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

Question No. 19.03-1

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.

APR1400 DCD Tier 2, Section 19.3, "Beyond Design Basis External Event," describes the mitigation strategies to manage and mitigate external events that are beyond the design basis of the APR1400 nuclear power plant. This section in the DCD addresses the conformance of the APR1400 design with SECY-12-0025 and Commission Order EA-12-049, and other related documents.

The NRC staff requests that the APR1400 design certification applicant describe the performance requirements 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 a BDBEE at an APR1400 nuclear power plant as follows:

a) All safety-related installed pumps, valves, and dynamic restraints that will be used at the APR1400 plant as part of the mitigation strategies for an extended loss of ac power event;

b) All non-safety related installed pumps, valves, and dynamic restraints that will be used at the APR1400 plant as part of the mitigation strategies for an extended loss of ac power event; and

c) All portable or FLEX flow systems (including pumps, valves, and dynamic restraints) that will be used at the APR1400 plant as part of the mitigation strategies for an extended loss of ac power event.

Response – (Rev. 1)

a) A summary of safety-related installed pumps and valves that will be used as part of the mitigation strategies for an extended loss of ac power event will be added to Technical Report APR1400-E-P-NR-14005-P/NP as indicated in Attachment 1. Because the performance requirements of these pumps and valves are described in various chapters and sections of the DCD Tier 2, the added table provides cross references to the respective DCD chapters and sections for the performance requirements for this safety related pumps and valves.

Please note that mitigating strategies to address BDBEE does not include any dynamic restraints (snubbers) in the piping design, hence, they are not identified within the technical report.

b) The installed non-safety related valves for the Spent Fuel Pool external makeup and spray water, and Emergency Containment Spray Backup System (ECSBS) are identified in the Technical Report APR1400-E-P-NR-14005-P/NP, Section 6.2.3 for SFP and Section 5.1.2.5.3 for ECSBS respectively. Further, Figure 6-3 and Table 6-1 of the Technical Report depict the installed non-safety related valves in the SFP external makeup and spray lines. DCD Tier 2, Figure 6.2.2-1 identifies the installed valves in the ECSBS.

Both of these systems have installed valves that are non-safety related (Quality Group D) but are qualified to Seismic Category I. Since these are in-line on/off valves, there is no specific regulating performance requirement for these components.

Please note that there are no installed non-safety related pumps and/or snubbers in the scope of the APR1400 design to mitigate BDBEE on core cooling, containment functions, and SFP cooling.

c) The following are the performance requirements for the portable or FLEX equipment utilized to mitigate the BDBEE as discussed in Technical Report APR1400-E-P-NR-14005-P/NP:

Items	Performance Requirements	Reference (TeR)
Primary side high-head FLEX Pump	To supply makeup water to RCS when ACP is not available. Design flowrate of 50 gpm at operating pressure of 1,500 psia	Sections 5.1.2.3.1.2.2 & 6.2.2.2
Primary side low-head FLEX Pump	To supply makeup water to RCS. Design flowrate of 750 gpm at TDH of 525 ft	Sections 5.1.2.3.3.2 & 6.2.2.2
Secondary side FLEX Pump	To supply cooling water to associated SG when TDAFWP is not available. Design flowrate of 310 gpm at a TDH of 525 ft	Sections 5.1.2.3.1.2.2 & 6.2.5.2
SFP Makeup FLEX Pump	To supply makeup water to SFP. Design flowrate of 500 gpm at a discharge pressure head of 105 ft	Sections 5.1.2.4.1.2 & 6.2.3.2
SFP Spray FLEX Pump	To supply makeup water to SFP. Design flowrate of 200 gpm at a discharge pressure head of 107 ft	Sections 5.1.2.4.1.2 & 6.2.3.2
SFP Isolation Valves at makeup and spray connections	Primary and secondary piping connections with proper fittings are provided with isolation valves.	Section 6.2.3.1 & Table 6-1
ECSBS FLEX Pump	To prevent containment over-pressurization. Design flowrate of 750 gpm at a discharge pressure head of 656 ft	Section 5.1.2.5.2.3 & Figure 5-2 & 5-3
480 V mobile GTG	To supply the power to Class 1E 480 V load centers, and etc. in Train A or B in Phase 2. Capacity of 1,000 kW	Sections 5.1.2.6.1.1 & 6.2.6.1; Table 5-5
4.16 kV mobile GTG	To supply the power to 4.16 kV switchgear, etc. in Train A or B during Phase 3. Capacity of 5,000 kW	Sections 5.1.2.6.1.1 & 6.2.6.1; Table 5-5
Fuel Oil Supply Isolation Valves on DFODT A and B	In-line valves to supply fuel oil to mobile GTG and FLEX pumps	Table 6-1
Raw Water Supply Isolation Valves	In-line valves to supply raw water to the FLEX pumps	Figure 6-2

The COL applicant is responsible for determining the final FLEX pump design head considering site conditions. The COL 19.3(5) in DCD Tier 2, Subsections 19.3.2.3.4 will be revised to clarify the scope of COL for the FLEX pumps as indicated in Attachment 2.

Also, Technical Report APR1400-E-P-NR-14005-P/NP will be revised to clarify the performance requirements for the FLEX equipment and the requirements for COL applicant as indicated in the Attachment 2.

The section and figure numbers for references related to ECSBS FLEX Pump are changed since that information was previously changed in the revised response to RAI 393-8432, Question 19.03-13, Rev.1. Therefore, the performance requirement of ECSBS FLEX Pump will be clarified in the revised response to RAI 393-8432, Question 19.03-13, Rev.2.

Impact on DCD

The COL 19.3(5) in DCD Tier 2, Subsections 19.3.2.3.4 will be revised as indicated in the Attachment 2.

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 will be revised as indicated in the Attachment 1 and Attachment 2.

LIST OF TABLES

LIST OF FIGURES

6.0 DESIGN FEATURES AND PROGRAMS TO ADDRESS BDBEE

This chapter compiles design enhancements and programs that are incorporated into the APR1400 design to cope with the lessons learned from the accidents at TEPCO's Fukushima Dai-ichi Nuclear Power Station, and satisfy the requirements/recommendations issued after the disaster by the U.S. NRC. Design features and program descriptions, design basis, and compliance with NRC recommendations are described herein.

6.1 Overall Description

The following is the overall description:

- Fukushima issues are described in DCD Chapter 19.3.
- Compliance with NRC guidance is described in DCD Tier 2, Section 1.9.
- COL information is described in DCD Chapter 19.3.
- Connection points for FLEX equipment are incorporated in the system figures along with Table 6-1, which identifies the external connection components.
- Installed safety related pumps and valves are summarized in Table 6-2, with cross references to the DCD.

6.2 Specific Design Enhancements and Programs

6.2.1 Beyond Design Basis Seismic and Flood Protection

BDB seismic and flood protection is a COL item.

6.2.2 Primary Side FLEX Pump(s) and Connections

6.2.2.1 Design Description

One primary side FLEX pump connection has been provided into the SIS, downstream of the safety injection pump (SIP) no. 1 discharge line connection to the direct vessel injection (DVI) nozzle on the reactor vessel (RV) in the RCS, as shown in Figure 6-1. The primary side FLEX pump connection can be used by the high-head or low-head FLEX pump, depending on their necessity. The primary side high-head FLEX pump suction is the IRWST, while the low-head FLEX pump suction is the RWT. The connector size to the hose screw connector upstream of the primary FLEX pump suction is designed as 6.35 cm(2.5 in) diameter in accordance with the fire industry standard, while the primary FLEX pump suction line is designed as 10.16 cm (4 in) diameter. The connection for FLEX pump will not introduce new failure during normal plant operation by keeping the RCS pressure boundary through manual isolation (Safety Class 1) and blind flange.

6.2.2.2 Design Basis

The IRWST is used as the water source for the ACP, and the primary side high-head FLEX pump. The water volume required for RCS inventory makeup during Phase 2 is approximately 643.52 m^3 (170,000 gal). The onsite water sources are sufficient to maintaining the plant in hot standby or hot shutdown condition for 2 weeks without considering consumption for the SFP cooling.

The primary side high-head FLEX pump is designed to supply 189.25 L/min (50 gpm) constantly, regardless of RCS pressure, in order to maintain the RCS inventory and remain in the hot shutdown 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

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9.1.3-1

Table 6-1 (1 of 2)

External Connection Components for BDBEE

Component	DCD Chapter and/or Section	Function
V2601	Figure 6.3.1-2	SFP external makeup line check valve
V2602	Figure 6.3.1-2	SFP external makeup line isolation valve
V2605	Figure 6.3.1-2	SFP external spray line check valve
V2606	Figure 6.3.1-2	SFP external spray line isolation valve
V2611	Figure 6.3.1-2	SFP external makeup line check valve
V2612	Figure 6.3.1-2	SFP external makeup line isolation valve
V2615	Figure 6.3.1-2	SFP external spray line check valve
V2616	Figure 6.3.1-2	SFP external spray line isolation valve
SI-801	Table 3.9-4, Table 3.9-13, Figure 6.3.2-1 (4 of 4)	External emergency injection line check valve
SI-803	Table 3.9-4, Table 3.9-13, Figure 6.3.2-1 (4 of 4)	External emergency injection line isolation valve
SI-805	Figure 6.3.2-1 (4 of 4)	External emergency injection line fill isolation valve
SI-807	Figure 6.3.2-1 (4 of 4)	External emergency injection line isolation valve
CH-784	Figure 9.3.4-1 (4 of 7)	Primary side high-head FLEX pump suction isolation
V2678A	Figure 10.4.9-1	AF FLEX pump suction line backflow prevention
V2678B	Figure 10.4.9-1	AF FLEX pump suction line backflow prevention
V2679A	Figure 10.4.9-1	AF FLEX pump suction line isolation
V2679B	Figure 10.4.9-1	AF FLEX pump suction line isolation
V2098A	Figure 10.4.9-1	AF FLEX pump discharge line backflow prevention
V2098B	Figure 10.4.9-1	AF FLEX pump discharge line backflow prevention
V2102A	Figure 10.4.9-1	AF FLEX pump discharge line isolation
V2102B	Figure 10.4.9-1	AF FLEX pump discharge line isolation
V2001A	Figure 9.5.4-1	Diesel fuel oil day tank discharge line to mobile equipment isolation
V2001B	Figure 9.5.4-1	Diesel fuel oil day tank discharge line to mobile equipment header isolation
V2001C	Figure 9.5.4-1	Diesel fuel oil day tank discharge line to mobile equipment header isolation
V2001D	Figure 9.5.4-1	Diesel fuel oil day tank discharge line to mobile equipment header isolation
V2202A	Figure 9.5.4-1	Diesel fuel oil supply line to mobile GTG isolation
V2202B	Figure 9.5.4-1	Diesel fuel oil supply line to mobile GTG isolation
V2202C	Figure 9.5.4-1	Diesel fuel oil supply line to mobile GTG isolation
V2202D	Figure 9.5.4-1	Diesel fuel oil supply line to mobile GTG isolation

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Table 6-1 (2 of 2)

Component	DCD Chapter and/or Section	Function
V2204A	Figure 9.5.4-1	Diesel fuel oil supply line to primary high-head pump isolation
V2204B	Figure 9.5.4-1	Diesel fuel oil supply line to primary high-head pump isolation
V2204C	Figure 9.5.4-1	Diesel fuel oil supply line to primary high-head pump isolation
V2204D	Figure 9.5.4-1	Diesel fuel oil supply line to primary high-head pump isolation
V2205A	Figure 9.5.4-1	Diesel fuel oil supply line to primary low-head pump isolation
V2205B	Figure 9.5.4-1	Diesel fuel oil supply line to primary low-head pump isolation
V2205C	Figure 9.5.4-1	Diesel fuel oil supply line to primary low-head pump isolation
V2205D	Figure 9.5.4-1	Diesel fuel oil supply line to primary low-head pump isolation
V2203C	Figure 9.5.4-1	Diesel fuel oil supply line to AF FLEX pump isolation
V2203D	Figure 9.5.4-1	Diesel fuel oil supply line to AF FLEX pump isolation
V2206A	Figure 9.5.4-1	Diesel fuel oil supply line to SFP pump isolation
V2206B	Figure 9.5.4-1	Diesel fuel oil supply line to SFP pump isolation
V2207A	Figure 9.5.4-1	Diesel fuel oil supply line to SFP spray pump isolation
V2207B	Figure 9.5.4-1	Diesel fuel oil supply line to SFP spray pump isolation
Circuit Breaker of Class 1E 4.16 kV Switchgear 01A (1-823-E-SW01A)	Figure 8.1-1 (1 of 2)	Provision for connecting to 4.16 kV mobile generator
Circuit Breaker of Class 1E 4.16 kV Switchgear 01B (1-823-E-SW01B)	Figure 8.1-1 (2 of 2)	Provision for connecting to 4.16 kV mobile generator
Circuit Breaker of Class 1E 480 V Load Center 01A (1-825-E-LC01A)	Figure 8.1-1 (1 of 2)	Provision for connecting to 480V mobile generator
Circuit Breaker of Class 1E 480 V Load Center 01B (1-825-E-LC01B)	Figure 8.1-1 (2 of 2)	Provision for connecting to 480V mobile generator
Battery	9.5.2.1	The communication systems are powered from one of the two dedicated 16-hour-rated non-safety-related batteries (normal and standby) in case of either AAC GTG failure during a LOOP or SBO condition.

Insert "A".

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Table 6-2 (1 of 3)

List of Installed Safety Related Pumps and Valves for BDBEE

Description	DCD Tier 2 Reference
Turbine driven Auxiliary Feedwater Pump	10.4.9, Table 10.4.9-1
Main Steam Safety Valve	10.3.2, Table 10.3.2-1
Main Steam Atmospheric Dump Valve	10.3.2, Table 10.3.2-1
Auxiliary Charging Pump	9.3.4, Table 9.3.4-2
Boric Acid Makeup Pump	9.3.4, Table 9.3.4-2
Boric Acid Makeup Pump	9.3.4, Table 9.3.4-2
Direct Boration Valve	9.3.4, *
BAST Gravity Valve (Train A)	9.3.4, *
BAST Gravity Valve (Train B)	9.3.4, *
Charging Containment Isolation Valve	9.3.4, Table 6.2.4-1
Diesel Fuel Oil Transfer Pump 1-595-PP01A	9.5.4, Table 9.5.4-1
Diesel Fuel Oil Transfer Pump 1-595-PP02A	9.5.4, Table 9.5.4-1
Diesel Fuel Oil Transfer Pump 1-595-PP01B	9.5.4, Table 9.5.4-1
Diesel Fuel Oil Transfer Pump 1-595-PP02B	9.5.4, Table 9.5.4-1
Shutdown Cooling Pump-1	5.4.7, Table 5.4.7-1
Shutdown Cooling Pump-2	5.4.7, Table 5.4.7-1
SCS Suction Line Isolation Valve SI-651	5.4.7, *
SCS Suction Line Isolation Valve SI-652	5.4.7, *
SCS Suction Line CTMT Isolation Valve SI-655	5.4.7, Table 6.2.4-1
SCS Suction Line Isolation Valve SI-656	5.4.7, *
SCS Warmup Line Isolation Valve SI-690	5.4.7, *
SCS Warmup Line Isolation Valve SI-691	5.4.7, *
SCS Test Return Line Isolation Valve SI-314	5.4.7, *
SCS Test Return Line Isolation Valve SI-315	5.4.7, *
SCS Test Return Line Isolation Valve SI-688	5.4.7, *
SCS Test Return Line Isolation Valve SI-693	5.4.7, *
SDCHX Bypass Flow Control Valve SI-312	5.4.7, *
SDCHX Bypass Flow Control Valve SI-313	5.4.7, *
SDCHX Discharge Isolation and Throttle Valve SI-310	5.4.7, *
SDCHX Discharge Isolation and Throttle Valve SI-311	5.4.7, *
IRWST Return Line CTMT Isolation Valve SI-300	5.4.7, Table 6.2.4-1
IRWST Return Line CTMT Isolation Valve SI-301	5.4.7, Table 6.2.4-1
SCS DVI CTMT Isolation Valve SI-600	5.4.7, Table 6.2.4-1
SCS DVI CTMT Isolation Valve SI-601	5.4.7, Table 6.2.4-1

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Table 6-2 (2 of 3)

Description	DCD Tier 2 Reference
IRWST Return Line Isolation Valve SI-395	5.4.7, *
SIP/SCP Suction Cross Connection Valve SI-344	5.4.7, *
SIP/SCP Suction Cross Connection Valve SI-346	5.4.7, *
CCW Pump 1A	9.2.2, Table 9.2.2-4
CCW Pump 1B	9.2.2, Table 9.2.2-4
CCW HX HE01A Outlet Valve 1-461-V-0021	9.2.2, Table 9.2.2-5
CCW HX HE01B Outlet Valve 1-461-V-0022	9.2.2, Table 9.2.2-5
CCW HX HE02A Outlet Valve 1-461-V-0023	9.2.2, Table 9.2.2-5
CCW HX HE02B Outlet Valve 1-461-V-0024	9.2.2, Table 9.2.2-5
CCW HX HE03A Outlet Valve 1-461-V-0025	9.2.2, Table 9.2.2-5
CCW HX HE03B Outlet Valve 1-461-V-0026	9.2.2, Table 9.2.2-5
CCW HX Bypass ISOL Valve 1-461-V-0027	9.2.2, Table 9.2.2-5
CCW HX Bypass ISOL Valve 1-461-V-0028	9.2.2, Table 9.2.2-5
Non-Safety Load ISOL Valve 1-461-V-0143	9.2.2, Table 9.2.2-5
Non-Safety Load ISOL Valve 1-461-V-0144	9.2.2, Table 9.2.2-5
Non-Safety Load ISOL Valve 1-461-V-0149	9.2.2, Table 9.2.2-5
Non-Safety Load ISOL Valve 1-461-V-0150	9.2.2, Table 9.2.2-5
DG A HX Inlet ISOL Valve 1-461-V-0191	9.2.2, Table 9.2.2-5
DG B HX Inlet ISOL Valve 1-461-V-0192	9.2.2, Table 9.2.2-5
RCP Cooling Return CTMT ISOL Valve 1-461-V-0249	9.2.2, Table 6.2.4-1
Letdown HX Cooling Supply CTMT ISOL Valve 1-461-V-0296	9.2.2, Table 6.2.4-1
Letdown HX Cooling Supply CTMT ISOL Valve 1-461-V-0297	9.2.2, Table 6.2.4-1
Letdown HX Cooling Return CTMT ISOL Valve 1-461-V-0301	9.2.2, Table 6.2.4-1
Letdown HX Cooling Return CTMT ISOL Valve 1-461-V-0302	9.2.2, Table 6.2.4-1
SC HX 01A Inlet ISOL Valve 1-461-V-0351	9.2.2, *
SC HX 01B Inlet ISOL Valve 1-461-V-0352	9.2.2, *
ESSEN CHLR CNDSR 1A Outlet ISOL Valve 1-461-V-0383	9.2.2, *
ESSEN CHLR CNDSR 1B Outlet ISOL Valve 1-461-V-0384	9.2.2, *
SFP Cooling HX 02A Inlet ISOL Valve 1-461-V-0389	9.2.2, *
SFP Cooling HX 02B Inlet ISOL Valve 1-461-V-0390	9.2.2, *
Essential Service Water (ESW) Pump 1A	9.2.1, Table 9.2.1-1
Essential Service Water (ESW) Pump 1B	9.2.1, Table 9.2.1-1
ESW PP 01A DISCH Valve 1-462-V-0045	9.2.1, *
ESW PP 01B DISCH Valve 1-462-V-0046	9.2.1, *
ESW Flow Control Valve 1-462-V-0071	9.2.1, *
ESW Flow Control Valve 1-462-V-0072	9.2.1, *

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Table 6-2 (3 of 3)

Description	DCD Tier 2 Reference
Cooling Tower Bypass Valve 1-462-V-0075	9.2.1, *
Cooling Tower Bypass Valve 1-462-V-0076	9.2.1, *
MSADV Inlet Isolation Valve 1-521-V105	10.3.2, *
MSADV Inlet Isolation Valve 1-521-V106	10.3.2, *
MSADV Inlet Isolation Valve 1-521-V107	10.3.2, *
MSADV Inlet Isolation Valve 1-521-V108	10.3.2, *
Aux. Feedwater CTMT Isolation Valve 1-542-V-0043	10.4.9, Table 6.2.4-1
Aux. Feedwater CTMT Isolation Valve 1-542-V-0044	10.4.9, Table 6.2.4-1
Essential Chilled Water Pump 1A	9.2.7, Table 9.2.7-1
Essential Chilled Water Pump 1A	9.2.7, Table 9.2.7-1

* These valves are inline valves, and there is no unique performance requirement for these valves.

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

Also, the COL applicant is to address site-specific strategies to mitigate BDBEEs as specified in NRC Order EA-12-049 (COL 19.3(5)), including but not limited to the following:

a. Evaluation of site-specific external hazards

b. Determination and protection of portable equipment including final design head for FLEX pumps

c. Providing means for acquisition, staging, and installation of equipment

d. Establishing means for maintaining and testing of portable equipment

e. Establishing procedures and guidance on mitigation of BDBEEs

f. Establishing training of personnel to the developed strategies and procedures

19.3.2.4 Recommendation 7.1 – Reliable Spent Fuel Pool Instrumentation

The APR1400 employs reliable indication of the water level in the SFP capable of supporting identification of the following pool water level conditions:

a. Level that is adequate to support operation of the normal fuel pool cooling system

b. Level that is adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck

c. Level at which fuel remains covered and actions to implement makeup water addition should no longer be deferred

The APR1400 SFP water level instrumentation is consistent with the guidelines addressed in NRC EA-12-051, NEI 12-02 (Reference 8), and JLD-ISG-2012-03 (Reference 9).

The primary instrument channel provides level indication through the use of guided wave radar (GWR) technology using the principle of time domain reflectometry (TDR).

The FLEX pump discharge hose is routed to one of the two permanent SFP makeup connections located outside the east wall of the auxiliary building, as shown in Figure 6-2. One primary connection location is mounted on the wall of auxiliary building adjacent to, and just south of, the emergency diesel generator (EDG) building, and the other connection is mounted on the wall of auxiliary building adjacent to, and just north of, the emergency diesel generator building. The alternate connection is close to the SFP makeup connections. An SFP spray connection is close to each SFP makeup connection.

Standpipes to SFP Area

The FLEX pump connections are each connected to an independent, seismically qualified standpipe that runs inside the auxiliary building from the pump staging area to a location above the SFP at El. 156 ft. The two standpipes for the SFP makeup pump and the two standpipes for the SFP spray pump are located at diverse locations in the auxiliary building and extend from the ground elevation to the SFP elevation. The standpipes are suitably separated on the same side of the auxiliary building. The standpipes have connections at the bottom at ground elevation and the connections are external to the auxiliary building. Operators are able to connect flexible hoses to the standpipes, which are supplied by a FLEX pump. The standpipes for SFP makeup have hard-piped connections to the SFP edge to allow water makeup to the pool. The standpipes for SFP spray have hard-piped connections to the spray headers to allow spray into the pool. Each spray header is equipped with a number of spray nozzles to direct flow into SFP area. An isolation valve and a check valve are provided on each standpipe.

The simplified arrangements of these makeup and spray provisions are shown in Figures 6-2 and 6-3.

SFP Makeup FLEX Pumps

The diesel-driven FLEX pumps are provided to supply SFP makeup and SFP spray at a rate of at least 1,893 L/min (500 gpm) and 757 L/min (200 gpm), respectively.

at discharge pressure heads of 32 m (105 ft) and 32.6 m (107 ft)

FLEX Equipment Storage

The flexible hoses, FLEX pump, FLEX pump fuel supply, and any other FLEX equipment required for this strategy are stored away from the auxiliary building (i.e., greater than 91.44 m [100 yards] away) so that mobilization of the equipment for SFP makeup capability can occur within the 25.03-hour period identified above. The specific storage location, mobilization, and other details for the FLEX equipment are COL items.

5.1.2.4.1.3 Phase 3: SFP Cooling (after 72 hours)

The APR1400 continues operating with Phase 2 strategies to provide makeup to the SFP in Phase 3. In Phase 3, makeup to the RWT is provided from offsite water sources by the COL applicant.

5.1.2.4.2 Supporting Analyses for the Operational Strategy for SFP Cooling

SFP decay heat removal capacity has been evaluated to confirm that SFP cooling can be continued during and after the occurrence of a BDBEE resulting in an ELAP and LUHS.

5.1.2.4.2.1 Evaluation Conditions

NEI 12-06, Section 3.2.1.6 defines the following SFP conditions as general criteria and baseline assumptions for SFP conditions:

- All boundaries of the SFP are intact, including the liner, gates, transfer canals, etc.

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a. Normally closed motor-operated valve (MOV) (fail as-is)

b. Air-operated valve (AOV) (fail closed)

c. Check valve inside containment (automatic isolation)

5.1.2.5.2 Containment Capability during Full-Power Operation

The containment design incorporates a prestressed concrete containment with a steel liner to house the nuclear steam supply system. The containment and associated systems are designed to safely withstand environmental conditions that may be expected to occur during the life of the plant, including both short-term and long-term effects following a design basis accident (DBA) and beyond DBA.

During a BDBEE, no major pipe break is postulated inside the containment, but RCP seal leakage is assumed to be at a leak rate of 94.64 L/min (25 gpm) per RCP, a total of 378.5 L/min (100 gpm) for four RCPs. The containment pressure and temperature analyses are performed using the GOTHIC (Version 8.0) computer program. The containment pressure reaches the design pressure of 5.25 kg/cm^2 A (74.7 psia) in about 63 days from the beginning of the event. The design temperature of 143 °C (290 °F) is not exceeded until 71 days following the event. Figure 5-3 provides the containment pressure and temperature responses with the assumed RCP seal leakage. Therefore, containment integrity is maintained following full-power events through all phases.

5.1.2.5.3 Containment Capability during Mode 5 Operation

Loss of residual heat removal (RHR) during mid-loop operation in mode 5 is additionally assumed for the evaluation of containment capability. In the RCS mid-loop operation, SG nozzle dams are installed on the steam generator plena and the pressurizer manway remains opened. 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.

Due to the mass and energy released from the RCS, containment pressure increases consistently from the beginning of the event, but it can be maintained below UPC by operating the ECSBS intermittently after reaching UPC at around 83 hours. 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 A (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. The FLEX pump provides the flow rate of 2,839 L/min (750 gpm) ~~and the differential pressure of at least 2.8 kg/cm^2 (40 psi) at the ECSBS nozzle.~~ at a discharge pressure head of 200 m (656 ft). The external water source for ECSBS operation is the RWT.

GOTHIC analyses are performed for evaluation of the containment pressure and temperature responses following loss of RHR in mode 5. Figure 5-4 shows that the containment pressure reaches the UPC value in about 3.5 days without ECSBS operation, but with the intermittent operation of ECSBS, containment pressure can be maintained within the UPC limit. Figure 5-5 shows that the containment temperature is maintained well below 185 °C (365 °F), which is less than the upper limit temperature of 196 °C (385 °F) for ensuring the operability of RCS sensors.

This subsection is changed by RAI 393-8432 - Question 19.03-13_Rev.1

5.1.2.6 Support Systems

5.1.2.6.1 Electrical Systems

This subsection describes the electrical strategies to support the FLEX items described above for NTTF 4.1 and 4.2.

As stated earlier, the BDBEE causes the unit to lose all ac power. The initial condition is assumed to be 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.

The COL applicant is responsible for determining the final FLEX pump design head considering site conditions.

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.

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 with proper fittings 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.~~ the makeup flow of 1,893 L/min (500 gpm) at a discharge pressure head of 32 m (105 ft), and the spray flow of 757 L/min (200 gpm) at a discharge pressure head of 32.6 m (107 ft). 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.

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.

The COL applicant is responsible for determining the final FLEX pump design head considering site conditions.