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.:	**420-8482**
SRP Section:	**19.03 – Beyond Design Basis External Event (APR1400)**
Application Section:	**19.3**
Date of RAI Issue:	**02/29/2016**

Question No. 19.03-34

NRC Commission paper SECY-12-0025 stated that the NRC staff expected new reactor design certification applications to address the Commission-approved Fukushima actions in their applications to the fullest extent practicable. In performing its review of the APR1400 design certification application, the NRC staff followed the guidance for satisfying the Commission directives regarding BDBEE mitigation strategies in Japan Lesson-Learned Project Directorate JLD-ISG-2012-01, Revision 0, which endorsed with clarifications the methodologies described in NEI 12–06, Revision 0. The guidance in JLD-ISG-2012-01 describes one acceptable approach for satisfying the Commission directives regarding BDBEE mitigation strategies (i.e., Order EA-12-049). TR APR1400-E-P-NR-14005-P, Rev. 0 provides details regarding mitigating strategies and design enhancements to meet Near-Term Task Force (NTTF) recommendations, NRC orders, and agency guidance related mitigation strategy during Beyond Design Basis External Events (BDBEE).

TR, APR1400-E-P-NR-14005-P, Revision 0, Section 5.1.2.3.1.2, “Phase 2: Coping with Installed Plant Equipment and Onsite Portable Resources (8 to 72 hours)," subsection 5.1.2.3.1.2.1 states that two 480 V, 1,000 kW, mobile GTGs are provided to meet N+1 requirements. One of the 480 V mobile gas turbine generators (GTGs) is connected to the 480 V Class 1E power system Train A or B, and supplies power to the 125 Vdc battery charger, the 480 V load center, and the motor control center (MCC). During this phase, additional cooling in MCR, electrical and I&C equipment rooms, turbine driven auxiliary feedwater pump (TDAFWP) rooms, and auxiliary control panel (ACP) room is not required based on heat-up calculations.

1. Please explain what type of environmental conditions, including temperature, are in the room housing the mobile GTGs, and whether there are any impacts to the functioning of the GTGs during Phase 2 and beyond.

2. Discuss how isolation between Class 1E and non-Class 1E equipment (mobile GTGs) is maintained, in accordance with NEI 12-06, Section 3.2.2, Guideline (13).

Response

As stated in COL item 19.3(4), the details of the storage location for FLEX equipment, including mobile GTGs, are to be addressed by the COL applicant. The environmental conditions (e.g., temperature, humidity, etc.) of the specific storage room will also be addressed by COL applicant. The typical information on the environmental conditions of the storage room housing the 480 V mobile GTGs needs to be considered as follows (Response 1).

And also, a discussion on how isolation between the mobile GTGs (non-Class 1E) and the Class 1E buses will be maintained is provided as follows (Response 2).

1. The temperature conditions inside the onsite storage building(s), where the 480V, 1000kW mobile gas turbine generator(s) will be located, is expected to be in the range of 40 °F to 120 °F (typical). However, the final selection of this temperature range is site specific and therefore, is part of COL 19.3(4). Also, during extreme cold conditions, it is anticipated that the onsite storage building(s) will maintain a minimum temperature of 40 °F using thermostatically controlled heaters. Mechanical cooling may not be necessary since the storage building(s) is (are) designed to only store equipment. The mobile GTG equipment will be specified to withstand and operate under the site-specific extreme temperature conditions (e.g., between (-) 40 °F and 127 °F). Also, in case water cooled GTG is specified, there will be proper drainage provisions to preclude freezing of fluid and/or use of anti-freeze to ensure that the equipment remains functional during the lowest postulated temperature conditions. Regarding impact of high humidity, the gas turbine portion may not be affected by high humidity. However, the generator portion is expected to be protected by internal heaters as necessary to get rid of the moisture.

   In light of the above, the functionality (performance) of the proposed 480V, 1000kW mobile gas turbine generator(s) is not expected to be affected by temperature and humidity during BDBEE, since the GTGs procured from the manufacturer will meet or exceed the specification and will consider impact on the GTG rating at elevated temperature (say, above 90 °F). Additionally, periodic testing and proper maintenance of the GTGs will be conducted in accordance with manufacturer's recommendations to demonstrate GTG readiness when called upon to operate during FLEX Phases 2 and beyond. Please note that this subject is a COL item (COL 19.3(4) and 19.3(5)) as discussed in DCD Sections 19.3.2.3.4, and will be fully addressed by the COL applicant to comply with the requirements of NEI 12-06, Rev 0 and JLD-ISG-2012-01, Rev 0.

2. As described in DCD Tier 2, Subsection 8.3.1.1.2.3, the Class 1E safety buses of the APR1400 are designed with the physical and electrical independence from non-Class 1E equipment. The interface arrangement between the Class 1E safety buses and the non-Class 1E equipment is maintained by Class 1E circuit breakers, which serve as isolation devices in accordance with IEEE Std. 384 as endorsed by NRC RGs 1.75.

   Specifically, in order to connect the mobile GTGs, the connection boxes are provided and installed in the entry and exit of the auxiliary building as described in DCD Tier 2, Subsection 8.3.1.1. Power cables between the connection boxes and the incoming circuit breaker (isolation device) of Class 1E buses are designed in APR1400. The mobile GTGs will be connected with the connection boxes by temporary cabling to

support phase 2 of the FLEX strategy. The specific design, location, and connection configuration has been comprehensively addressed in the response to RAI 61-7984, Question 08.03.01-5 (Reference KHNP submittal MKD/NW-15-0131L, dated September 8, 2015, ML15251A244).

Additionally, the electrical isolations and interactions between the local equipment (e.g., connection boxes, Class 1E safety buses, electrical loads, etc.) and FLEX equipment (mobile GTGs) are accomplished according to the plant procedure(s) and/or FLEX support guidelines (FSGs), which will be prepared by the COL applicant (COL 19.3(5)) in accordance with the NEI 12-06, Section 3.2.2, Guideline(13).

These procedure and/or FSG will provide specific instructions to the operator for the transition from installed sources to the portable equipment to address the proposed FLEX strategy. This aspect of the interface is stated in COL item 19.3(5) and 19.3(7) of DCD Tier 2, Section 19.3.4.

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.

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Question No. 19.03-36

NRC Commission paper SECY-12-0025 stated that the NRC staff expected new reactor design certification applications to address the Commission-approved Fukushima actions in their applications to the fullest extent practicable. In performing its review of the APR1400 design certification application, the NRC staff followed the guidance for satisfying the Commission directives regarding BDBEE mitigation strategies in Japan Lesson-Learned Project Directorate JLD-ISG-2012-01, Revision 0, which endorsed with clarifications the methodologies described in NEI 12–06, Revision 0. The guidance in JLD-ISG-2012-01 describes one acceptable approach for satisfying the Commission directives regarding BDBEE mitigation strategies (i.e., Order EA-12-049). TR APR1400-E-P-NR-14005-P, Rev. 0 provides details regarding mitigating strategies and design enhancements to meet Near-Term Task Force (NTTF) recommendations, NRC orders, and agency guidance related mitigation strategy during Beyond Design Basis External Events (BDBEE).

NEI 12-06, Revision 0 guidance states that “unlike 50.54(hh)(2), the intention of this guidance is to have permanent, installed connection points for portable fluid and electrical equipment. Electrical diversity can be accomplished by providing a primary and alternate method to repower key equipment and instruments utilized in FLEX strategies. At a minimum, the primary connection point should be an installed connection suitable for both the on-site and off-site equipment. The secondary connection point may require reconfiguration (e.g., removal of valve bonnets or breaker) if it can be shown that adequate time is available and adequate resources are reasonably expected to be available to support the reconfiguration. Both the primary and alternate connection points do not need to be available for all applicable hazards, but the location of the connection points should provide reasonable assurance of at least one connection being available.” TR, APR1400-E-P-NR-14005-P, Revision 0, Table 5-9, Conformance with NEI 12-06," Rev. 0, states that the appropriate standard mechanical and electrical connections need to be specified and the COL applicants are responsible to establish a means to ensure the necessary resources are available from offsite. Table 5-9 (8 of 20) also states that connections for primary and secondary FLEX pumps, and mobile GTGs, are

provided on the outside of the exterior wall of the auxiliary building, thereby providing reasonable assurance of the accessibility of personnel and equipment.

1. Provide the COL item that will be used by the COL applicant to ensure the appropriate connection points for the electrical equipment, including voltages and classification.

2. Section 5.1.2.6.1.1 states that the provisions to connect these GTGs are incorporated into the design. Please discuss what the provisions are.

Response

The mobile GTGs are connected to the Class 1E onsite ac power system train A or B based on each phase of the mitigation strategies for BDBEEs. During phase 1 (or 2), the appropriate electrical connections between local equipment and FLEX equipment will be accomplished to support phase 2 (or 3) according to the FLEX strategies and its associated provisions.

The following provides responses to each corresponding question the staff asked.

1. In order for the COL applicant to ensure the appropriate connection points for the electrical equipment including locations, voltages, and classification, KHNP will add a COL item in the DCD Tier 2, Section 19.3.

2. As described in DCD Tier 2, Subsection 8.3.1.1, the mobile GTGs supply power to the Class 1E buses through connection boxes, which are watertight type. The connection boxes are installed in the entry and exit of the auxiliary building taking into account the accessibility of the onsite 480 V mobile GTG and 4.16 kV mobile GTG mobilized from offsite.

   With regard to electrical connections, power cables between the connection boxes and incoming circuit breakers of the Class 1E buses are designed as permanent installations and the temporary cables will be connected between the mobile GTGs and connection boxes according to the APR1400 FLEX strategies.

   Further discussion on the design aspects of the mobile GTGs are provided in the response to RAI 61-7984, Question No. 08.03.01-5 (Reference KHNP submittal MKD/NW-15-0131L, dated September 8, 2015, ML15251A244).

Impact on DCD

DCD Tier 2, Table 1.8-2, Subsection 19.3.2.3.4, and 19.3.4 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 1.8-2 (29 of 29)

Item No.	Description
COL 19.3(1)	The COL applicant is to perform site-specific seismic hazard evaluation and seismic risk evaluation as applicable in accordance with NTTF Recommendation 2.1 as outlined in the NRC RFI.
COL 19.3(2)	The COL applicant is to address the flood requirements for wet sites
COL 19.3(3)	The COL applicant is to develop the details for offsite resources.
COL 19.3(4)	The COL applicant is to address the details of storage location for FLEX equipment.
COL 19.3(5)	The COL applicant is to address site-specific strategies to mitigate BDBEEs as specified in the NRC Order EA-12-049.
COL 19.3(6)	The COL applicant is to address SFP level instrumentation maintenance procedure development and perform training as specified in NRC Order EA-12
COL 19.3(7)	The COL applicant is to address development of EOPs, SAMGs, and EDMGs that incorporate lessons learned from TEPCO's Fukushima Dai-Ichi nuclear power plant accident as addressed in SECY-12-0025.
COL 19.3(8)	The COL applicant is to address enhancement of the offsite communication system as specified in the NRC Request for Information pertaining to NTTF Recommendation 9.3.
COL 19.3(9)	The COL applicant is to address staffing for large-scale natural events as specified in the NRC RFI pertaining to NTTF Recommendation 9.3.
COL 19.3(10)	The COL applicant is to provide site-specific details of the electrical connection points (including locations, voltage level, and electrical classification) for FLEX equipment such as FLEX pumps and mobile GTGs.

Add

event. The technical report (Reference 5) provides the containment pressure and temperature analyses response for the full-power case with the assumed RCP seal leakage, and confirms that, during the course of the event for all phases, containment integrity is maintained.

Loss of RHR during mid-loop operation in Mode 5 is additionally assumed for the evaluation of containment capability. In this event, steam is assumed to be released from the RCS to the containment through the pressurizer manway due to the boiling of reactor coolant following the loss of RHR. The ECSBS is assumed to start spraying water into the containment atmosphere via a FLEX pump when the containment pressure reaches the UPC value of 12.9 kg/cm^2 (184 psia). After the initial operation, the ECSBS is assumed to be intermittently operated for 2 hours whenever the containment pressure reaches the UPC value. GOTHIC analyses are performed to confirm that the containment pressure and the temperature can be controlled within the UPC limit with the ECSBS operation following the loss of RHR in mode 5.

19.3.2.3.4 Supporting Systems

To mitigate the BDBEE, the following supporting systems have also been evaluated in Reference 5:

a. Electrical system (ac power and dc power)

b. Emergency lighting

c. Communication system

d. Water sources

e. Fuel oil

The design approach meets the NEI 12-06 in meeting the N+1 approach for the FLEX equipment, and primary and alternative connection points for fluids and electrical items. Regarding the storage of robust FLEX equipment and commodities, the N+1 philosophy has been adopted for the storage housing. Reference 5 describes the requirements in detail and the necessary design changes for APR1400 to meet the industry regulations. The

Add

The COL applicant is to provide site-specific details of the electrical connection points (including locations, voltage level, and electrical classification) for FLEX equipment such as FLEX pumps and mobile GTGs (COL 19.3(10)).

COL 19.3(3) The COL applicant is to develop the details for offsite resources.

COL 19.3(4) The COL applicant is to address the details of storage location for FLEX equipment.

COL 19.3(5) The COL applicant is to address site-specific strategies to mitigate BDBEEs as specified in the NRC Order EA-12-049.

COL 19.3(6) The COL applicant is to address SFP level instrumentation maintenance procedure development and perform training as specified in NRC Order EA-12-051.

COL 19.3(7) The COL applicant is to address development of EOPs, SAMGs, and EDMGs that incorporate lessons learned from TEPCO's Fukushima Dai-Ichi nuclear power plant accident as addressed in SECY-12-0025.

COL 19.3(8) The COL applicant is to address enhancement of the offsite communication system as specified in the NRC Request for Information pertaining to NTTF Recommendation 9.3.

COL 19.3(9) The COL applicant is to address staffing for large-scale natural events as specified in the NRC RFI pertaining to NTTF Recommendation 9.3.

Add

19.3.5 References

1. SECY-12-0025, “Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami,” U.S. Nuclear Regulatory Commission, February 2012.

2. Order EA-12-049, “Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,” U.S. Nuclear Regulatory Commission, March 12, 2012.

3. Order EA-12-051, “Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,” U.S. Nuclear Regulatory Commission, March 12, 2012.

COL 19.3(10) The COL applicant is to provide site-specific details of the electrical connection points (including locations, voltage level, and electrical classification) for FLEX equipment such as FLEX pumps and mobile GTGs.

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Question No. 19.03-38

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DCD Tier 2 Section 9.5.3.1, “Design Bases,” states in part that the emergency lighting system is composed of emergency ac and emergency dc lighting systems. Emergency ac lighting is supplied from Class 1E buses. Emergency dc lighting system is composed of the lighting powered from the non-Class 1E 125 Vdc station battery and the lighting powered by an individual 8 hours rated self-contained battery pack units in accordance with NRC RG 1.189. TR, APR1400-E-P-NR-14005-P, Revision 0, Section 5.1.2.6.1.3, “Emergency Lighting,” states in part that emergency lighting in areas such as the main control room (MCR) and technical support center (TSC) / operational support center (OSC) is provided from the Class 1E batteries during Phase 1.

1. Please clarify where the emergency lighting system is being powered from (emergency ac, emergency dc, or combination) during phase 1 of the BDBEE for areas such as MCR, TSC/OSC, and other areas requiring lighting for operator actions.

Response

For MCR and TSC/OSC, emergency dc lighting is powered from Class 1E batteries from train C or D during phase 1 of the BDBEE. For other areas requiring lighting for operator actions, self-contained battery lighting fixtures which are addressed in DCD Tier 2, Subsection 9.5.3.2 provide the lighting during phase 1 of the BDBEE.

DCD Tier 2, Table 8.3.2-1 and Technical Report, APR1400-E-P-NR-14005-NP, Rev. 0, Subsection 5.1.2.6.1.3 will be revised to reflect the above information.

Impact on DCD

DCD Tier 2, Table 8.3.2-1 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

APR1400-E-P-NR-14005-NP, Rev. 0, Subsection 5.1.2.6.1.3 will be revised as shown in the Attachment.

Table 8.3.2-1 (3 of 4)

3. Train C

125 V DC Load Name	DC Load Classification and Load Currents [A][8], [9]			
	Continuous	Noncontinuous	Momentary	Random
MOV Inverter		25[1]		
- IWS Valve 1[2]				229.6
- IWS Valve 2[2]				229.6
- RCS Valve 1[2]				47.8
- RCS Valve 2_LRC (Locked Rotor Current)[2], [3]				581.2
- RCS Valve 2_FLC (Full Load Current)[2], [3]				121.9
AFP Turbine LCP	8.8		60[4]	
Aux. Feedwater Isolation Valves		180[5]		
Reactor Trip Switchgear System			3[6]	
Solenoids for FW&MS, SIS Valves	3.5			
Solenoids for Miscellaneous Valves	3.8			
Lamp and Relay, Trip of SWGR and LC	4.7		35[7]	
IP Inverter	259.6			
EDG-C Control Power	11.5			
Emergency DC Lighting		40.0[10]		

(1) This value is no load current.
(2) These loads are random loads of the MOV inverter.
(3) RCS valve load current values are loaded successively just before the end of the duty cycle.
(4) This value is superimposed on the continuous value for the first minute.
(5) This current is loaded for the first 5 minutes every 1 hour.
(6) This current is loaded for the first minute.
(7) This current is superimposed on the continuous value for the first minute.
(8) The duty cycle is 16 hours long.
(9) The dc loads can change during detail design.
(10) This current is loaded for the first 8 hours.

Add

Add

Table 8.3.2-1 (4 of 4)

4. Train D

125 V DC Load Name	DC Load Classification and Load Currents [A][8], [9]			
	Continuous	Noncontinuous	Momentary	Random
MOV Inverter		25[1]		
- IWS Valve 3[2]				229.6
- IWS Valve 4[2]				229.6
- RCS Valve 3[2]				47.8
- RCS Valve 4_ LRC (Locked Rotor Current)[2], [3]				581.2
- RCS Valve 4_ FLC (Full Load Current)[2], [3]				121.9
AFP Turbine LCP	8.8		60[4]	
Aux. Feedwater Isolation Valves		180[5]		
Reactor Trip Switchgear System			3[6]	
Solenoids for FW&MS, SIS Valves	3.5			
Solenoids for Miscellaneous Valves	3.8			
Lamp and Relay, Trip of SWGR and LC	4.7		35[7]	
IP Inverter	261.4			
EDG-D Control Power	11.5			
Emergency DC Lighting		40.0[10]		

(1) This value is no load current.
(2) These loads are random loads of the MOV inverter.
(3) RCS valve load current values are loaded successively just before the end of the duty cycle.
(4) This value is superimposed on the continuous value for the first minute.
(5) This current is loaded for the first 5 minutes every 1 hour.
(6) This current is loaded for the first minute.
(7) This current is superimposed on the continuous value for the first minute.
(8) The duty cycle is 16 hours long.
(9) The dc loads can change during detail design.

Add

Add

(10) This current is loaded for the first 8 hours.

after the onset of BDBEE, the capacities of all the batteries are sufficient to provide dc power to all essential loads necessary to perform their safety duties.

During Phase 2, a 480 V mobile GTG is connected to either Train A or Train B of the Class 1E load center to supply power and recharge respective batteries to fully charged condition.

Battery Qualification

The safety-related batteries that are extended for use longer than 8 hours, with reduced discharge rate through load shedding, are not required to be additionally qualified for FLEX profiles since the NRC endorsed the NEI White Paper with clarifications in September 2013 (References 10 and 11).

dc

5.1.2.6.1.3 Emergency Lighting

Emergency lighting in areas such as the MCR and technical support center (TSC) / operational support center (OSC) is provided from the Class 1E batteries during Phase 1, and from the mobile GTG during Phases 2 and 3.

emergency ac lighting is provided

Access to manual valves requires lighting, and access to instrumentation monitoring or equipment operation also requires lighting. Under this adverse condition, the APR1400 is designed to provide portable lighting (e.g., flashlights or headlamps) as necessary to perform essential functions.

5.1.2.6.1.4 Communications

Design features are incorporated into onsite plant communication system to enhance emergency preparedness for BDBEEs associated with simultaneous LUHS. These are described below.

The APR1400 communication subsystems provide an independent and diverse mode of communications. A failure of one subsystem does not affect the capability to communicate using the other system.

Electric power is provided to the communications subsystems from the non-Class 1E uninterruptible power system (UPS) with 1-hour capacity in normal operation. The wireless communication system is supplied from the dedicated emergency UPS with 16-hour capacity.

However, normal communications may be lost or hampered during an ELAP. In this condition, portable communication devices are provided to support interaction between personnel in the plant and those providing overall command and control. Communication gear (satellite phones and radios) are also provided for onsite and offsite communications. This system provides an alternate communication path for outside connections. The satellite telephone equipment includes a roof-mounted antenna and transceiver.

5.1.2.6.2 Water Supply System

The primary source of water for the core cooling function is the AFWST for the first 72 hours, and the RWT can be used thereafter for up to 12 days, if required (Table 5-2).

For the SFP makeup and spray function, the RWT is the source of water.

5.1.2.6.3 Fuel Oil Supply System

EDG fuel oil day tank and the underground 7-day fuel oil storage tanks are used for running the diesel-driven FLEX pumps. During Phase 3, fuel oil is provided from an offsite source. Table 5-6 provides a summary of the fuel oil demands during the three phases of this event.

The existing onsite EDG fuel oil storage tanks and associated diesel fuel oil day tanks have a capacity of