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.:	**297-8309**
SRP Section:	**19.03 – Beyond Design Basis External Event (APR1400)**
Application Section:	**19.3**
Date of RAI Issue:	**11/09/2015**

Question No. 19.03-3

The NRC staff requests that the APR1400 design certification applicant describe the provisions for design, manufacture, testing, installation, and surveillance to provide assurance of the seismic, environmental, and functional capability of all nonsafety-related installed pumps, valves, and dynamic restraints to perform their intended functions as part of the mitigation strategies (including initial full-power operation and mid-loop operation) to ensure core cooling, containment function, and spent fuel pool cooling capabilities during an extended loss of ac power event at an APR1400 nuclear power plant. In addition, the applicant should indicate where the APR1400 DCD Tier 2 specifies the provisions for the design, manufacture, testing, installation, and surveillance for the nonsafety-related installed pumps, valves, and dynamic restraints that perform functions as part of the mitigation strategies, or provide proposed modifications to the APR1400 DCD Tier 2 to incorporate these provisions.

Response

As stated in response to RAI 19.03-1, Item (1), the installed non safety valves for the Spent Fuel Pool external makeup water and Emergency Containment Spray Backup system are identified in the Technical Report APR1400-E-P-NR-14005-P, Section 6.2.3 for SFP and Section 5.1.2.5.3 for ECSBS respectively. Further, Figure 6.3 of the Technical Report APR1400-E-P-NR-14005-P depicts the installed non safety valves in the SFP external makeup lines and DCD Tier 2, Figure 6.2.2-1 provides the installed valves in the ECSBS. Figure 6-2 of Technical Report APR1400-E-P-NR-14005-P depicts the Raw Water Supply Isolation Valves; these are in-line valves to supply raw water to the FLEX pumps. The Raw Water Supply Isolation Valves are non safety-related (Quality Group D) and seismic Category I. Further, please note that the mitigating strategy does not have installed non safety-related pumps and/or snubbers in the scope of the APR1400 design.

The specific site related seismic and environmental (including flooding) requirements is a COL item, as indicated in DCD Chapter 19.3.4, COL Items 19.3(1) and 19.2(2), which will be addressed by the COL Applicant. However, the non safety-related equipment is designed as

Quality Group D and Seismic Category I. The design, manufacture, testing, and installation will be in accordance with the industry codes and standards as discussed in response to RAI 19.03-4.

Impact on DCD

There is no impact on DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on 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. 19.03-4

The NRC staff requests that the APR1400 design certification applicant describe the provisions for design, manufacture, testing, installation, and surveillance to provide assurance of the seismic, environmental, and functional capability of all portable or FLEX flow systems (including pumps, valves, and dynamic restraints) that are part of the mitigation strategies (including initial full-power operation and mid-loop operation) to ensure core cooling, containment function, and spent fuel pool cooling capabilities during an extended loss of ac power event at an APR1400 nuclear power plant. For example, APR1400-E-P-NR-14005-P, “Evaluations and Design Enhancements to Incorporate Lessons Learned from the Fukushima Dai-Ichi Nuclear Accident,” Revision 0, December 2014, referenced in APR1400 DCD Tier 2, Section 19.3, indicates in several subsections that FLEX pumps have a “robust design,” without explanation of their design, manufacture, testing, installation, and surveillance provisions. The applicant should indicate where the APR1400 DCD Tier 2 specifies the provisions for the design, manufacture, testing, installation, and surveillance for portable or FLEX pumps, valves, and dynamic restraints that perform functions as part of the mitigation strategies, or provide proposed modifications to the APR1400 DCD Tier 2 to incorporate these provisions.

Response

NEI 12-06, Rev 0 Section 11.0 stipulates the quality attributes and equipment design requirements for FLEX or portable equipment utilized for the mitigating strategies for BDBEE. Accordingly, the FLEX or portable equipment will be procured as “commercial” grade with the design, storage, maintenance, testing as outlined in the NEI document. Additionally, the FLEX or portable equipment will be specified to comply with 10CFR50, Appendix A, GDC 2, as applicable.

The following examples of FLEX equipment utilized for mitigation strategies for APR1400 demonstrates adherence to the above statement:

SFP Spray Pump, SFP Makeup Pump, ECSBS Pump, Primary & Secondary side Pumps will be designed, manufactured, tested and installed in accordance with the applicable commercial codes and standards. Additionally, this FLEX equipment will be designed to satisfy GDC 2 to ensure meeting functional requirements for external environment such as seismic, flooding, wind, etc. for the specific site (COL item).

- The DCD Chapter 19.03 will be revised to reflect the above by adding the following statement:
- "SFP Spray Pump, SFP Makeup Pump, ECSBS Pump, Primary & Secondary side Pumps will be designed, manufactured, tested and installed in accordance with the applicable commercial codes and standards, and with the design, storage, maintenance, testing as outlined in the NEI 12-06, Rev 0 Section 11.0. Additionally, the FLEX equipment will be designed to satisfy GDC 2 to ensure meeting functional requirements for external environment such as seismic, flooding, wind, etc. for the specific site (COL item)."
- "The installed non-safety related in-line valves for the Spent Fuel Pool external makeup water and Emergency Containment Spray Backup system are Quality Group D, and qualified to Seismic Category I requirements. Since these are in-line valves, there is no specific performance requirement for these components."
- "There are no installed non safety related pumps and/or snubbers in the scope of the APR1400 design to mitigate BDBEE."

Impact on DCD

DCD Tier 2, Subsection 19.3.2.3.4, 19.3.4, and Table 1.8-2 (29 of 29) will be revised as indicated on the attached markup.

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

Technical Report APR1400-E-P-NR-14005-P/NP, Section 6.2.2.2, 6.2.3.2, and 6.2.5.2 will be revised as indicated on the attached markup.

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

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SFP Spray Pump, SFP Makeup Pump, ECSBS Pump, Primary & Secondary side Pumps will be designed, manufactured, tested and installed in accordance with the applicable commercial codes and standards, and with the design, storage, maintenance, testing as outlined in the NEI 12-06, Rev 0 Section 11.0. Additionally, the COL applicant is to design the FLEX equipment to satisfy GDC 2 to ensure meeting functional requirements for external environment such as seismic, flooding, wind, etc. for the specific site (COL 19.3(10)).

The installed non-safety related in-line valves for the Spent Fuel Pool external makeup water and Emergency Containment Spray Backup system are Quality Group D, and qualified to Seismic Category I requirements. Since these are in-line valves, there is no specific performance requirement for these components.

There are no installed non safety related pumps and/or snubbers in the scope of the APR1400 design to mitigate BDBEE.

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.

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 design the FLEX equipment to satisfy GDC 2 to ensure meeting functional requirements for external environments such as seismic, flooding, wind, etc. for the specific site.

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 design the FLEX equipment to satisfy GDC 2 to ensure meeting functional requirements for external environments such as seismic, flooding, wind, etc. for the specific site.

condition, if the event occurs during full-power operation or lower mode of operation with SGs available. Alternatively, the low-head FLEX pump is designed to have a TDH of 160.02 m (525 ft) (17 kg/cm^2 A [243 psia] approximately) at 2,839 L/min (750 gpm) in order to maintain the RCS inventory and keep the cold shutdown condition by feed-and-bleed at lower modes of operation with SGs not available.

The FLEX pump is designed to meet the requirements of 10 CFR 50, Appendix A, General Design Criterion (GDC) 2, and is therefore classified as a "robust design." The FLEX pump and the piping associated with this design are also classified as "robust design." All equipment is commercial grade.

6.2.2.3 Compliance with NRC Recommendation

By incorporating this design into the APR1400, an alternate strategy of providing RCS inventory makeup is available when the ACP is not available. This core cooling strategy is described as the contingency plan in Subsection 5.1.2.3 of this report. This design change increases the reliability of the IRWST to maintain RCS water inventory after a BDBEE. This design feature complies with the requirements specified in References 5, 7, and 8.

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6.2.3 Spent Fuel Pool – Makeup Line and Spray Line Enhancements

6.2.3.1 Design Description

As part of the FLEX strategy to address Recommendation 4.2, Figures 6-2, 6-3, and 6-4 depict the SFP configuration to maintain SFP cooling by providing SFP makeup and SFP spray capabilities. Therefore, the following design is provided in the APR1400 to enhance the capability of the SFP diverse makeup lines and SFP spray lines to cope with BDBEEs:

- Primary Connection: Permanently installed suction connection from the RWT for FLEX pump suction.

  RWT is used as the suction water source of the FLEX pumps. Two seismically qualified, 15.24 cm(6 in) diameter lines are installed downstream of RWT in the yard. The primary and secondary piping connections with isolation valves are located outside building and hose connector are located in the yard. A 15.24 cm(6 in) flexible hose is connected between the water supply line and the FLEX pump suction.

- Hose connections are provided for the FLEX pump connections for the SFP spray lines and SFP diverse makeup standpipes at the exterior of the auxiliary building.

6.2.3.2 Design Basis

The FLEX pump is designed to meet the requirements of 10 CFR 50, Appendix A, GDC 2, and is therefore classified as a "robust design." The FLEX pump and the piping associated with this design are also classified as "robust design." All equipment is commercial grade.

The SFP diverse makeup and spray lines are 15.24 cm (6 in) and 10.16 cm (4 in) pipes, respectively, to accommodate the 1,893 L/min (500 gpm) of makeup flow and 757 L/min (200 gpm) of spray flow. Since a flow rate of 493.28 L/min (130.31 gpm), approximately, is required to restore SFP inventory during SFP boiling (see Subsection 5.1.2.4), pipe sizes for the SFP makeup and spray lines are sufficient to provide the necessary flow rate during BDBEE.

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These seismically qualified SFP makeup and SFP spray lines are connected to an onsite source of water, namely, the RWT. These enhanced design features enable the plant to cope for up to 6.4 days (in consideration of ECSBS actuation at the same time) without offsite resources.

B

The primary side FLEX Pump will be designed, manufactured, tested and installed in accordance with the applicable commercial codes and standards, and with the design, storage, maintenance, testing as outlined in the NEI 12-06, Rev 0 Section 11.0. Additionally, the COL applicant is to design the FLEX equipment to satisfy GDC 2 to ensure meeting functional requirements for external environment such as seismic, flooding, wind, etc. for the specific site (COL 19.3(10)).
The installed non-safety related in-line valve for the safety injection system is Quality Group D, and qualified to Seismic Category I requirements. Since this is in-line valve, there is no specific performance requirement for this component.

C

The SFP spray pump and SFP makeup pump will be designed, manufactured, tested and installed in accordance with the applicable commercial codes and standards, and with the design, storage, maintenance, testing as outlined in the NEI 12-06, Rev 0 Section 11.0. Additionally, the COL applicant is to design the FLEX equipment to satisfy GDC 2 to ensure meeting functional requirements for external environment such as seismic, flooding, wind, etc. for the specific site (COL 19.3(10)).
The installed non-safety related in-line valves for the SFP external makeup water system are Quality Group D, and qualified to Seismic Category I requirements. Since these are in-line valves, there is no specific performance requirement for these components.

D

The secondary side Pump will be designed, manufactured, tested and installed in accordance with the applicable commercial codes and standards, and with the design, storage, maintenance, testing as outlined in the NEI 12-06, Rev 0 Section 11.0. Additionally, the COL applicant is to design the FLEX equipment to satisfy GDC 2 to ensure meeting functional requirements for external environment such as seismic, flooding, wind, etc. for the specific site (COL 19.3(10)).

The primary and backup instrument channels provide continuous level indication over a minimum range from the high SFP alarm El. 154 ft 2 in plus the accuracy of the SFP water level instrument channel to the top of the spent fuel racks at El 129 ft 6 in minus the accuracy of the SFP water level instrument channel.

6.2.4.2 Design Basis

The SFP instruments selected are seismically mounted. The probe is designed to operate in borated water and non-borated water over the entire expected range of pool conditions from normal water temperatures to boiling temperatures. Cables and connections are designed for expected radiation levels and environments of greater than 100 °C (212 °F) and 100 percent humidity.

6.2.4.3 Compliance with NRC Recommendations

The requirements and guidelines of NEI 12-02, Rev. 1 and NRC's JLD-ISG-2012-03, Rev. 0 are met.

6.2.5 AFWS Secondary Side FLEX Pump Connection

6.2.5.1 Design Description

Two secondary side diesel-driven FLEX pump connections are provided to the auxiliary feedwater system (AFWS) supply lines. One FLEX pump is connected to the train of the TDAFWP PP01A and the other to the TDAFWP PP001B. The FLEX pump suction and discharge pipes are 15.24 cm (6 in) diameter with Siamese connection. The suction and discharge connections are provided at the upstream of the auxiliary feedwater pump (AFWP) suction and the upstream of the AFW modulating valve, respectively. The RWT is an alternate water source that is independent, seismically qualified, and is connected to the AFWP suction. The piping sections connected at the AFW supply lines are classified as Safety Class 3, seismic Category I. The piping section downstream of the isolation valve at the exterior of the auxiliary building up to the connector is non-safety class and designed as seismic Category I. The specific features are depicted in Figure 6-5. Also, Figure 6-6 depicts the fuel oil connection for the secondary side FLEX pumps.

6.2.5.2 Design Basis

The AFWSTs are used as the water source for the TDAFWP and the secondary side FLEX pumps. Before water in the AFWST depletes, the suction of the TDAFWP is switched to the RWT. The onsite water sources are sufficient to keep the hot shutdown condition and for continuous NCC operation for at least 12 days.

Each secondary side FLEX pump is designed to remove decay heat and keep the hot shutdown condition. The fuel for secondary side FLEX pump is supplied from the EDG fuel oil storage tank A/B as shown in Figure 6-6.

The secondary side FLEX pump is designed to meet the requirements of 10 CFR 50, Appendix A, GDC 2, and is therefore classified as a "robust design." The FLEX pump and the piping associated with this design are also classified as "robust design." All equipment is commercial grade. Each secondary side FLEX pump is designed for 1,174 L/min (310 gpm) at a TDH of 160 m (525 ft).

The COL applicants are responsible to determine the final FLEX pump design head considering site conditions.

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6.2.5.3 Compliance with NRC Recommendations

By incorporating this design into the APR1400, alternative water makeup sources to the TDAFWP are available to supplement the water source to the SG and provide RCS cooldown. This design increases