the unit auxiliary transformers (UATs) and standby auxiliary transformer (SATs). The staff’s concerns related to the APR1400 design where the non-safety and safety buses are being fed from a common transformer winding are (1) voltage regulation at the safety buses, (2) transients from the non-safety loads or system impacting the safety loads or system, and (3) the creation of a failure point between the offsite power and the safety buses.

The applicant’s response to RAI 8426, Question 08.01-14, to address the staff’s concerns associated with the non-safety and safety buses being fed from a common transformer winding is discussed below.

(1) The on-load tap changers (OLTCs) at the primary side of the UATs and SATs ensure that the voltage regulation at the medium voltage (MV) safety buses is maintained in an acceptable range, and voltage regulation study was performed.

(2) There is a potential for transients at the safety buses caused by accident or operating occurrences on the non-safety buses such as (a) large motor starting, (b) motor reacceleration during a bus transfer condition, or a (c) short circuit.

a) A large motor starting study has been performed and the results of the study demonstrate that voltage variation at the safety buses is maintained within acceptable limits during the non-safety large motor starting condition.

b) The transient effect of re-acceleration of non-safety motors during a bus transfer is assessed by the fast bus transfer study and the result of the study concludes that the re-acceleration of non-safety motors do not hinder the re-acceleration of the safety motors.

c) During a short circuit on the non-safety bus, the design allows the safety bus to remain connected, or to be transferred to the alternate power supply.

(3) The UAT (or SAT) relays are able to detect an electric fault at a connection point between safety or non-safety buses. Power is then transferred to the alternate PPS or to the EDG power source, to eliminate the failure point between the offsite power source and the safety buses.

The applicant also explained that a failure mode effects analysis (FMEA) was performed and demonstrates that the APR1400 offsite power system retains its ability to feed the safety loads of both divisions through both (normal and alternate) PPS upon a single failure on the non-safety bus.

The staff finds the response acceptable and requests that the applicant incorporate in the DCD, its justification to support that the APR1400 design is in compliance with GDC 17, and in conformance with SECY-91-078, such that

(1) Voltage regulation at the medium voltage (MV) safety buses is maintained in an acceptable range,

(2) Potential transients caused by accident or operating occurrences on the non-safety buses such as (a) large motor starting, (b) motor re-acceleration during a bus transfer condition, or a (c) short circuit will not impact the safety buses, and

(3) Power is transferred to the alternate PPS or to the EDG power source, to eliminate the failure point between the offsite power source and the safety buses, when there is a fault at the connection point between the safety and non-safety at the common 4.16kV transformer winding.

The staff requests that the applicant explain how (e.g. COL Item, ITAAC) they will verify that transients on the non-safety buses will not impact the safety buses as described in the APR1400 design.

Response – (Rev.1)

The specific electrical system design features of the APR1400, provided in response to RAI 8426, Question 08.01-14 (Reference KHNP submittal MKD/NW-16-1174L, dated Jan 4, 2017; ML17004A024), will be reflected in the relevant subsections of the DCD Tier 2 as shown in the attachment to support that the APR1400 is in compliance with GDC 17 and SECY-91-078. DCD Tier 2, Subsection 8.3.1.3.9 is being added to specifically describe the bus transfer study.

In addition, DCD Tier 1, Subsection 2.6.1.1, Table 2.6.1-3, and Tier 2, Subsection 14.3.2.6 will be revised such that the COL applicant will verify through ITAAC that transients or failures occurring in the non-Class 1E buses will not cause failure of the Class 1E loads.

In DCD Tier 1, Table 2.6.1-3, ITAAC Item 26 is being added for the COL applicant to verify that the Class 1E loads will not fail due to transients on non-Class 1E electrical equipment during non-Class 1E large motor starting or re-acceleration by performing transient analyses (i.e., motor starting, bus transfer analysis) using the actual equipment data of the site.

The existing ITAAC Item 20 will be used to verify that the Class 1E buses remain unaffected by a short-circuit fault on the non-Class 1E buses or circuits by proper coordination of overcurrent protection for the Class 1E power system. The existing ITAAC Item 8 of Table 2.6.1-3 of DCD Tier 1 will be used to verify that the medium voltage Class 1E buses can be automatically transferred satisfactorily to the alternate preferred offsite power supply should the normal preferred offsite power supply not be available.

Impact on DCD

The changes that were proposed in the original response to this RAI have been incorporated into Revision 2 of the DCD; therefore, only the pages containing proposed changes as a result of Revision 1 of this response are included in the Attachment.

DCD Tier 2, Subsections 8.3.1.1.2.3 and 8.3.4 will be revised as shown in the attachment.

Impact on PRA

PRA impact screening assessment reveals the double-incoming circuit breakers of non-Class 1E switchgears do not impact on the PRA result, and therefore, are not incorporated into the PRA model. Instead, the relevant information will be included in the PRA notebook (Auxiliary Power System).

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.

Following a LOOP, the associated Class 1E EDGs are started and the safety buses are isolated from offsite sources and fed solely from the associated EDG. The four load sequencers (one for each Class 1E bus) used for bus load shedding and load sequencing are independent from one another. The Class 1E 4.16 kV bus degraded voltage relay scheme is designed to meet the requirements of Branch Technical Position (BTP) 8-6 (Reference 8). The protective relay scheme is described in detail in Subsection 8.3.1.1.3.11.

Non-Class 1E loads are connected to the Class 1E bus by Class 1E isolation devices. The isolation devices meet Regulatory Position (1) of RG 1.75. Periodic testing of the isolation devices (e.g., visual inspection of fuses and fuse holders, circuit breaker operability tests, etc.) is performed during every refueling outage to demonstrate that the overall coordination scheme under multiple faults of non-safety-related loads remains within the limits specified in the design criteria. Pressurizer heater backup groups are provided power from the Class 1E 4.16 kV bus in accordance with 10 CFR 50.34 (Reference 9). Emergency ac lighting is powered from the Class 1E 480V MCC buses. Emergency lighting is described in Subsection 9.5.3.

The Class 1E and non-Class 1E onsite power system is designed such that the Class 1E loads will not fail upon a failure or presence of transients on non-Class 1E electrical equipment. In the event of a fault on non-Class 1E buses, the faulted bus is securely isolated by protective devices while the other Class 1E and non-Class 1E buses remain connected to the offsite power source by proper coordination of protective devices. In case of a fault at UAT or SAT winding or its connection to the Class 1E and non-Class 1E buses, the faulted non-Class 1E equipment or circuit is properly isolated by protective devices and the power supply to Class 1E buses is automatically transferred to the SATs or EDGs. The operational occurrences and incidental conditions of the non-Class 1E power system, such as voltage regulation, large motor starting, re-acceleration of motors during bus transfer, and short circuit conditions, are evaluated by the electrical power system studies as described in Subsection 8.3.1.3 to demonstrate that the Class 1E onsite ac power system retains its intended function during the operational and incidental conditions caused or affected by the non-Class 1E offsite and onsite power systems. This design feature properly satisfies GDC 17 and the staff position in SECY-91-078 (Reference ~~29~~).

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The physical separation between the redundant equipment, including cables and raceways, is designed in accordance with IEEE Std. 384 as endorsed by NRC RG 1.75. The design criteria for the cable designs are described in Subsection 8.3.1.1.10. The identification of

61. IEEE Std. C37.16-2009, "IEEE Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC (3200 V and below) Power Circuit Breakers," Institute of Electrical and Electronics Engineers, 2009.

62. Generic Letter 2007-01, "Inaccessible or Underground Power Cable Failures that Disable Accident Mitigation Systems or Cause Plant Transients."

63. NUREG-0800, Standard Review Plan, BTP 8-1, "Requirements for Motor-Operated Valves in the ECCS Accumulator Lines," Rev. 3, March 2007.

64. NUREG-0800, Standard Review Plan, BTP 8-2, "Use of Diesel Generator Sets for Peaking," Rev. 3, March 2007.

65. NUREG-0800, Standard Review Plan, BTP 8-4, "Application of Single Failure Criterion to Manually Controlled Electrically Operated Valves," Rev. 3, March 2007.

66. NUREG-0800, Standard Review Plan, BTP 8-5, "Supplemental Guidance for Bypass and Inoperable Status Indication for Engineered Safety Features Systems," Rev. 3, March 2007.

67. NUREG-0800, Standard Review Plan, BTP 8-7, "Criteria for Alarms and Indications Associated with Diesel Generator Unit Bypassed and Inoperable Status," Rev. 3, March 2007.

68. SECY-91-078, "Chapter 11 of the Electric Power Research Institute's (EPRI's) Requirements Document and Additional Evolutionary Light Water Reactor (LWR) Certification Issues," U.S. Nuclear Regulatory Commission, March 25, 1991.