UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

August 11, 2016

Vice President, Operations
Entergy Operations, Inc.
River Bend Station
5485 U.S. Highway 61N
St. Francisville, LA 70775

SUBJECT: RIVER BEND STATION, UNIT 1 – SAFETY EVALUATION REGARDING IMPLEMENTATION OF MITIGATING STRATEGIES AND RELIABLE SPENT FUEL INSTRUMENTATION RELATED TO ORDERS EA-12-049 AND EA-12-051 (CAC NOS. MF0952 and MF0953)

Dear Sir or Madam:

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design-Basis External Events" and Order EA-12-051, "Order to Modify Licenses With Regard To Reliable Spent Fuel Pool Instrumentation," (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML12054A736 and ML12054A679, respectively). The orders require holders of operating reactor licenses and construction permits issued under Title 10 of the *Code of Federal Regulations* Part 50 to modify the plants to provide additional capabilities and defense-in-depth for responding to beyond-design-basis external events, and to submit for review Overall Integrated Plans (OIPs) that describe how compliance with the requirements of Attachment 2 of each order will be achieved.

By letter dated February 28, 2013 (ADAMS Accession No. ML13066A738), Entergy Operations, Inc. (Entergy, the licensee) submitted its OIP for the River Bend Station, Unit 1 (River Bend, RBS) in response to Order EA-12-049. At six month intervals following the submittal of the OIP, the licensee submitted reports on its progress in complying with Order EA-12-049. These reports were required by the order, and are listed in the attached safety evaluation. By letter dated August 28, 2013 (ADAMS Accession No. ML13234A503), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" (ADAMS Accession No. ML082900195). By letters dated February 25, 2014 (ADAMS Accession No. ML13365A281), and February 18, 2015 (ADAMS Accession No. ML15026A645), the NRC issued an Interim Staff Evaluation (ISE) and audit report, respectively, on the licensee's progress. By letter dated September 29, 2015 (ADAMS Accession No. ML15279A345), Entergy submitted a compliance letter and Final Integrated Plan (FIP) in response to Order EA-12-049. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-049.

By letter dated February 28, 2013 (ADAMS Accession No. ML130660550), Entergy submitted its OIP for RBS in response to Order EA-12-051. At six month intervals following the submittal of the OIP, the licensee submitted reports on its progress in complying with Order EA-12-051. These reports were required by the Order, and are listed in the attached safety evaluation. By

2015 (ADAMS Accession No. ML15026A645), the NRC staff issued an ISE and audit report, respectively, on the licensee's progress. By letter dated March 26, 2014 (ADAMS Accession No. ML14083A620), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-051 in accordance with NRC NRR Office Instruction LIC-111, similar to the process used for Order EA-12-049. By letter dated May 18, 2015 (ADAMS Accession No. ML15154A837), Entergy submitted a compliance letter and FIP in response to Order EA-12-051. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-051.

The enclosed safety evaluation provides the results of the NRC staff's review of Entergy's strategies for River Bend. The intent of the safety evaluation is to inform Entergy on whether or not its integrated plans, if implemented as described, provide a reasonable path for compliance with Orders EA-12-049 and EA-12-051. The staff will evaluate implementation of the plans through inspection, using Temporary Instruction 191, "Implementation of Mitigation Strategies and Spent Fuel Pool Instrumentation Orders and Emergency Preparedness Communications/Staffing/ Multi-Unit Dose Assessment Plans" (ADAMS Accession No. ML14273A444). This inspection will be conducted in accordance with the NRC's inspection schedule for the plant.

If you have any questions, please contact John Hughey, Orders Management Branch, River Bend Project Manager, at 301-415-3204 or at John.Hughey@nrc.gov.

Sincerely,

Mandy K Halter

Mandy Halter, Acting Chief
Orders Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket No.: 50-458

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO ORDERS EA-12-049 AND EA-12-051

ENTERGY OPERATIONS, INC

RIVER BEND STATION, UNIT 1

DOCKET NO. 50-458

1.0 INTRODUCTION

The earthquake and tsunami at the Fukushima Dai-ichi nuclear power plant in March 2011 highlighted the possibility that extreme natural phenomena could challenge the prevention, mitigation and emergency preparedness defense-in-depth layers already in place in nuclear power plants in the United States. At Fukushima, limitations in time and unpredictable conditions associated with the accident significantly challenged attempts by the responders to preclude core damage and containment failure. During the events in Fukushima, the challenges faced by the operators were beyond any faced previously at a commercial nuclear reactor and beyond the anticipated design-basis of the plants. The U.S. Nuclear Regulatory Commission (NRC) determined that additional requirements needed to be imposed at U.S. commercial power reactors to mitigate such beyond-design-basis external events (BDBEEs).

On March 12, 2012, the NRC issued Order EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" [Reference 4]. This order directed licensees to develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities in the event of a BDBEE. Order EA-12-049 applies to all power reactor licensees and all holders of construction permits for power reactors.

On March 12, 2012, the NRC also issued Order EA-12-051, "Issuance of Order to Modify Licenses With Regard To Reliable Spent Fuel Pool Instrumentation" [Reference 5]. This order directed licensees to install reliable SFP level instrumentation with a primary channel and a backup channel, and with independent power supplies that are independent of the plant alternating current (ac) and direct current (dc) power distribution systems. Order EA-12-051 applies to all power reactor licensees and all holders of construction permits for power reactors.

2.0 REGULATORY EVALUATION

Following the events at the Fukushima Dai-ichi nuclear power plant on March 11, 2011, the NRC established a senior-level agency task force referred to as the Near-Term Task Force (NTTF). The NTTF was tasked with conducting a systematic and methodical review of the NRC regulations and processes and determining if the agency should make additional improvements to these programs in light of the events at Fukushima Dai-ichi. As a result of this review, the NTTF developed a comprehensive set of recommendations, documented in SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," dated July 12, 2011 [Reference 1]. Following interactions with stakeholders, these recommendations were enhanced by the NRC staff and presented to the Commission.

On February 17, 2012, the NRC staff provided 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" [Reference 2], to the Commission. This paper included a proposal to order licensees to implement enhanced BDBEE mitigation strategies. As directed by Staff Requirements Memorandum (SRM)-SECY-12-0025 [Reference 3], the NRC staff issued Orders EA-12-049 and EA-12-051.

2.1 Order EA-12-049

Order EA-12-049, Attachment 2 [Reference 4], requires that operating power reactor licensees and construction permit holders use a three-phase approach for mitigating BDBEEs. The initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment and SFP cooling capabilities. The transition phase requires providing sufficient, portable, onsite equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from off site. The final phase requires obtaining sufficient offsite resources to sustain those functions indefinitely. Specific requirements of the order are listed below:

1) Licensees or construction permit (CP) holders shall develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and SFP cooling capabilities following a beyond-design-basis external event.

2) These strategies must be capable of mitigating a simultaneous loss of all alternating current (ac) power and loss of normal access to the ultimate heat sink [UHS] and have adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to this Order.

3) Licensees or CP holders must provide reasonable protection for the associated equipment from external events. Such protection must demonstrate that there is adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to this Order.

4) Licensees or CP holders must be capable of implementing the strategies in all modes of operation.

5) Full compliance shall include procedures, guidance, training, and acquisition, staging, or installing of equipment needed for the strategies.

On August 21, 2012, following several submittals and discussions in public meetings with NRC staff, the Nuclear Energy Institute (NEI) submitted document NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0 [Reference 6], to the NRC to provide specifications for an industry-developed methodology for the development, implementation, and maintenance of guidance and strategies in response to the Mitigation Strategies order. The NRC staff reviewed NEI 12-06 and on August 29, 2012, issued its final version of Japan Lessons-Learned Directorate (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" [Reference 7], endorsing NEI 12-06, Revision 0, with comments, as an acceptable means of meeting the requirements of Order EA-12-049, and published a notice of its availability in the *Federal Register* (77 FR 55230).

2.2 Order EA-12-051

Order EA-12-051, Attachment 2 [Reference 5], requires that operating power reactor licensees and construction permit holders install reliable SFP level instrumentation. Specific requirements of the order are listed below:

> All licensees identified in Attachment 1 to the order shall have a reliable indication of the water level in associated spent fuel storage pools capable of supporting identification of the following pool water level conditions by trained personnel: (1) level that is adequate to support operation of the normal fuel pool cooling system, (2) level that is adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck, and (3) level where fuel remains covered and actions to implement make-up water addition should no longer be deferred.
>
> 1. The spent fuel pool level instrumentation shall include the following design features:
>
> 1.1 Instruments: The instrumentation shall consist of a permanent, fixed primary instrument channel and a backup instrument channel. The backup instrument channel may be fixed or portable. Portable instruments shall have capabilities that enhance the ability of trained personnel to monitor spent fuel pool water level under conditions that restrict direct personnel access to the pool, such as partial structural damage, high radiation levels, or heat and humidity from a boiling pool.
>
> 1.2 Arrangement: The spent fuel pool level instrument channels shall be arranged in a manner that provides reasonable protection of the level indication function against missiles that may result from damage to the structure over the spent fuel pool. This protection may be provided by locating the primary instrument channel and fixed portions of the backup instrument channel, if applicable, to maintain instrument channel separation within the spent fuel pool area, and to utilize inherent shielding from missiles provided by existing recesses and corners in the spent fuel pool structure.

1.3 Mounting: Installed instrument channel equipment within the spent fuel pool shall be mounted to retain its design configuration during and following the maximum seismic ground motion considered in the design of the spent fuel pool structure.

1.4 Qualification: The primary and backup instrument channels shall be reliable at temperature, humidity, and radiation levels consistent with the spent fuel pool water at saturation conditions for an extended period. This reliability shall be established through use of an augmented quality assurance process (e.g., a process similar to that applied to the site fire protection program).

1.5 Independence: The primary instrument channel shall be independent of the backup instrument channel.

1.6 Power supplies: Permanently installed instrumentation channels shall each be powered by a separate power supply. Permanently installed and portable instrumentation channels shall provide for power connections from sources independent of the plant ac and dc power distribution systems, such as portable generators or replaceable batteries. Onsite generators used as an alternate power source and replaceable batteries used for instrument channel power shall have sufficient capacity to maintain the level indication function until offsite resource availability is reasonably assured.

1.7 Accuracy: The instrument channels shall maintain their designed accuracy following a power interruption or change in power source without recalibration.

1.8 Testing: The instrument channel design shall provide for routine testing and calibration.

1.9 Display: Trained personnel shall be able to monitor the spent fuel pool water level from the control room, alternate shutdown panel, or other appropriate and accessible location. The display shall provide on-demand or continuous indication of spent fuel pool water level.

2. The spent fuel pool instrumentation shall be maintained available and reliable through appropriate development and implementation of the following programs:

2.1 Training: Personnel shall be trained in the use and the provision of alternate power to the primary and backup instrument channels.

2.2 Procedures: Procedures shall be established and maintained for the testing, calibration, and use of the primary and backup spent fuel pool instrument channels.

2.3 Testing and Calibration: Processes shall be established and maintained for scheduling and implementing necessary testing and calibration of the primary and backup spent fuel pool level instrument channels to maintain the instrument channels at the design accuracy.

On August 24, 2012, following several NEI submittals and discussions in public meetings with NRC staff, the NEI submitted document NEI 12-02, "Industry Guidance for Compliance With NRC Order EA-12-051, To Modify Licenses With Regard to Reliable Spent Fuel Pool Instrumentation," Revision 1 [Reference 8], to the NRC to provide specifications for an industry-developed methodology for compliance with Order EA-12-051. On August 29, 2012, the NRC staff issued its final version of JLD-ISG-2012-03, "Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation," [Reference 9] endorsing NEI 12-02, Revision 1, as an acceptable means of meeting the requirements of Order EA-12-051 with certain clarifications and exceptions, and published a notice of its availability in the *Federal Register* (77 FR 55232).

3.0 TECHNICAL EVALUATION OF ORDER EA-12-049

By letter dated February 28, 2013 [Reference 10], Entergy Operations, Inc. (Entergy, the licensee) submitted its Overall Integrated Plan (OIP) for River Bend Station, Unit 1 (River Bend, RBS) in response to Order EA-12-049. By letters dated August 28, 2013 [Reference 11], February 26, 2014 [Reference 12], August 28, 2014 [Reference 13], February 25, 2015 [Reference 14], and August 26, 2015 [Reference 38], the licensee submitted six-month updates to its OIP. By letter dated August 28, 2013 [Reference 15], the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML082900195). By letters dated February 25, 2014 [Reference 16] and February 18, 2015 [Reference 17], the NRC issued an Interim Staff Evaluation (ISE) and an audit report on the licensee's progress. By letter dated September 29, 2015 [Reference 18] the licensee reported that full compliance with the requirements of Order EA-12-049 was achieved, and submitted a Final Integrated Plan (FIP).

3.1 Overall Mitigation Strategy

Attachment 2 to Order EA-12-049 describes the three-phase approach required for mitigating BDBEEs in order to maintain or restore core cooling, containment and SFP cooling capabilities. The phases consist of an initial phase (Phase 1) using installed equipment and resources, followed by a transition phase (Phase 2) in which portable onsite equipment is placed in service, and a final phase (Phase 3) in which offsite resources may be placed in service. The timing of when to transition to the next phase is determined by plant-specific analyses.

While the initiating event is undefined, it is assumed to result in an extended loss of ac power (ELAP) with loss of normal access to the ultimate heat sink (LUHS). Thus, the ELAP with LUHS is used as a surrogate for a BDBEE. The initial conditions and assumptions for the analyses are stated in NEI 12-06, Section 3.2.1, and include the following:

1. The reactor is assumed to have safely shutdown with all rods inserted (subcritical).
2. The dc power supplied by the plant batteries is initially available, as is the ac power from inverters supplied by those batteries; however, over time the batteries may be depleted.

3. There is no core damage initially.
4. There is no assumption of any concurrent event.
5. Because the loss of ac power presupposes random failures of safety-related equipment (emergency power sources), there is no requirement to consider further random failures.

River Bend is a General Electric boiling-water reactor (BWR) with a Mark III containment. The FIP describes the licensee's three-phase approach to mitigate a postulated ELAP event.

At the onset of an ELAP, the reactor trips and the main condenser is unavailable due to the loss of circulating water. Decay heat is removed when the safety relief valves (SRVs) open on high pressure and dump steam from the reactor pressure vessel (RPV) to the suppression pool (SP). Makeup to the RPV is provided by the reactor core isolation cooling (RCIC) turbine-driven pump. One hour after the event, the operators take manual control of the SRVs to perform a controlled cooldown and depressurization of the reactor. The cooldown of the primary system is stopped when reactor pressure reaches a control band of 200 pounds per square inch gage (psig) to 400 psig to ensure sufficient steam pressure to operate RCIC. The RCIC suction is aligned to the SP if the condensate storage tank (CST) is unavailable. Between 4 and 5 hours after the event, the licensee’s primary strategy calls for the RCIC suction to be transferred from the SP to the upper containment pool (UCP) to provide a cooler source of water for extended operation of RCIC. In Phase 2, upon depletion of the water supply in the UCP, the vessel will be completely depressurized and the discharge of the suppression pool cleanup and cooling (SPC) heat exchanger is realigned from the SP to inject directly into the RPV for core cooling.

River Bend has also included an alternate strategy for core cooling should the SPC core cooling path be unavailable or once the UCP has been depleted. The alternate core cooling strategy utilizes the FLEX pump 3 (FLX-P3) to inject cooling water from the standby cooling tower (SCT) basin into the RPV via the low pressure core spray (LPCS) flushing line connection. The primary purpose of the FLX-P3 is to provide makeup water from the SCT basin to the SFP. However, the pump design includes a discharge manifold with 4 outlets with shutoff valves that accommodates hose connections to support both SFP makeup and the core cooling function simultaneously. The FLX-P3 can meet the flow capacity requirements for simultaneous SFP makeup and core cooling.

The primary strategy involves placing a core cooling strategy, which is an alternate method to NEI 12-06 guidance, in service following depletion of the UCP water source for RCIC injection to the RPV. This is expected to occur approximately 34 hours following the ELAP/LUHS. However, if the UCP is not available to provide water to RCIC, then RCIC would maintain suction on the SP. The RCIC can provide adequate core cooling in this configuration (aligned only to the SP) for at least as long as would be possible with RCIC aligned to the UCP. Therefore, the alternate core cooling method is diverse and completely independent of the primary core cooling strategy that utilizes the SPC system.

The intent is to extend Phase 2 strategies long-term with no immediate reliance on equipment from the National SAFER [Strategic Alliance for FLEX Emergency Response] Response Centers (NSRC) for reactor core cooling. Alternatively, in Phase 3, additional FLEX equipment from the NSRC can be utilized to allow reactor core cooling via the residual heat removal (RHR) B train in the alternate method of decay heat removal (DHR) or in the normal shutdown cooling (SDC) mode.

During the BDBEE, containment integrity is maintained by normal design features of the containment, such as the containment isolation valves and heat removal utilizing portions of the SPC system. As the SP heats up due to RCIC operation and relief valve operation, the containment will begin to heat up and pressurize. The FLEX strategy is based on using the SPC pumps and heat exchanger and cooling water from the Standby Service Water (SSW) system to cool the SP for containment heat removal. This is initiated as part of Phase 2 and occurs 8 hours after the ELAP/BDEEE event. Licensee analyses have concluded that containment and drywell temperatures and pressures will remain below their design limits. The peak SP water temperature exceeds the 185 degrees Fahrenheit (°F) design temperature for a short period of time (total of approximately 8 hours) but the licensee concluded that is acceptable given that containment pressure remains at least 5 psi below its design limit of 15 psig. The analysis also demonstrates that a general cooling trend is established at 8 hours when SP cooling via the SPC pump and heat exchanger is established and the reactor can be totally depressurized to allow direct SPC injection without challenging containment integrity. The intent is to extend Phase 2 strategies long-term with no immediate reliance on equipment from NSRC for containment integrity control. Alternatively, in Phase 3, additional FLEX equipment from the NSRC can be utilized to allow reactor core and containment cooling via RHR B train in the alternate method of DHR or in the normal SDC mode.

The licensee stated that the basic FLEX strategy for maintaining SFP cooling will be the use of the large inventory and heat capacity of water in the SFP. The initial coping strategy for SFP cooling is to monitor SFP level using instrumentation installed pursuant to NRC Order EA-12-051. The licensee has calculated that the time to boil is 9.51 hours and the time to boil off to the top of fuel is 137.62 hours from initiation of the event. Prior to boiling the operators will open the double doors on the 95 feet (ft.) elevation to the new fuel receiving area, and doors to the stairwell and roof will be opened to establish a chimney effect for ventilation through the stairwell to the roof.

Three strategies exist for makeup to the SFP in Phase 2. The first method is with the FLEX 3 pump connected to the SSW basin and running hose to the SFP. The FLEX 3 pump is placed near the SCT and non-collapsible hose is used to establish a suction path to the SCT basin. A hose is then routed from the pump discharge to the SFP where diffusers are attached to the end of the hose and placed into the pool. Method 2 provides the capability to supply makeup water to the SFP without accessing the refueling floor utilizing the discharge of the FLEX 3 pump via hose connected to a drain line off of the Fuel Pool Cooling and Cleanup (SFC) system. Method 3 is spray cooling utilizing existing equipment that is intended to support the mitigating strategies requirements from previous NRC Order EA-02-026, Section B.5.b, and Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Section 50.54(hh)(2).

For Phase 3 SFP cooling, additional capabilities will be obtained from the NSRC as a backup to the on-site FLEX high capacity pumps.

Below are specific details on the licensee's strategies to restore or maintain core cooling, containment, and SFP cooling capabilities in the event of a BDBEE and the results of the staff's review of these strategies. The NRC staff evaluated the licensee's strategies against the endorsed NEI 12-06, Revision 0, guidance.

3.2 Reactor Core Cooling Strategies

In accordance with Order EA-12-049, licensees are required to maintain or restore cooling to the reactor core in the event of an ELAP concurrent with a LUHS. Although the ELAP results in an immediate trip of the reactor, sufficient core cooling must be provided to account for fission product decay and other sources of residual heat. Consistent with endorsed guidance from NEI 12-06, Phase 1 of the licensee's core cooling strategy credits installed equipment (other than that presumed lost to the ELAP/LUHS) that is robust in accordance with the guidance in NEI 12-06. In Phase 2, robust installed equipment is supplemented by onsite FLEX equipment, which is used to cool the core either directly (e.g., pumps and hoses) or indirectly (e.g., FLEX electrical generators and cables repowering robust installed equipment). The equipment available onsite for Phases 1 and 2 is further supplemented in Phase 3 by equipment transported from the NSRCs.

As reviewed in this section, the licensee's core cooling analysis for the ELAP/LUHS event presumes that, per endorsed guidance from NEI 12-06, the reactor would have been operating at full power prior to the event and that no additional random failures occur. Therefore, primary containment integrity is being credited by the licensee, and the nominal suppression pool liquid volume during power operation is assumed to be available as a heat sink for core cooling during the ELAP/LUHS event. Maintenance of sufficient RPV inventory, despite blowdown from SRVs and the ongoing system leakage expected under ELAP conditions, is accomplished through a combination of installed systems and FLEX equipment. The specific means used by the licensee to accomplish adequate core cooling during the ELAP/LUHS event are discussed in further detail below. The licensee's strategy for ensuring compliance with Order EA-12-049 for conditions where one or more units are shut down or being refueled is reviewed separately in Section 3.11 of this evaluation.

3.2.1 Core Cooling Strategy and RPV Makeup

3.2.1.1 Phase 1

Phase 1 of the core cooling strategy relies on the use of installed plant equipment. Injection of cooling water into the RPV will be accomplished through the RCIC system. The RCIC system is initially lined up to the CST and will pump water into the core from the CST, if the CST is available. However, the CST is not protected against seismic and windborne missile hazards, and thus cannot be credited to be available in all FLEX scenarios; if the CST is not available, RCIC suction will automatically transfer to the SP via the action of dc-powered CST level instrumentation and valves.

The RCIC pump's design-basis function is to supply water to the RPV when the reactor is isolated from the main condenser. The RCIC pump is powered by steam from the RPV and is robust for the hazards considered in the ELAP evaluation. The RCIC pump is designed to automatically start when the RPV reaches Low Level 2 initiation signal. In the event that RCIC does not automatically start, procedural guidance directs the operators to manually initiate the pump from the control room or to locally start the pump from the RCIC room. RCIC discharges into the RPV via a connection to the Feedwater A injection line. RCIC system valves are powered by the 125 volt direct current (Vdc) Bus and are used to control the cooling flow to the RPV, balancing it with the outflow of steam through the SRVs to the suppression pool in order to maintain RPV level within its desired control band.

Pressure control of the RPV is accomplished using the SRVs, which are powered by redundant logic off of the 125 Vdc Buses. At approximately 1 hour after the initiation of the event, operators will have confirmed that an ELAP is underway, and begin a controlled blowdown through one SRV to a target RPV pressure of 200 psig, at a rate less than 100°F per hour. After this point, the reactor pressure is maintained between 200 and 400 psig to allow continued operation of the RCIC system.

At approximately 4 hours after the start of the ELAP, SRV blowdown and RCIC pump exhaust will have caused SP temperature to reach between 175-180°F. The licensee calculates that the elevated SP temperature may begin to challenge RCIC net positive suction head (NPSH) and impact RCIC equipment at this point. Therefore, a permanent cross-tie line from the Fuel Pool Cooling and Cleanup system to the RCIC/HPCS suction line has been installed at River Bend, which would allow RCIC suction from the Upper Containment Pool (UCP). Prior to the SP reaching 185 °F, operators will align RCIC suction to the UCP, if possible, providing cooler water (approximately 90-100° F) for injection into the RPV. Aligning RCIC suction to the UCP may not be possible in some ELAP scenarios, in which case operators will continue to use the SP as the RCIC water source until the RPV is depressurized and the SPC system realigned to inject into the RPV (see the Phase 2 core cooling strategy in Section 3.2.1.2). Attachment 3 of the licensee's compliance letter indicates that RCIC can provide adequate core cooling while continuing to draw directly from the SP for at least 34 hours into the ELAP event.

The normal air supply to the air-operated SRVs is provided by the main steam and safety relief system compressors, which are assumed to be lost in a FLEX scenario. The SRVs have backup air accumulators, which have sufficient pressure for a 4-hour station blackout (SBO) event, and which are supplemented by seismically-protected FLEX air bottles which can be connected in the auxiliary building.

3.2.1.2 Phase 2

At 8 hours into the event, it will be necessary to begin cooling the SP to limit containment heatup and prevent SP boiling, and ultimately allow operators to stabilize SP temperature and containment pressure. To do this, the licensee's preferred option would rely on an alternative to the endorsed guidance in NEI 12-06 that involves repowering of installed equipment that the licensee has determined to be robust to the hazards considered within the scope of Order EA-12-049. Specifically, the SPC system is placed online, with the installed SPC pump powered by one of two (primary and alternate) 480 Volt (V) (ac, (Vac) 500 kilo Watt (kW) FLEX portable diesel generators (DG). One SPC pump will take suction from the SP via the LPCI "C" suppression pool suction line, discharge to the SPC heat exchanger, and finally discharge back to the SP via the LPCI "C" test return line.

Cooling water to the SPC heat exchanger will be provided by one of two 2500 gallons per minute (gpm) FLEX pumps. The primary pump, FLEX Pump 1 (FLX-P1), is a permanently staged (but not pre-connected) electric motor-driven pump powered by a single 480 Vac, 500 kW FLEX DG. If this pump is not available, the portable diesel-driven FLEX Pump 2 (FLX-P2) would be deployed, serving the same function. The FLEX pump connects to the SSW system, taking suction from the SSW basin and discharging to the ultimate heat sink: the SCT and water storage basin. Therefore, reactor decay heat is ultimately rejected to the SCT; although the SCT fans are not powered due to the ELAP, the licensee's FIP states that the large volume of water in the SCT provides sufficient water at acceptable temperatures through 72 hours after the event.

In scenarios where the UCP can be used as a suction source for the RCIC pump, at approximately 34 hours after start of the ELAP, the UCP will be depleted and a new source of RPV injection is required. Operators will open one SRV to completely depressurize the RPV, and eventually open two more SRVs before water level in the vessel reaches 90 inches (in.). The primary strategy at this point is to re-align the SPC system to provide both containment and core cooling. The SPC pump continues to take suction through the LPCI "C" suction line and discharges through the SPC heat exchanger; colder water from the heat exchanger then discharges to the RPV. Heated water from the RPV returns to the SP through the three open SRVs. The containment cooling function is still in effect, since the SP itself is also cooled by the SPC heat exchanger. The SSW flow to the heat exchanger is driven by a FLEX pump, as before, with core decay heat and containment heat rejected to the SCT.

Although the licensee determined that the core cooling strategy using the SPC system is robust to the hazards considered under Order EA-12-049, this system does not provide diverse injection points to the reactor vessel via separate divisions or trains. To address this issue, the licensee stated that it can employ an alternate core cooling flowpath if the preferred strategy using the SPC core cooling alignment is unavailable. In this case, to support a transition to FLEX equipment, the RPV is fully depressurized from approximately 200 psig using the SRVs. The FLX-P3 is then aligned to provide 200 gpm of flow from the SSW system to the RPV via a fire hose and a low pressure core spray (LPCS) flushing line connection. Because the injection of raw SSW water into the RPV could result in the accumulation of suspended debris and impurities resulting in restrictions of core cooling flowpaths, especially those at the core inlet, the licensee intends to inject into the RPV via the LPCS system, however, core cooling flow would have the opportunity to flow down from the core spray sparger and into the core from above.

The NRC staff considers the selection of this injection alignment to be a reasonable precaution against the potential for debris blockage to adversely affect core cooling during Phase 2 of the ELAP event inasmuch as it would (1) permit coolant to enter the core at the less-restrictive core outlet and (2) allow the potential for steam rising out of the core to dislodge accumulations of debris that may form. The FLEX 3 Pump's primary function is to provide makeup water to the SFP, but the licensee calculates that the required flow rates for both SFP cooling and core cooling functions together are well within the capability of the pump. An inline flowmeter on the core cooling hose is available to monitor flow to the RPV.

3.2.1.3 Phase 3

In Phase 3, the cooling tower fans are repowered from a 480 Vac DG furnished by the NSRC. The licensee generally intends to continue the strategies employed in Phase 2 past the first 24 hours. The licensee has calculated that core cooling can be maintained for at least 72 hours using either the primary (SPC pump with SPC heat exchanger and a FLEX 1 or FLEX 2 cooling water pump) or the alternate (FLEX 3 pump) core cooling strategies. According to the licensee's FIP, water purification equipment would be requested from the NSRC in the event of an ELAP. If the alternate core cooling strategy, which entails injection of raw water into the

RPV, is being employed, placing this water purification equipment into service during Phase 3 of the event would serve as a reasonable precaution against the potential for core blockage to adversely affect core cooling over an indefinite coping period.

An additional long-term core cooling strategy is to cool the reactor using the RHR “B” train in either the alternate method of DHR or in the normal SDC mode, with the “B” RHR pump powered by a DG from the NSRC. One of the two 2500 gpm FLEX pumps will provide SSW flow to the RHR “B” heat exchangers. As in the primary Phase 3 strategy, the SCT fans would be powered by an NSRC DG.

3.2.2 Staff Evaluations

3.2.2.1 Availability of Structures, Systems, and Components (SSCs)

Guidance document NEI 12-06 provides guidance that the baseline assumptions have been established on the presumption that other than the loss of the ac power sources and normal access to the UHS, installed equipment that is designed to be robust with respect to design-basis external events is assumed to be fully available. Installed equipment that is not robust is assumed to be unavailable. Below are the baseline assumptions for the availability of SSCs for core cooling during an ELAP caused by a BDBEE.

3.2.2.1.1 Plant SSCs

NEI 12-06, Section 3.2 states that installed equipment that is designed to be robust with respect to design-basis external events is assumed to be fully available. In addition, Condition 6 of NEI 12-06, Section 3.2.1.3, states that permanent plant equipment contained in structures with designs that are robust with respect to seismic events, floods, and high winds, and associated missiles, are available. The RBS Updated Final Safety Analysis Report (UFSAR), Section 3.2.1, Revision 17, states that plant structures, systems and components (SSCs) important to safety are designed to withstand the effects of a Safe Shutdown Earthquake (SSE), that SSCs (including their foundations and supports) designed to remain functional in the event of an SSE are designated as Seismic Category I. The RBS UFSAR Section 3.4.1.1.1 states that safety-related systems and components, as identified in UFSAR Table 3.2-1, are protected to all postulated flood levels and conditions applicable to RBS. The RBS UFSAR Table 3.2-1 lists the seismic classification and tornado protection of SSCs. In addition, RBS UFSAR Table 3.2-3 states that Safety Class 1, 2, and 3 SSCs are designed as Seismic Category 1.

Phase 1

The RBS Phase 1 core cooling FLEX strategies rely on the existing RCIC pump to remove heat from the RCS by providing cooling water to the RPV from the SP and relieving pressure from the RPV through the SRV’s back into the SP. In addition, the licensee relies on the UPC, Class IE batteries, dc distribution system and, for Phase 2 core cooling, the SPC system, SSW system, SSW cooling tower (SCT), RHR system, the low-pressure core spray system (LPCS).

As described in the RBS UFSAR, Table 3.2-1, the RCIC system including piping, valves, pump, turbine, and support structures, is a Seismic Category I system. The RCIC pump is located in the Auxiliary Building, a Seismic Category 1 structure that provides protection against seismic events, floods, high winds, tornados and tornado-generated missiles, and other such design-basis natural phenomena. The RCIC system valves are powered by the Class 1E 125V dc batteries and associated dc distribution system. According to the RBS UFSAR, Table 3.2-1, the Class 1E 125V dc power system is designed as Seismic Category I. The 125 V dc system batteries, racks, chargers, switch gear, and distribution panels are located in the control building (CB), which is a Seismic Category 1 structure that provides protection from tornados and tornado-generated missiles, and all other applicable external hazards. In the event that the automatic start of the RCIC system does not occur, the RBS Emergency Operating Procedures (EOPs) provide guidance to the operators to manually initiate the RCIC system or to take action to locally start and control the system from the RCIC room.

As described in the licensee's FIP, the RCIC takes suction initially from the CST and operates to inject makeup water to the RPV. The CST is not seismically qualified and it is considered unavailable following a BDBEE. If the CST becomes unavailable, RCIC suction will immediately swap to the SP as a result of low CST level as sensed by CST level indication or operators will manually align the RCIC suction to the SP. The suction valves, CST level transmitter, and instrument loop are located on Seismic Category 1 piping and powered by the Class 1E 125V dc system. In addition to the suction source for the RCIC pump, the SP is the heat sink for reactor vessel SRV discharge and RCIC turbine steam exhaust. The SP is an integral part of the primary containment and drywell structures. The RBS UFSAR, Table 3.2-1, describes the primary containment and drywell as Seismic Category 1 structures. The primary containment is surrounded by the shield building, a Seismic Category 1 structure that provides protection from tornados and tornado-generated missiles, and all other applicable external hazards.

Prior to the SP reaching 185 °F, the licensee plans to realign RCIC suction from the SP to the UCP. The alignment is accomplished via a cross-tie from the fuel pool cooling and cleanup (SFC) system lines from the UCP to the RCIC/HPCS suction line from the CST. The UCP is a Seismic Category 1 structure located within primary containment which provides protection from tornados and tornado-generated missiles, and all other applicable external hazards. The RBS UFSAR Table 3.2-1 lists the SFC cooling subsystem piping and valves as Seismic Category 1 components located in Seismic category 1 structures which provide protection from tornados and tornado-generated missiles, and all other applicable external hazards. The cross-tie is located in a below-grade piping tunnel which, according to RBS UFSAR Table 3.2-1, is a Seismic Category 1 structure that provide protection from tornados and tornado-generated missiles, and all other applicable external hazards

Operators relieve pressure from the RPV through the SRVs. As described in the RBS UFSAR, Table 3.2-1, the SRVs and associated piping are designed as Seismic Category I components and are located inside the drywell which provides protection from tornados and tornado-generated missiles, and all other applicable external hazards. The SRVs are air operated valves which rely on the Class 1E 125Vdc power system, and the instrument and service air system. The RBS UFSAR Table 3.2-1 lists the air system piping and valves from the SRVs up to and including the safety related air accumulators as Seismic Category 1 components. The components are located within Seismic Category 1 structures which provide protection from tornados and tornado-generated missiles, and all other applicable external hazards. However, the air system upstream of the SRV accumulators, including the air compressors, is non-safety related is assumed to be unavailable during an ELAP.

As described in the licensee's FIP, the accumulators are designed to supply enough air for the SRVs to cope with a 4-hour SBO. Before the depletion of the air accumulator, the licensee will connect nitrogen bottles to the safety related portion of the SRV air piping via air hoses and regulators. The bottles are stored in seismically mounted racks located in the auxiliary building. The RBS UFSAR Table 3.2-1 lists the auxiliary building as a Seismic Category 1 structure which provides protection from tornados and tornado-generated missiles, and all other applicable external hazards.

Phase 2

As part of the transition to Phase 2, the licensee plans to begin cooling the suppression pool using the SPC system to remove decay heat being deposited into the containment and prevent SP boiling. The strategy uses one of two SPC pumps (powered by a portable diesel generator) to draw water from the SP through the SPC heat exchangers (HXs) and inject back into the SP directly or into the RPV with flow eventually returning to the SP through the SRVs. According to the RBS UFSAR, Table 3.2-1, the SPC system is a non-safety, non-seismically designed system. However, the piping, valves, pumps, and HX credited for FLEX are located within the auxiliary building or pipe tunnel, both of which are Seismic Category 1 structures and provide protection from tornados and tornado-generated missiles, and all other applicable non-seismic external hazards.

In accordance with NEI 12-06, the licensee performed Engineering Report RBS-CS-13-00007, Revision 000, "Evaluation of the Suppression Pool Cleanup (SPC) System Components Credited for FLEX Implementation to Function Following a Seismic Event," in order to demonstrate SPC component functionality following a seismic event. The NRC staff performed a review of the engineering report to evaluate whether the credited portions of the SPC system could be considered robust through evaluation as allowed by NEI 12-06. The licensee's evaluation reviewed existing seismic design and evaluation documentation, and used industry standard seismic margin assessment methods to evaluate the SPC pumps, HXs, valves, unit cooler, and small-bore piping. The licensee's evaluation determined that the as-built configuration of SPC system components credited for implementation of RBS FLEX strategies have a high confidence of component functionality following a seismic event. As such, the needed SPC system components can be credited as available for use following a seismic event.

The licensee plans to use one of two FLEX pumps to establish flow through the secondary side of the SPC HX. The FLEX pumps take a suction from the SSW basin via SSW piping and discharging to the SPC HX and back to the SSW basin via SSW piping and the SSW cooling tower (SCT). The RBS UFSAR, Table 3.2-1, lists the SSW system piping and valves as Seismic Class 1 components and are contained in Seismic Class 1 structures that provide protection from tornados and tornado-generated missiles, and all other applicable non-seismic external hazards. Table 3.2-1 lists the SCT as a Seismic Class 1 structure that is protected from tornados and tornado-generated missiles, and all other applicable non-seismic external hazards.

Pump FLX-P1 is permanently staged (but not connected) in the tunnel from the SSW basin to the auxiliary building ("G" tunnel). When needed, the licensee can connect the pump to the SSW system through use of a combination of piping and hoses. As part of the audit process, the NRC staff had concerns about the potential for flooding of the tunnel from the rupture of non-seismically qualified piping as identified in the licensee's OIP. The licensee stated that there are several lines that are non-safety related, Class 4 piping in the tunnel that may, at any time, contain water and/or be connected to water supplies. The licensee evaluated the piping and identified 15 lines that have at least some sections that are not seismically robust and that a failure in any of these lines could render the tunnels temporarily inaccessible until the flooding is controlled. The licensee determined that that the closure of four valves in the yard following a seismic FLEX event will effectively isolate these potential flooding sources. The licensee updated its procedure Abnormal Operating Procedure (AOP)-0065, Revision 000, "Extended Loss of AC Power (ELAP)" to provide direction to the operators to evaluate the tunnel for flooding and isolate the necessary valves if flooding is occurring. In addition, if FLX-P1 is unavailable, the diesel-driven FLX-P2 pump can be staged at grade level and connected to the SSW without having to access the tunnel.

Phase 3

For Phase 3, the licensee plans to continue Phase 2 strategies with the addition of repowering the SCT cooling fans using an NSRC-provided diesel generator. As discussed previously, the SCT is a Seismic Category 1 structure that is protected from all applicable external hazards. As an alternative strategy, the licensee may choose to use NSRC-supplied diesel generators to repower portions of the RHR system for use in alternate decay heat removal or shutdown cooling modes. The RBS UFSAR, Table 3.2-1 lists the RHR system as a Seismic Class 1 system that is protected from all applicable external hazards.

Based on the location and design of the credited plant SSCs, as described in Entergy's UFSAR, and FIP, and if aligned and utilized in accordance with Entergy's control strategy, as described in the FIP, the credited plant SSCs should be available to support core cooling during an ELAP, consistent with NEI 12-06, Section 3.2.1.3, Condition 6.

Primary and Alternate Connection Points for Core Cooling

Section 3.2.2 of NEI 12-06 states that the portable pumps for core and SFP cooling functions are expected to have a primary and an alternate connection or delivery point. At a minimum, the primary connection point should be an installed connection suitable for both the on-site and off-site equipment but the secondary connection point can require reconfiguration if the licensee can show that adequate time and resources are available to support the reconfiguration. NEI 12-06, Table C-1 states that primary and alternate injection points are required to establish capability to inject through separate divisions/trains (i.e., should not have both connections in one division/train). NEI 12-06, Section 3.2.2 states that 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 assurance that one connection will be available.

As described in its FIP, the licensee provides water to the RPV from the UHS via the SPC system by repowering the SPC pumps with portable diesel generators. Each pump can be powered by primary and alternate electrical connection. Because the SPC system takes suction from the SP, the water needs to be cooled in order to remain a viable core cooling source. The licensee has the capability to use two different pumps to provide cooling water from the SCT basin to the secondary side of the SPC HX. Each pump provides for a primary and alternate connection point for HX cooling water injection.

As part of the audit process, the NRC staff visited the site to review the licensee's strategy and walk-down the proposed core cooling strategy lineup in order to better understand the SPC system's capabilities and limitations, if any. The staff discovered that even though the licensee had a primary and alternate pump for RPV injection with a primary and alternate means to repower the pumps, the pumps shared a common suction and discharge path. This situation also existed for the HX secondary side injection; the licensee has a primary and alternate pump with different injection points, but the pumps share a common flow path through the secondary side of the HX and back to the SCT. The staff discussed this configuration with the licensee and expressed concern that the common flow paths of the primary and alternate core cooling methods present a single point vulnerability that greatly limits the flexibility and diversity of the strategy and is not consistent with the guidance in NEI 12-06, Table C-1. As a result, the licensee developed an alternate strategy to use the FLX-P3 pump (which is credited for SFP cooling water) if needed to pump water from the SCT basin and inject into the RPV via a hose connection to a flushing line on the LPCS portion of the RHR system. The alternate strategy provides a core cooling method that is diverse and completely independent of the primary SPC strategy.

Based on the location and design of the FLEX connections, as described in Entergy's FIP, and if aligned and utilized according to Entergy's control strategy, as described in the FIP, at least one FLEX connection should be available to support core cooling during an ELAP, consistent with NEI 12-06, Section 3.2.2 and Table C-1.

3.2.2.1.2 Plant Instrumentation

The licensee's FIP identifies the following instrumentation required to implement the core cooling strategy:

- RPV wide range level indication
- RPV pressure

The instrumentation identified by the licensee to support its core cooling strategy is consistent with the recommendation specified in the endorsed guidance of NEI 12-06.

This instrumentation is initially powered by batteries during Phase 1, and via battery chargers powered by the FLEX DGs in Phases 2 and 3. Therefore, based upon the information provided by the licensee, the NRC staff understands that indication for the above instruments should be available and accessible continuously throughout the ELAP event.

The licensee plans to monitor indication for the above instruments from the MCR. If 120 Vdc and 120 Vac Vital Bus infrastructure is damaged, operators can obtain the critical parameters locally at a containment electrical penetration terminal cabinet using a digital multimeter per FLEX Support Gudeline (FSG) -007, "Loss of DC Control Power."

3.2.2.2 Thermal-Hydraulic Analyses

The licensee concluded that its mitigating strategy for reactor core cooling would be adequate based in part on thermal-hydraulic analysis performed using Version 4 of the Modular Accident Analysis Program (MAAP). Because the thermal-hydraulic analysis for the reactor core and containment during an ELAP event are closely intertwined, as is typical of BWRs, River Bend has addressed both in a single, coupled calculation. This dependency notwithstanding, the NRC staff's discussion in this section of the safety evaluation (SE) solely focuses on the licensee's analysis of reactor core cooling. The staff's review of the licensee's analysis of containment thermal-hydraulic behavior is provided subsequently in Section 3.4.4.2 of this evaluation.

The MAAP is an industry-developed, general-purpose thermal-hydraulic computer code that has been used to simulate the progression of a variety of light water reactor accident sequences, including severe accidents such as the Fukushima Dai-ichi event. Initial code development began in the early 1980s, with the objective of supporting an improved understanding of and predictive capability for severe accidents involving core overheating and degradation in the wake of the accident at Three Mile Island Nuclear Station, Unit 2. Currently, maintenance and development of the code is carried out under the direction of the Electric Power Research Institute (EPRI).

To provide analytical justification for their mitigating strategies in response to Order EA-12-049, a number of licensees for BWRs and pressurized-water reactors (PWRs) completed analysis of the ELAP event using Version 4 of the MAAP code (MAAP4). Although MAAP4 and predecessor code versions have been used by industry for a range of applications, such as the analysis of severe accident scenarios and probabilistic risk analysis (PRA) evaluations, the NRC staff had not previously examined the code's technical adequacy for performing best-estimate simulations of the ELAP event. In particular, due to the breadth and complexity of the physical phenomena within the code's calculation domain, as well as its intended capability for rapidly simulating a variety of accident scenarios to support PRA evaluations, the NRC staff observed that the MAAP code makes use of a number of simplified correlations and approximations that should be evaluated for their applicability to the ELAP event. Therefore, in support of the staff's reviews of licensees' strategies for ELAP mitigation, the NRC staff audited the capability of the MAAP4 code for performing thermal-hydraulic analysis of the ELAP event for both BWRs and PWRs. The NRC staff's audit review involved a limited review of key code models as well as confirmatory analysis with the TRACE code to obtain an independent assessment of the predictions of the MAAP4 code.

To support the NRC staff's review of the use of MAAP4 for ELAP analyses, in June 2013, EPRI issued a technical report entitled "Use of Modular Accident Analysis Program (MAAP) in Support of Post-Fukushima Applications." The document provided general information concerning the code and its development, as well as an overview of its physical models, modeling guidelines, validation, and quality assurance procedures.

Based on the staff's review of EPRI's June 2013 technical report, as supplemented by further discussion with the code vendor, audit review of key sections of the MAAP code documentation, and confirmation of acceptable agreement with NRC staff simulations using the transient reactor analysis code, TRACE, the NRC staff concluded that, under certain conditions, the MAAP4 code may be used for best-estimate prediction of the ELAP event sequence for BWRs.

The NRC staff issued an endorsement letter dated October 3, 2013, which documented these conclusions and identified specific limitations that BWR licensees should address to justify the applicability of simulations using the MAAP4 code for demonstrating that the requirements of Order EA-12-049 have been satisfied.

The licensee addressed the limitations from the NRC staff's endorsement letter in an addendum to its MAAP calculation. The licensee's response utilized the generic roadmap and response template that had been developed by EPRI to support consistency in individual licensee's responses to the limitations from the endorsement letter. The staff's audit review of this information, as well as its audit of River Bend's plant-specific MAAP analysis, confirmed that the licensee had acceptably addressed all limitations from the endorsement letter. In particular, based upon review of the MAAP calculation documentation, the NRC staff concluded that appropriate inputs and modeling options had been selected for the code parameters expected to have dominant influence for the ELAP event. The NRC staff further observed that the limitations imposed in the endorsement letter, particularly those concerning the RPV collapsed liquid level being maintained above the reactor core and the primary system cooldown rate being maintained within Technical Specification limits, were satisfied. Specifically, the licensee's analysis calculated that RBS would maintain the collapsed liquid level in the reactor vessel at least 10 feet above the top of the active fuel region throughout the analyzed ELAP event. By maintaining the reactor core fully covered with water, adequate core cooling is assured for this event. Additionally, RBS's fulfillment of the endorsement letter condition regarding the primary system cooldown rate signifies that thermally induced volumetric contraction and other changes in primary system thermal-hydraulic conditions should proceed relatively slowly with time, which supports the NRC staff's confidence in the predictions of the MAAP code. Furthermore, that the licensee should be capable of maintaining the entire reactor core submerged throughout the ELAP event is consistent with the staff's expectation that the licensee's flow capacity for primary makeup (i.e., installed RCIC pump and, subsequently, installed SPC pumps or FLEX pumps) should be sufficient to support adequate heat removal from the reactor core during the analyzed ELAP event, including potential losses due to expected primary leakage.

Therefore, based on the evaluation above, the licensee's analytical approach should appropriately determine the sequence of events for reactor core cooling, including time-sensitive operator actions, and evaluate the required equipment to mitigate the analyzed ELAP event, including pump sizing and cooling water capacity.

3.2.2.3 Recirculation Pump Seals

An ELAP event would result in the interruption of cooling to the recirculation pump seals, potentially resulting in increased leakage due to the distortion or failure of the seals, elastomeric O-rings, or other components. Sufficient primary makeup must be provided to offset recirculation pump seal leakage and other expected sources of primary leakage, in addition to removing decay heat from the reactor core.

The licensee's calculations for River Bend assumed a seal leakage rate at full system pressure and temperature of 18 gpm per recirculation pump. In addition, the licensee's calculation assumed an additional primary system leakage rate equal to the Technical Specification limit (averaged over the previous 24-hour period) of 30 gpm. Thus, between the two recirculation pumps and the additional primary system leakage, the total primary leakage rate assumed for River Bend during the ELAP event was 66 gpm at full system pressure and temperature.

River Bend utilizes Byron Jackson recirculation pumps with Flowserve N-7500 seals. The Flowserve N-7500 seals installed on River Bend's recirculation pumps are similar in design to the N-Seals for which the NRC staff has reviewed and endorsed leakage rates for application to the ELAP event for specific PWRs. As noted in the NRC staff's endorsement letter on this topic, dated November 12, 2015, the upper bound leakage rates under ELAP conditions that have been estimated for Flowserve N-Seals installed at PWRs vary based on plant-specific conditions, but are in all cases less than 5 gpm. Among the noteworthy differences between the N-Seals installed at BWRs and PWRs are that current BWR installations (1) rely on a reduced number of stages due to the lower BWR operating pressure, (2) are scaled-down geometrically compared to most PWRs, according to differences in pump shaft size, and (3) do not provide for the possibility of isolating the controlled leakoff flow from the seal, as is possible for some PWRs. However, the NRC staff does not expect these differences to have a significant impact on the expected seal leakage rate for BWR applications because (1) the design of each seal stage is intended to be capable of sealing against full system pressure, and, furthermore, the vendor's method for determining the leakage rate for PWRs was not dependent upon the number of stages in the seal design, (2) the NRC staff's review of Flowserve's determination of the expected N-Seal leakage for PWRs explicitly considered pump shaft sizes for which the N-7500 model would be applicable, and (3) credit for isolation of the controlled seal leakoff flow was not explicitly credited in determining the leakage rates determined in Flowserve's white paper, with the exception of determining the short-term thermal exposure profile for seal elastomers. Thus, even while considering the differences between BWR and PWR installations, based on the basic design of the hydrodynamic seals and pressure breakdown devices and their materials of construction, the NRC staff would expect a roughly similar level of performance for equivalent inlet conditions.

The NRC staff considered the expected leakage rate for the N-7500 seals installed at River Bend in light of experience obtained reviewing the application of N-Seals to PWRs. In particular, the NRC staff noted during its audit of River Bend's thermal-hydraulic analysis that the expected primary temperature and pressure conditions during an ELAP event generally compare favorably to those of the PWRs considered in the staff's endorsement letter. Furthermore, as is typical of the majority of U.S. BWRs, River Bend has an installed steam-driven pump (i.e., RCIC) that is capable of injecting into the primary system under ELAP conditions. Based on information provided by the licensee during the audit, the RCIC system at River Bend is designed to provide an injection flow of at least 600 gpm, which significantly exceeds the combined flow requirement to offset boil-off from decay heat, in addition to the expected system leakage. Although the net flow capacity for some FLEX pumps intended for primary makeup may be reduced relative to that of RCIC, due to diminishing decay heat removal requirements by the time these pumps would be aligned and reductions in primary leakage due to RPV depressurization, they maintain adequate flow capacity. As such these pumps provide a similar functional capability, and the NRC staff concludes that (1) the licensee's assumed recirculation pump seal leakage rate of 18 gpm at full system temperature and pressure appears reasonable for the ELAP event and (2) sufficient margin exists to accommodate primary system leakage rates greater than expected.

Based upon the discussion above, the NRC staff concludes that the recirculation pump seal leakage rates assumed in the licensee's thermal-hydraulic analysis may be applied to the beyond-design basis ELAP event for the site.

3.2.2.4 Shutdown Margin Analyses

As described in its UFSAR, River Bend's design is such that the control rods provide adequate shutdown margin under all anticipated plant conditions, with the assumption that the highestworth control rod remains fully withdrawn. River Bend's Technical Specification 1.1 further clarifies that shutdown margin is to be calculated for a cold, xenon-free condition to ensure that the most reactive core conditions are bounded.

Based on the NRC staff's audit review, the licensee's ELAP mitigating strategy maintains the reactor within the envelope of conditions analyzed by the licensee's existing shutdown margin calculation. Furthermore, the existing calculation retains conservatism because the guidance in NEI 12-06 permits analyses of the beyond-design-basis ELAP event to assume that all control rods fully insert into the reactor core.

Therefore, based on the evaluation above, the NRC staff concludes that the sequence of events in the proposed mitigating strategy should result in acceptable shutdown margin for the analyzed ELAP event.

3.2.2.5 FLEX Pumps and Water Supplies

As described in Section 2.9.3 of the licensee's FIP, the licensee credits three portable pumps in its core cooling FLEX strategies designated as, FLX-P1, FLX-P2 and FLX-P3. Pumps FLX-P1 and FLX-P2 are redundant to each other and provide the motive force to supply cooling water to the SPC HX in Phase 2 and Phase 3. However, the licensee has the capability to use either pump to supply water to the RHR HX in Phase 3 if desired. Both pumps are sized to provide 2500 gpm at a minimum total dynamic head of 160 feet. Pump FLX-P1 is an electric driven pump powered by a portable diesel generator. Pump FLX-P1 is permanently staged in the "G" tunnel and is used as the primary means to supply water to the secondary side of the SPC HX . The pump draws suction from the SCT and pumps water through the existing SSW "B" supply header to the SPC heat exchangers and water is returned to the SCT through the existing SSW return line. Pump FLX-P2 is a portable diesel-driven pump that serves an alternate method to provide cooling water from the SCT to the secondary side of the SPC HX. Pump FLX-P2 will be deployed from FLEX storage building 1 to a location at grade adjacent to the SCT pipe chase. Pump FLX-P2 will draw suction from the SCT via a new pipe run through the SCT pipe chase with connect to existing SSW piping. The pump will discharge to the SSW "B" supply header via a new pipe run in the SCT pipe chase terminating in the "G" tunnel.

In accordance with NEI 12-06, Section 11.2, the licensee performed Calculation G13.18.12.0-084, Revision 1, "Hydraulic Analysis of FLEX Coping Strategies," to determine the hydraulic demand of the FLEX pumps in order to provide the performance requirements for proper selection and procurement of pumps FLX-P1 and FLX-P2. The NRC staff performed a review of the calculation to determine if the licensee used standard evaluation methods, and proper assumptions and inputs, and compared the results of the calculation to the actual design specifications of the procured pumps. The licensee's calculation uses classical hydraulic analysis head loss and pressure gradient methods via AFT Fathom Pipe Flow Analysis System software, and includes all pumps, valves, hoses, strainers, elevations, and line distances for the FLEX Strategy water supply using the most limiting set of conditions for RPV injection and SP cooling. The calculation determined the minimum required flow rate, minimum discharge pressure, and maximum NPSH required for a pump to be able to perform its required function. Comparison of the actual pump performance data and the sizing criteria of the calculation shows that FLX-P1 and FLX-P2 pumps should have the capacity needed to perform the required function for Phase 2 RPV injection and SP cooling, and Phase 3 RHR SDC.

Pump FLX-P3 is the primary pump for SFP cooling and the alternate pump for providing cooling water injection to the RPV in Phase 2 and 3 if the SPC system becomes unavailable. The pump is a diesel-driven pump that, operating at 1800 rpm can provide 450 gpm at a pressure head of 430 ft. The pump is deployed at grade level taking suction from the SCT basin and discharging to the RPV via hose connection to a flushing line on the LPCS portion of the RHR system, and to the SFP via hose aligned to either of the SFP cooling methods (discussed in Section 3.3 of this evaluation). The pump has four discharge connections that can be independently controlled. Because the licensee credits the FLX-P3 pump for multiple functions that may be required concurrently, the licensee must demonstrate that the pump has the capacity the provide the most limiting case of RPV injection flow concurrent with the most limiting case of SFP flow .

In accordance with NEI 12-06, Section 11.2, the licensee performed Calculation G13.18.2.0-085, Revision 1, "Determine Hydraulic Performance Requirements for FLEX Pump No. 3 for Spent Fuel Makeup," to determine if the existing FLX-P3 pump has the capability to provide concurrent RPV and SFP cooling under the most limiting conditions. The NRC staff performed a review of the calculation to determine if the licensee used standard evaluation methods, and proper assumptions and inputs, and compared the results of the calculation to the actual design specifications of the procured pumps. The licensee's calculation uses classical hydraulic analysis head loss and pressure gradient methods, and includes all pumps, valves, hoses, strainers, elevations, and line distances for the FLEX Strategy water supply using the most limiting set of conditions for alternate RPV injection and SFP cooling. The calculation determined the minimum required flow rate, minimum discharge pressure, and maximum NPSH for a pump to be able to perform its required function. Comparison of the actual pump performance data and the sizing criteria of the calculation shows that FLX-P3 has the capacity needed to perform the required function for alternate RPV injection and SFP cooling.

Based on the staff's review of the FLEX pumping capabilities at RBS, as described in the above hydraulic analyses and the FIP, the NRC staff concludes that the portable FLEX pumps should perform as intended to support core cooling, SFP cooling and RCS inventory control during an ELAP event, consistent with NEI 12-06, Section 11.2.

3.2.2.6 Electrical Analyses

The River Bend electrical FLEX strategies are practically identical for maintaining or restoring core cooling, containment, and spent fuel pool cooling, except as noted in Sections 3.3.4.4 and 3.4.4.4 of this SE. Furthermore, the electrical coping strategies are the same for all modes of operation.

After determining that the emergency diesel generators (EDGs) cannot be restarted and off-site power is unlikely to be restored during performance of SBO procedure, the operators would declare BDBEE and plant will have a loss of power for extended period of time. In its FIP, the licensee assumes that this determination can be made at approximately one (1) hour after the onset of an ELAP/LUHS event.

At the initiation of the BDBEE, the reactor scrams, main steam isolation valves automatically close, feed water is lost, and the SRVs automatically cycle to control pressure, causing reactor water level to drop. When reactor water level reaches -43 in., RCIC automatically starts. The instrument loop and suction valves are DC-powered and the valves will change position.

The RBS Phase 1 coping strategy involves relying on installed equipment and onsite resources such as station safety-related 125 Vdc Division I and Division II batteries and Switchgears. River Bend established that the goal for the duration of Phase 1 is at least 8 hours. In order to extend battery availability to meet the required 8-hour time duration, non-essential dc loads beyond those shed by the SBO AOP, are shed beginning at 1 hour into the event. In addition to load shedding, the Division II battery is eventually cross-tied to the Division I bus to continue powering Division I dc loads. The cross-tie occurs when the Division I battery is depleted to a capacity where it can no longer sustain the required loads and will be controlled by procedure RBS-FSG-004, "ELAP DC Bus Loadshed and Management." During the cross-tie process, Division I and Division II batteries will be momentarily connected. The licensee performed an evaluation regarding the "momentary cross-tie" that was supported by information from the battery manufacturer, GNB (RBS engineering change, EC-45120, Rev.0, Attachment 7.003 in P2E - "Operational Characteristics of VRLA Batteries Configured in Parallel Strings") regarding the paralleling of two battery strings with different battery capacities. The licensee concluded that there will be no adverse impact on the dc system, the battery capacity, or the capability to supply dc power to the loads. This action will only be implemented during an ELAP event and will be administratively controlled, so there will be no impact on the design basis or licensing basis of the plant.

The NRC staff reviewed the summary of the RBS dc system analysis (Calculation E-143 (EC 45120), "ENB-BAT01A Duty Cycle, Current Profile, and Size Verification," Rev. 011, and E-144 (EC 45120), "ENB-BAT01B Duty Cycle, Current Profile, and Size Verification," Rev. 007) to verify the capability of the dc system to supply the required loads during the first phase of the RBS FLEX mitigation strategies plan for an ELAP as a result of a BDBEE. The licensee's analysis identified the required loads and their associated ratings (amperage and minimum voltage) and loads that would be shed to ensure battery operation for at least 8 hours (power is expected to be restored to the battery charger by this time). The NRC staff reviewed this analysis and the dc load profiles provided in RBS Calculations E-143, E-144 and G13.18.3.6*021 (EC 45120), "DC System Analysis, Methodology & Scenario Development," Rev. 001. The NRC staff also reviewed the guidance in the dc load shed strategies in Attachment 3 of AOP-0050, "RBS Station Operating Manual, Abnormal Operating Procedure, Station Blackout," Rev. 047. Based on these reviews, the NRC staff expects that the RBS dc system should have adequate capacity and capability to power the loads required to mitigate the consequences during the first phase of an ELAP as a result of a BDBEE, provided that necessary load shedding is completed within the times assumed in the licensee's analysis.

As a part of the ELAP mitigating strategy, the licensee plans to store two 480 Vac, 200 kW DGs to power battery Chargers, three 480 Vac, 500 kW DGs (one for FLX-P1 Pump and two for the SPC Pumps), cables, electrical connectors, FLEX Pumps, hoses etc. in the BDBEE storage building. These FLEX generators will power the required installed equipment as part of the RBS FIP strategies. The licensee identified this as an alternative approach from the strategies identified in NEI 12-06 due to reliance on permanently installed plant structures and systems.

The RBS Phase 2 electrical power supply strategies involve transition from installed plant equipment to the onsite FLEX equipment and implementation of primary and alternate strategies to supply electrical power to the Phase 2 equipment such as battery chargers, SPC pumps and the FLX-P1 Pump. The RBS FIP stated that transition from Phase 1 (reliance on station batteries) to Phase 2 (repowering station battery chargers) will be made using one FLEX 480 Vac, 200 kW portable diesel generator (PDG). The FLEX PDG will be connected to electrical bus EJS-SWG1A, powering battery charger ENB-CHGR1A, which provides 125 Vdc power to the bus ENB-SWG01A that charges the Division I batteries (this action needs to be completed within 8 hours). The FLEX PDG will also be used to provide an alternate Phase 2 electrical power source to repower the non-divisional backup swing battery charger BYS-CHGR1D through a transfer switch as discussed in Section 3.7.3.2 of this SE. The seismically qualified safety-related swing battery charger can provide power to any of the three Class 1E dc buses through existing switchgear.

The licensee stated in the FIP that the decision to deploy the FLEX PDGs will be made during the initial response phase; however battery coping durations are calculated to last at least 8 hours for ELAP. Transition from Phase 1 to Phase 2 (repowering SPC pumps and FLX-P1 pump) will be made using two FLEX 480 Vac, 500 kW PDGs. The connection of one FLEX PDG to the staged FLX-P1 in the "G" tunnel and the connection of the second FLEX PDG to SPC-P1A or SPC-P1B is anticipated to be completed by 8 hours after the event. The only actions required are to deploy the FLEX PDGs, plug into receptacles, and start the PDGs. The required FLEX PDGs to power this equipment will be maintained in the on-site FLEX storage buildings.

The NRC staff reviewed the summary of the RBS Calculation G13.18.3.6-023 (EC44959), "FLEX Strategy – Portable Diesel Generator System Sizing," Rev. 0, and finds that Phase 2 PDGs and Phase 3 turbine generators (TGs) have been adequately sized to power the required loads and the rating of these generators bound the loading requirements. The NRC staff review finds that this calculation also included acceptable short circuit and breaker coordination and electrical loading evaluations for the FLEX design. Based on review of the above calculation, single line electrical diagrams, station procedures, and interactions with the licensee's staff, the NRC staff finds that the licensee's approach is acceptable given the storage and staging locations of the FLEX DGs, the protection and diversity of the power supply pathways, the separation and isolation of the DGs from the Class 1E emergency DGs, and availability of procedures to direct operators on how to align, connect, and protect associated systems and components. The NRC staff also finds that the FLEX PDGs should have sufficient capacity and capability to supply the necessary loads following an applicable BDBEE.

For Phase 3, RBS plans to continue the Phase 2 coping strategy with additional assistance provided from offsite equipment/resources. Table 5 of the River Bend FIP identified two 4160 Vac, 1 MW TGs to support Phase 3 loads for core cooling, containment cooling and instrumentation FLEX strategies. Additionally, Table 5 of the FIP lists two 480 Vac, 1100 kW TGs that will be supplied by the NSRC for this site; one set for Phase 3 operation to restart SCT fans for core cooling and containment cooling, and second set for defense in depth.

The NRC staff reviewed the summary of the RBS Calculation G13.18.3.6-023(EC44959), Rev. 0 and finds that the Phase 3 TGs have been adequately sized to power the required loads and the rating of these generators bound the loading requirements. Based on its review, the NRC staff finds that the 480 Vac and 4160 Vac TGs being supplied from the NSRCs should provide adequate power to enable RBS to maintain or restore core cooling, spent fuel pool cooling, and containment integrity indefinitely following an applicable BDBEE.

3.2.3 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that should maintain or restore core cooling and RCS inventory during an ELAP event consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01 (and the alternative to the guidance to utilize installed plant equipment for Phase 2 and 3), and should adequately address the requirements of the order.

3.3 Spent Fuel Pool Cooling Strategies

NEI 12-06, Table 3-1 and Appendix C summarize an acceptable approach consisting of three separate capabilities for the SFP cooling strategies. This approach uses a portable injection source to provide the capability for 1) makeup via hoses on the refueling floor capable of exceeding the boil-off rate for the design basis heat load; 2) makeup via connection to spent fuel pool cooling piping or other alternate location capable of exceeding the boil-off rate for the design basis heat load; and 3) spray via portable monitor nozzles from the refueling floor using a portable pump capable of providing a minimum of 200 gpm per unit (250 gpm if overspray occurs). During the event, the licensee selects the method to use based on plant conditions. This approach also requires a strategy to mitigate the effects of steam from the SFP, such as venting.

As described in NEI 12-06, Section 3.2.1.7 and JLD-ISG-2012-01, Section 1.1, strategies that must be completed within a certain period of should be identified and a basis that the time can be reasonably met should be provided. NEI 12-06, Section 3 provides the performance attributes, general criteria, and baseline assumptions to be used in developing the technical basis for the time constraints. Since the event is beyond design basis, the analysis used to provide the technical basis for time constraints for the mitigation strategies may use nominal initial values (without uncertainties) for plant parameters, and best-estimate physics data. All equipment used for consequence mitigation may be assumed to operate at nominal setpoints and capacities. NEI 12-06, Section 3.2.1.2 describes the initial plant conditions for the at-power mode of operation; Section 3.2.1.3 describes the initial conditions; and Section 3.2.1.6 describes SFP initial conditions.

NEI 12-06, Section 3.2.1.1 provides the acceptance criterion for the analyses serving as the technical basis for establishing the time constraints for the baseline coping capabilities to maintain SFP cooling. This criterion is keeping the fuel in the SFP covered with water.

The ELAP causes a loss of cooling in the SFP. As a result, the pool water will heat up and eventually boil off. The licensee's response is to provide makeup water. The timing of operator actions and the required makeup rates depend on the decay heat level of the fuel assemblies in the SFP. The sections below address the response during operating, pre-fuel transfer or post-fuel transfer operations. The effects of an ELAP with full core offload to the SFP is addressed in Section 3.11.

3.3.1 Phase 1

For Phase 1 SFP cooling the licensee credits the large inventory and heat capacity of the water in the SFP. Following the loss of normal SFP cooling, the SFP will slowly heat up and eventually begin to boil. Licensee Calculation G13.18.12.4-041 (discussed in more detail in Section

3.3.4.2 of this evaluation) determines the SFP time to boil is 9.51 hours and the time to boil off to the top of fuel is 137.62 hours from initial loss of SFP cooling. The licensee's initial coping strategy for SFP cooling is to allow evaporative cooling of the SFP while monitoring SFP level using instrumentation installed as required by NRC Order EA-12-051.

3.3.2 Phase 2

In accordance with NEI 12-06, Table 3-1 and Appendix C, the licensee has developed three baseline SFP cooling strategies. The strategies use a portable injection source to provide makeup via hoses on the refueling floor, makeup via connection to spent fuel pool cooling piping or other alternate location to allow make up without having to access the refueling floor, and via spray using portable monitor nozzles from the refueling floor.

The licensee's first method provides water at a rate that matches boil-off to the SFP using pump FLX-P3 to take suction from the SSW basin and discharging through fire hoses connected directly to the FLX-P3 pump discharge. Prior to the onset of bulk boiling, the licensee will attach a diffuser to the end of a fire hose and place the hose into the pool the licensee will then route hoses from the SFP to an area outside of the refueling floor. Before the SFP level reaches 107 ft.-10 5/16 in. (or 23 ft. above the top of irradiated fuel), the licensee will deploy pump FLX-P3 near the SCT and attach a non-collapsible hose with a strainer on the end to the suction of the pump. The licensee will lower the suction hose and attached strainer in to the SCT basin to establish a suction path. The licensee will then route a fire hose from the discharge of the pump in accordance with RBS Procedure OSP-0066, "Extensive Damage Mitigation Procedure," Attachment 13, Section 3.2 and attach the discharge hose to the previously laid hose leading to the SFP.

The licensee's second method provides water at a rate that matches boil-off to the SFP using pump FLX-P3 to take suction from the SSW basin and discharging to the SFP through a fire hose connected to existing SFC piping. This method provides the capability to supply makeup water to the SFP without accessing the refueling floor. Before the SFP level reaches 107 ft.-10 5/16 in., the licensee deploys pump FLX-P3 in the same manner as in the first method. With this method however, the licensee connects fire hose from the discharge of the FLX-P3 pump to a 2 in. drain line on SFC system piping. To attach the fire hose the licensee will remove the existing threaded pipe cap and replace it with a vent valve and a 2 in. to 2.5 in. fire hose adapter. The licensee plans to store the required adapters, necessary tools, and the 2.5 in. hose in the FLEX storage buildings.

The licensee's third method provides water at a rate of 250 gpm (to account for over spray) to the SFP using pump FLX-P3 to take suction from the SSW basin and discharge to the SFP through a fire hose connected to a monitor spray nozzle allowing for spray cooling of the SFP. The spray monitor and discharge hose will be deployed prior to the onset of bulk boiling. This method will utilize existing equipment and that is intended to support the mitigating strategies requirements from previous NRC Order EA-02-026, Section B.5.b, and 10 CFR 50.54(hh)(2).

3.3.3 Phase 3

For Phase 3 SFP cooling, the licensee plans to continue using Phase 2 strategies and equipment, and augment as necessary with the additional equipment received from the NSRC.

3.3.4 Staff Evaluations

3.3.4.1 Availability of Structures, Systems, and Components

The baseline assumptions established in NEI 12-06 presume that, other than the loss of the ac power sources and normal access to the UHS, installed equipment that is designed to be robust with respect to design-basis external events is, in general, is assumed to be fully available. Installed equipment that is not robust is, in general, assumed to be unavailable. In addition, the base line assumptions established NEI-12-06 for the SFP, allow licensees to presume that all boundaries of the SFP are intact, including the liner, gates, transfer canals, etc., and that the SFP cooling system is intact, including attached piping.

3.3.4.1.1 Plant SSCs

NEI 12-06, Section 3.2 states that installed equipment that is designed to be robust with respect to design-basis external events is assumed to be fully available. In addition, Condition 6 of NEI 12-06, Section 3.2.1.3, states that permanent plant equipment contained in structures with designs that are robust with respect to seismic events, floods, and high winds, and associated missiles, are available. The RBS UFSAR, Section 3.2.1, Revision 17, states that plant SSCs important to safety are designed to withstand the effects of a SSE , that SSCs (including their foundations and supports) designed to remain functional in the event of an SSE are designated as Seismic Category I. The RBS UFSAR Section 3.4.1.1.1 states that safety-related systems and components, as identified in UFSAR Table 3.2-1, are protected to all postulated flood levels and conditions applicable to RBS. The RBS UFSAR Table 3.2-1 lists the seismic classification and tornado protection of SSCs. In addition, RBS UFSAR Table 3.2-3 states that Safety Class 1, 2, and 3 SSCs are designed as Seismic Category 1.

The licensee's method 1 and method 3 for SFP cooling use only portable equipment and do not require any connections to existing plant SSCs. The licensee's method 2 for SFP cooling requires attaching a fire hose to a 2 in. drain line on the SFC piping. The RBS UFSAR, Table 3.2-1 lists the piping and valves of the cooling subsystem of fuel pool cooling and cleanup system as Seismic Category 1 components. As described in the licensee's FIP, the connection to the SFC piping is located in the fuel handling building which, according to RBS UFSAR Table 3.2-1, is a Seismic Category 1 structure that provides protection from tornados and tornado-generated missiles, and all other applicable non-seismic external hazards.

Based on the location and design of the credited portions of the SFC system piping, as described in the RBS UFSAR, and if aligned and utilized in accordance with Entergy's SFP cooling strategy as described in the FIP, the credited flow paths should be available to support SFP cooling during an ELAP consistent with NEI 12-06, Section 3.2.1.3, Condition 6, and Section 3.2.1.6.

Section 3.2.2 of NEI 12-06 states that portable fluid connections for core and SFP cooling functions are expected to have a primary and an alternate connection or delivery point (e.g., the primary means to put water into the SFP may be to run a hose over the edge of the pool) and that at a minimum, the primary connection point should be an installed connection suitable for both the on-site and off-site equipment while the secondary connection point may require reconfiguration if it can be shown that adequate time and resources are available to support the reconfiguration. In addition, Section 3.2.2 states that 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 assurance that one connection will be available.

The licensee uses three baseline capabilities to provide a diverse and flexible strategy for maintaining or restoring SFP cooling during an ELAP. The licensee uses a portable pump and fire hoses to provide makeup water directly into the pool, indirectly via fire hose and spray monitors on the refuel floor, and via fire hose connected existing SFC piping. Having the ability to supply water to the SFP using the three methods provides assurance that at least one method should be available for SFP cooling during an ELAP in accordance with Section 3.2.2 of NEI 12-06.

In order to establish a vent pathway for steam and condensate, the double doors on the 95 ft. elevation (door F95-1) to the new fuel receiving area will be opened. Door F113-2 will be opened to the stairwell and door F171-1 will be opened on the roof. Because cooler air will be allowed to enter the fuel building through the F95-1 doors, a chimney effect will be established through the stairwell to the roof. These actions will be performed at 8 hours following the onset of the event, which is prior to degraded conditions on the refueling floor to the point that it affects habitability, due to boiling in the SFP.

In addition, the licensee plans to complete hose deployment and spay nozzle setup on the SFP refueling floor before conditions degrade to the point that they affect habitability, due to boiling in the SFP.

3.3.4.1.2 Plant Instrumentation

In its FIP, the licensee stated that the instrumentation for SFP level will align with the requirements of Order EA-12-051. Furthermore, the licensee stated that these instruments will have initial local battery power with the capability to be powered from the 480 V FLEX DGs. The NRC staff's review of the SFP level instrumentation, including the primary and back-up channels, the display to monitor the SFP water level and environmental qualifications to operate reliably for an extended period are discussed in Section 4 of this SE.

3.3.4.2 Thermal-Hydraulic Analyses

NEI 12-06, Section 3.2.1.6 describes SFP initial conditions. Section 3.2.1.6, Condition 4, states that SFP heat load assumes the maximum design-basis heat load for the site. In accordance with NEI 12-06, the licensee performed Calculation G13.18.12.4-041, "Spent Fuel Pool and Upper Containment Pool Time to Boil and Uncover Fuel for Extended Loss of Offsite Power (FLEX)," which uses the maximum expected SFP heat load immediately following a full core offload. With a full core offload, following the loss of ac power and normal SFP cooling the pool will begin to heat up and reach the bulk boiling temperature of 212 degrees F in 9.51 hours. If cooling is not restored, the pool will begin to boil and eventually reach the top of the fuel in 137.62 hours from the loss of SFP cooling. In order to match the inventory lost from boiling, a makeup rate of greater than 59.5 gallons per minute must be established. Deployment of a SFP makeup strategy with a flow rate that exceeds boil-off rate within 72 hours of the loss of SFP cooling will provide for adequate makeup to restore the SFP level and maintain an acceptable level of water for shielding purposes.

3.3.4.3 FLEX Pumps and Water Supplies

The water supply and evaluation of the FLX-P3 pump is discussed in Section 3.2.2.5 of this evaluation.

3.3.4.4 Electrical Analyses

The licensee's FIP defines strategies capable of mitigating a simultaneous ELAP and LUHS resulting from an applicable BDBEE by providing the capability to maintain or restore core cooling at the River Bend site. The licensee's strategy for RCS Inventory Control uses the same electrical strategy as for maintaining or restoring core cooling, containment, and SFP cooling. Furthermore, the electrical coping strategies are the same for all modes of operation.

The NRC staff performed a comprehensive analysis of the licensee's electrical strategies, which includes the spent fuel pool cooling strategy. The NRC staff's review is discussed in detail in Section 3.2.2.6 of this evaluation.

3.3.5 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that if implemented appropriately should maintain or restore SFP cooling following an ELAP consistent with NEI 12-06 guidance as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.4 Containment Function Strategies

NEI 12-06, Table 3-1 provides some examples of acceptable approaches for demonstrating the baseline capability of the containment strategies to effectively maintain containment functions during all phases of an ELAP event. One method is venting containment to keep pressure below limits. River Bend is a BWR with a Mark III containment. The Mark III containment is not equipped with a hardened containment vent capable of performing the necessary pressure control and heat removal functions associated with an ELAP event; therefore, consistent with Table 3-1, RBS has proposed an alternative containment heat removal mechanism to satisfy the requirements of Order EA-12-049. Specifically, RBS will utilize FLEX equipment to repower SPC and Alternate Decay Heat Removal pumps to circulate suppression pool water through the shell side of the SPC Heat Exchanger. The tube side of the heat exchanger will be supplied with cooling water from the SCT basin.

The licensee performed a containment evaluation, G13.18.12.4, "MAAP Analysis of Containment Conditions for Extended Loss of AC Power (FLEX)," Rev. 1, which was based on the boundary conditions described in Section 2 of NEI 12-06. The calculation analyzed the alternative heat removal strategy and concludes that the containment parameters of pressure and temperature in the Drywell remain below the respective UFSAR Table 6.2-1, Rev. 23, design limits of 25 per square inch differential (psid) (Drywell pressure differential is defined as drywell pressure minus containment pressure) and 330 °F for at least 72 hours following an ELAP-inducing event. Furthermore, the calculation concludes that the pressure in the Wetwell (also referred to as the suppression pool) (designated as "Containment" in the UFSAR) also remains below the design limit of 15 psig for at least 72 hours. The 185 °F design limit for the

Wetwell (liquid) temperature is calculated to be exceeded by a peak value of approximately 23 °F. A justification for exceeding this temperature limit is discussed in Section 3.4.4.1.1 of this SE.

Additionally, although core damage is not expected, NEI 12-06, Table 3-1, guides licensees with Mark III containments to repower the unit's hydrogen igniters by using a portable power supply as a defense-in-depth measure to maintain containment integrity. The RBS FIP indicates that the portable diesel generator will be deployed and the igniters powered within 3 hours following an ELAP-inducing event as a contingency action that addresses containment integrity. The FLEX procedures contain the steps needed to repower the hydrogen igniters using a hydrogen igniter portable diesel generator. A hydrogen igniter portable diesel generator will be stored in each FLEX storage building.

3.4.1 Phase 1

During Phase 1, containment integrity is maintained by normal design features of the containment. Decay heat will be transmitted to the suppression pool via RCIC steam exhaust and Safety Relief Valve (SRV) operations. As the suppression pool heats up, the containment atmosphere will begin to heat up and slightly pressurize. Eight hours after the ELAP, containment pressure will reach approximately 7 psig, which is well under the 15 psig design pressure. The SP design temperature of 185°F is exceeded at approximately 5 hours following the onset of the ELAP event. A justification for exceeding this temperature limit is discussed in Section 3.4.4.1.1. Containment temperature and pressure and Suppression Pool temperature and level instruments remain available during Phase 1. Instrumentation indication is available in the MCR.

The Phase 1 coping strategy relies upon the station safety related, 125Vdc batteries (ENB-BAT01A - Division I and ENB-BAT01B - Division II) to provide power to critical instrumentation, SRVs, the RCIC system, and other dc loads. Entergy established that the goal for the duration of Phase 1 is at least 8 hours. In order to extend battery availability to meet the required 8-hour time duration, non-essential DC loads beyond those shed by the SBO AOP are shed beginning at 1 hour into the event. In addition to load shedding, the Division II battery (ENB-BAT01 B) is eventually cross-tied to the Division I bus (ENB-SWG01A) to continue powering Division I dc loads. The cross-tie occurs when the Division I battery is depleted to a capacity where it can no longer sustain the required loads.

3.4.2 Phase 2

The RBS FIP states that by 8 hours following an ELAP event, it is crucial to begin cooling the suppression pool to remove decay heat being deposited into the containment and prevent suppression pool boiling. Therefore, according to the sequence of events in the RBS FIP, by 6 hours following an ELAP event, RBS will initiate alignment of one of the SPC pumps (SPC-P1A/B) to take suction from the low pressure coolant injection (LPCI) "C" suppression pool suction line and discharge through the SPC heat exchanger (SPC-E1) to the SP through the LPCI "C" test return line. The SPC pumps will be powered directly from a FLEX portable diesel generator. One of two 2500 gpm FLEX pumps (one electric motor-driven, and one diesel motor-driven) provide primary and alternate connection points for cooling water to the SPC heat exchanger. The electric motor-driven pump, FLX-P1, is powered by a single 480 Vac, 500 kW FLEX DG.

Following the initiation of suppression pool cooling using the SPC system, a gradual reduction in SP temperature occurs after peaking at approximately 208°F at about 8 hours. The temperature drops to approximately 170°F in 50 hours and then increases to 185°F when the RPV is depressurized for SPC core cooling. The SP temperature will then continue on a gradual trend downward. Containment pressure increases to approximately 9 psig prior to decreasing due to pool cooling. SP level will continue to rise until external sources of injection (i.e. Upper Containment Pool (UCP)) are terminated. Water will reach a level of approximately 27' in the containment (and eventually in the drywell). The licensee stated in the FIP, that there are no adverse consequences at this level and the expected containment pressure is well within the primary containment pressure limit (PCPL) in the RBS EOPs.

3.4.3 Phase 3

The RBS FIP states that the Phase 3 strategy is to extend Phase 2 strategies long term with no immediate reliance on equipment from the NSRC. Based on the licensee's containment analysis, an SPC pump along with the SPC heat exchanger and either the FLX-P1 or FLX-P2 cooling water pump can sustain core cooling past 72 hours. Furthermore, the RBS FIP states that Phase 3 is considered to begin when the SSW cooling tower fans are repowered from a 480V NSRC PDG connected to EHS-MCC16B.

3.4.4 Staff Evaluations

3.4.4.1 Availability of Structures, Systems, and Components

NEI 12-06 baseline assumptions have been established on the presumption that other than the loss of the ac power sources and normal access to the UHS, installed equipment that is designed to be robust with respect to design-basis external events is assumed to be fully available. Installed equipment that is not robust is assumed to be unavailable. Below are the baseline assumptions for the availability of SSCs for maintaining containment functions during an ELAP.

3.4.4.1.1 Plant SSCs

As stated in Section 6.2.1.1 of the RBS UFSAR, Rev. 14, the containment system employs the drywell/pressure suppression features of the BWR-Mark III containment concept. The containment is a steel structure in the form of a right circular cylinder with torispherical dome and flat bottom. Surrounding the containment is a reinforced concrete shield building. Table 3.2-1 of the UFSAR, lists the containment as a Seismic Category I structure, and further defines the design criteria for Seismic Category I structures by stating that all civil structures classified as Seismic Category I are designed for the effects of RBS natural phenomena such as tornado, wind loads, external missiles and floods, in addition to seismic effects. Section 3.8.1.1 of the UFSAR further confirms that the containment has the capability to maintain its functional integrity during any postulated design event, including protection against missiles from internal or external sources.

The SPC and Alternate Decay Heat Removal is designed as a non-safety related system to maintain suppression pool water clarity and chemistry, and provide an alternate method of decay heat removal when the reactor is shutdown. The portions of the system that are used in the FLEX strategy includes pumps SPC-P1A and SPC-P1B, heat exchanger SPC-E1 and associated system piping.

The SPC system components credited for use in FLEX are contained in seismic category I structures which provide protection from the applicable BDBEEs. The pumps and heat exchanger are located in a seismic category I piping tunnel which also provides protection for BDBEEs. During the audit process, the licensee provided Engineering Report RBS-CS-13-00007, which demonstrates SPC component functionality following a seismic event by utilizing a combination of existing seismic design and evaluation documentation review and seismic margin assessment methods. Specific components requiring additional evaluation included pumps SPC-P1A and SPC-P1B, heat exchanger SPC-E1, unit cooler HVY-UC1, various valves, and small-bore piping. The evaluation, of the as-built configuration of SPC system components, credited for implementation of RBS FLEX strategies, are justified as having high confidence of component functionality following a seismic event. Therefore, these components can be credited for use during a post-earthquake FLEX event.

As stated in Section 3.4 above, the 185 °F design limit for the SP temperature is calculated to be exceeded by a peak value of approximately 23°F and remain over the limit for approximately 8 hours during an ELAP event. During the audit process, the licensee discussed that the 185 °F design limit was established for a Design Basis Event (DBE) when containment integrity is challenged by internal containment pressure. The containment MAAP analysis demonstrated that the containment pressure remains at least 5 psi below the design pressure of 15 psi for the time period that the suppression pool temperature is above the design limit of 185°F, as well as throughout the entire ELAP event. In addition, during the audit process, the licensee provided the NRC staff with Evaluation 7201.120-009-001A, "River Bend Station Containment Internal Pressure Fragility Analysis, January 1992," which demonstrates containment pressure limits much greater than 15 psig at 300 °F. Based on this existing RBS containment fragility evaluation, it was determined that slightly exceeding the suppression pool temperature design limits will not have an effect on containment integrity. It was also determined from the MAAP analysis that exceeding the Heat Capacity Temperature Limit (HTCL), Pressure Suppression Pressure Level (PSPL), and SRV Tailpipe Level Limit (SRVTPLL) without emergency depressurization is acceptable by procedurally controlling the reduction in reactor RPV pressure, which significantly reduces the stresses.

Regarding the potential consequences of the elevated SP temperature, the NRC staff finds that the exceedance of the SP temperature design limit for the relatively short duration described above has been adequately justified to demonstrate that there will not be significant adverse effects. Thus, it is reasonable that the structural integrity of the SP will be maintained under the expected ELAP conditions.

Section 6.2.5.2.5 of the UFSAR states that the hydrogen igniters (which are part of the hydrogen control system) are designed as a safety grade system and are capable of operating for the duration of the hydrogen generation event. Furthermore, the igniter assemblies are classified and designed as electrical Class 1E and seismic Category I.

Based on the above UFSAR qualifications, calculations, and the implementation of the described plant modifications, the equipment essential to the containment heat removal and containment integrity protection strategies is robust, as defined by NEI 12-06, and should be available following an ELAP-inducing event.

3.4.4.1.2 Plant Instrumentation

NEI 12-06, Table 3-1 specifies that containment pressure, suppression pool temperature, and suppression pool level are key containment parameters which should be monitored by repowering the appropriate instruments.

Containment temperature and pressure and Suppression Pool temperature and level instruments is credited for all phases of the containment integrity strategy. Instrumentation indication is available in the MCR.

The RBS FIP states that the above key parameters are available prior to and after load stripping of the DC and AC buses during Phase 1. Availability during Phases 2 and 3 will be maintained by repowering the class 1E battery charger for the Division 1 station batteries using a FLEX PDG.

In the unlikely event that 120 Vdc and 120 Vac vital bus infrastructure is damaged, alternate FLEX strategy guidelines for obtaining the critical parameters locally is provided in RBS-FSG-007. Therefore, the licensee should have the ability to appropriately monitor the key containment parameters as delineated in NEI 12-06, Table 3-1.

3.4.4.2 Thermal-Hydraulic Analyses

The licensee performed calculation G13.18.14.1-048, "MAAP Analysis of Containment Conditions for Extended Loss of AC Power (FLEX)," Rev. 1, to demonstrate the effectiveness of the proposed containment heat removal strategy. The calculation utilized the MAAP computer code, Version 4.0.7, to model the heat-up and pressurization of the containment under ELAP conditions.

As stated in the FIP, Case 1 (baseline) of this calculation models the containment response with the licensee's specific containment heat removal strategy being employed at the times described in Section 3.4.2 above. It assumes that the reactor has been operating at 100% power for 100 days (as specified in NEI 12-06, Rev. 0, Section 2) when the ELAP event occurs. During an ELAP event, the containment will begin to heat up and pressurize due to the discharge of the SRVs, leakage from the recirculation system, and the RCIC system exhaust steam as described in the core cooling strategy of Section 3.2.1. Under these conditions and with the employment of the heat removal strategy, Case 1 concludes that the containment parameters of pressure and temperature in the Drywell reach maximum values of 4.5 psid and 253 °F and then stabilize or decrease in the first 72 hours following an ELAP-inducing event. Furthermore, it concludes that the pressure in the Wetwell reaches a maximum value of 10.2 psig, and the temperature in the Wetwell (air space) reaches 185 °F. As stated in the Section 3.4 introduction, each of these values is below their respective UFSAR limit. The 185 °F design limit for the Wetwell (liquid) temperature is calculated to be exceeded by a peak value of approximately 23 °F. A justification for exceeding this temperature limit is discussed in Section 3.4.4.1.1.

3.4.4.3 FLEX Pumps and Water Supplies

The capability of the FLEX systems to perform their function with respect to the containment heat removal strategy is discussed in Section 3.2.2.5.

3.4.4.4 Electrical Analyses

The RBS electrical FLEX strategies are practically identical for maintaining or restoring core cooling, containment, and spent fuel pool cooling, except as noted in Sections 3.3.4.4 and 3.4.4.4 of this SE. Furthermore, the electrical coping strategies are the same for all modes of operation.

After determining that the EDGs cannot be restarted and off-site power is unlikely to be restored for a period greater than the four hour SBO coping time, the RBS operators would declare an ELAP. In the FIP, the licensee stated that this determination can be made at about 1 hour after the onset of an ELAP/LUHS event.

During Phase 1, the reactor remains isolated and pressurized with RCIC providing core cooling and initially taking suction from the SP. The SRVs control reactor pressure. One hour after the event, operators will initiate a controlled reactor cooldown and manual depressurization of the RVP to achieve a pressure band of 200 to 400 psig. The operator will be directed to perform deep dc load shed to minimize the load on the batteries. Load shedding will be completed within 1.5 hours to ensure that the station batteries are available for a minimum of 8 hours at which time the FLEX portable generator will be available to repower station battery chargers. The licensee performed a containment evaluation analysis based on the boundary conditions described in Section 2 of NEI 12-06. The licensee stated in its FIP, that the Class 1E battery coping time of 8 hour and 55 minutes (with crosstie of Division II to Division I bus) was calculated in accordance with the [Institute of Electrical and Electronics Engineers] IEEE-485 methodology using the manufacturer discharge test data applicable to the licensee's FLEX strategy as outlined in the NEI white paper on Extended Battery Duty Cycles. The time margin between the calculated battery duration for the FLEX strategy and the expected deployment time for FLEX equipment to supply the dc loads is approximately 3 hours for RBS, as discussed in Section 3.2.2.6 of this SE.

The strategy to re-power the station battery charger requires the use of a PDG. The PDGs (primary and alternate) for battery charging are 480 Vac, 200 kW trailer-mounted generators as discussed in Section 3.2.2.6 of this SE and will be deployed to the west of the CB at the west side, outside access door.

The licensee stated in the FIP that the Hydrogen Igniters are ac powered by motor control centers (MCCs) EHS-MCC2A for Div. I and EHS-MCC2K for Div. II. This power will be lost in the FLEX event. These igniters will be repowered using a 15 kW, 480 Vac hydrogen igniter diesel generator deployed to the west side of the auxiliary building near an exterior security gate and west stairwell exterior door.

Additional replacement 480 Vac and 4160 Vac TGs are available from the NSRC for the Phase 3 strategy as discussed in Section 3.2.2.6 of this SE. The SCT fans are required to be repowered as part of Phase 3 strategy in order to ensure continued cooling of the SP and RPV. The SSW cooling tower fans are repowered with an 1100kW, 480 Vac NSRC turbine generator connected to EHS-MCC16B, which is located in the SCT. An alternate strategy makes use of two 1 MW, 4160 Vac NSRC turbine generators to provide power to the SSW cooling tower fans through the Division II 4160 Vac bus.

3.4.5 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should maintain or restore containment functions following an ELAP event consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01 (and the alternative to the guidance to utilize installed plant equipment for Phase 2 and 3), and should adequately address the requirements of the order.

3.5 Characterization of External Hazards

Sections 4 through 9 of NEI 12-06, Rev. 0, provide the methodology to identify and characterize the applicable BDBEEs for each site. In addition, NEI 12-06 provides a process to identify potential complicating factors for the protection and deployment of equipment needed for mitigation of site-specific BDBEEs leading to an ELAP and loss of normal access to the UHS. Characterization of the applicable hazards for a specific site includes the identification of realistic timelines for the hazard, characterization of the functional threats due to the hazard, development of a strategy for responding to events with warning, and development of a strategy for responding to events without warning.

The licensee reviewed the plant site against NEI 12-06 and determined that FLEX equipment should be protected from the following hazards: seismic; external flooding; severe storms with high winds; ice and extreme cold; and extreme high temperatures.

References to external hazards within the licensee's mitigating strategies and this SE are consistent with the guidance in NEI-12-06 and the related interim staff guidance in JLD-ISG-2012-01 [Reference 7]. NEI 12-06 directed licensees to proceed with evaluating external hazards based on currently available information. For most licensees, this meant that the OIP used the current design basis information for hazard evaluation. Coincident with the issuance of the order, on March 12, 2012 the NRC staff issued a Request for information Pursuant to 10 CFR 50.54(f) [Reference 19] (hereafter referred to as the 50.54(f) letter), which requested that licensees reevaluate the seismic and flooding hazards at their sites using updated hazard information and current regulatory guidance and methodologies. Due to the time needed to reevaluate the hazards, and for the NRC to review and approve them, the reevaluated hazards were generally not available until after the mitigation strategies had been developed. The NRC staff has developed a proposed rule, titled "Mitigation of Beyond-Design-Basis Events," hereafter called the MBDBE rule, which was published for comment in the *Federal Register* on November 13, 2015 [Reference 43]. The proposed MBDBE rule would make the intent of Orders EA-12-049 and EA-12-051 generically applicable to all present and future power reactor licensees, while also requiring that licensees consider the reevaluated hazard information developed in response to the 50.54(f) letter.

The NRC staff requested Commission guidance related to the relationship between the reevaluated flooding hazards provided in response to the 50.54(f) letter and the requirements for Order EA-12-049 and the MBDBE rulemaking (see COMSECY-14-0037, Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of

Flooding Hazards," dated November 21, 2014 [Reference 44]). The Commission provided guidance in a SRM to COMSECY-14-0037 [Reference 20]. The Commission approved the staff's recommendations that licensees need to address the reevaluated flooding hazards within their mitigating strategies for BDBEEs, and that licensees may need to address some specific flooding scenarios that could significantly damage the power plant site by developing scenario-specific mitigating strategies, possibly including unconventional measures, to prevent fuel damage in reactor cores or SFPs. The NRC staff did not request that the Commission consider making a requirement for mitigating strategies capable of addressing the reevaluated flooding hazards be immediately imposed, and the Commission did not require immediate imposition. In a letter to licensees dated September 1, 2015 [Reference 45], the NRC staff informed the licensees that the implementation of mitigation strategies should continue as described in licensee's OIPs, and that the NRC SEs and inspections related to Order EA-12-049 will rely on the guidance provided in JLD-ISG-2012-01, Revision 0, and the related industry guidance in NEI 12-06, Revision 0. The hazard reevaluations may also identify issues to be entered into the licensee's corrective action program consistent with the OIPs submitted in accordance with Order EA-12-049.

As discussed above, licensees are reevaluating the site seismic and flood hazards as requested in the NRC's 50.54(f) letter. After the NRC staff approves the reevaluated hazards, licensees will use this information to perform flood and seismic mitigating strategies assessments (MSAs) per the guidance in NEI 12-06, Revision 2, Appendices G and H [Reference 46]. The NRC staff endorsed Revision 2 of NEI 12-06 in JLD-ISG-2012-01, Revision 1 [Reference 47]. The licensee's MSAs will evaluate the mitigating strategies described in this SE using the revised seismic hazard information and, if necessary, make changes to the strategies or equipment. Licensees will submit the MSAs for NRC staff review.

The licensee developed its OIP for mitigation strategies by considering the guidance in NEI 12-06 and the site's design-basis hazards. Therefore, this SE makes a determination based on the licensee's OIP and FIP. The characterization of the applicable external hazards for the plant site is discussed below.

3.5.1 Seismic

In its FIP, the licensee stated that seismic hazard is applicable to RBS. Per the 50.54(f) letter, licensees were also asked to provide a seismic hazard screening and evaluation report to reevaluate the seismic hazard at their site. The licensee completed a seismic hazard screening report (SHSR) [Reference 22] in March 2014. The licensee stated in the SHSR that the safe shutdown earthquake (SSE) seismic criterion for RBS is 0.10g horizontal ground acceleration. Based on the results of the SHSR, the licensee determined that RBS screened out for a risk evaluation (1-10 Hz), high frequency evaluation and that RBS also screened out for a spent fuel pool evaluation. Therefore, RBS did not perform any further seismic evaluations. The NRC staff completed its review of the RBS SHSR, as documented by letter dated February 18, 2016 [Reference 37]. The NRC staff concluded that no further response or regulatory actions associated with the 50.54(f) letter review of the Near-term Task Force (NTTF) Recommendation 2.1, "Seismic," are required for RBS.

3.5.2 Flooding

The licensee stated in its FIP that the RBS design-basis flood level is 96 ft. mean sea level (MSL), which is limited by regional precipitation, as described in UFSAR, Table 3.4-1. The RBS site grade level is a minimum of 90 ft MSL and the average plant grade is 94.5 ft. MSL. Therefore, RBS screens in for an assessment of external flooding. Accordingly, the licensee has submitted its flood hazard reevaluation report (FHRR) [Reference 21].

The FHRR results were bounded by the original UFSAR site flooding vulnerabilities and characteristics, with the exception of flooding due to local intense precipitation (LIP). Re-evaluation of flooding due to LIP has resulted in a reevaluated flood height of 98.3 ft. MSL versus the current licensing basis flooding height of 96 ft. MSL. However, the licensee determined that the higher reevaluated flood height is not expected to impact the FLEX strategy. The elevation of the FLEX storage buildings is sufficient to preclude any impact from the LIP levels and reevaluated flood depths are generally low (less than 0.5 ft.) in most deployment paths. Flood depths in some areas are significant (greater than 2 ft.), however, procedures and programs (e.g. RBS-FSG-005, Revision 0, “Initial Assessment and FLEX Equipment Staging”) that address deploying FLEX equipment, account for the flood levels as well as any impact on deployment timing and FLEX equipment locations.

Flooding is expected to be largely reduced in locations utilized for deployment of Phase 2 equipment. Deployment on-site of Phase 3 equipment from the Regional Response Center is not expected to be impacted due to recession of flood waters prior to Phase 3.

According to the information presented in the FHRR, flood levels from a LIP event recede to below the current licensing basis of 96 ft MSL within approximately 2 hours. Additional conservatism is provided in that RBS-FSG-005 contains direction to utilize sand bagging or other suitable flood protection devices to prevent flood waters from entering open flood doors that may need to remain open for routing of portable electrical cables, even though the flood reanalysis demonstrates that the flood levels will recede below the current licensing basis value of 96 ft. MSL before the FLEX strategy requires the doors to be opened.

The NRC staff has reviewed the flood hazard information submitted by the licensee [Reference 36] and has concluded that the licensee's reevaluated flood hazards information is suitable for the assessment of mitigating strategies developed in response to Order EA-12-049 (i.e., defines the mitigating strategies flood hazard information described in guidance documents currently being finalized by the industry and NRC staff), for River Bend. Further, the staff has concluded that the licensee's reevaluated flood hazard information is a suitable input for other assessments associated with Near Term Task Force Recommendation 2.1 "Flooding". The NRC staff plans to issue a staff assessment documenting the basis for these conclusions at a later time.

With regard to potential impact from large internal flooding sources, the licensee described a need in its OIP for an evaluation of the seismic robustness of non-safety related Class 4 piping located in RBS piping tunnels utilized in the FLEX strategy. The licensee performed an evaluation that determined that there are several lines that are non-safety related, Class 4 piping in the tunnel that may, at any time, contain water and/or be connected to water supplies. The licensee evaluated the piping and identified 15 lines that have at least some sections that are not seismically robust and that a failure in any of these lines could render the tunnels temporarily inaccessible until the flooding is controlled. The licensee determined that that the closure of four valves in the yard following a seismic FLEX event will effectively isolate these potential flooding sources. The licensee updated its procedure AOP-0065, Revision 000, "Extended Loss of AC Power (ELAP)," to provide direction to the operators to evaluate the tunnel for flooding and isolate the necessary valves if flooding is occurring.

As the licensee's flooding reevaluation activities are completed, the licensee will enter appropriate issues into the corrective action program. The licensee has appropriately screened in the flooding hazard and identified the hazard levels for reasonable protection of the FLEX equipment.

3.5.3 High Winds

NEI 12-06, Section 7, provides the NRC-endorsed screening process for evaluation of high wind hazards. This screening process considers the hazard due to hurricanes and tornadoes.

The screening for high wind hazards associated with hurricanes should be accomplished by comparing the site location to NEI 12-06, Figure 7-1. If the resulting frequency of recurrence of hurricanes with wind speeds in excess of 130 miles per hour (mph) exceeds 10^{-6} per year, the site should address hazards due to extreme high winds associated with hurricanes.

The screening for high wind hazard associated with tornadoes should be accomplished by comparing the site location to NEI 12-06, Figure 7-2. If the recommended tornado design wind speed for a 10^{-6}/year probability exceeds 130 mph, the site should address hazards due to extreme high winds associated with tornadoes.

In its FIP, the licensee describes that RBS is centered at 30°45'26" N latitude and 91°19'54" W longitude and per NEI 12-06 guidance, hurricane and tornado hazards are applicable to RBS. Current plant design bases address the storm hazards of hurricanes, high winds and tornados.

All seismic category I structures are designed to withstand sustained winds up to 100 mph fastest mile at 30 ft above ground, based upon a 100-year period of recurrence.

The design basis tornado parameters for the site are as follows:

Maximum rotational wind velocity - 290 mph
Maximum translational velocity - 70 mph
Minimum translational velocity - 5 mph
External pressure drop - 3.0 psi
Rate of pressure drop - 2.0 psi/sec
Radius at maximum rotational speed - 150 ft.
Tornado Missiles:
    4 in. x 12 in. wood plank
    3- in. diameter steel pipe
    1- in. diameter steel rod
    6- in. diameter steel pipe
    12- in. diameter steel pipe
    13 ½ in. utility pole
    Automobile

Therefore, high-wind hazards are applicable to the plant site. The licensee has appropriately screened in the high wind hazard and characterized the hazard in terms of wind velocities and wind-borne missiles.

3.5.4 Snow, Ice, and Extreme Cold

As discussed in NEI 12-06, Section 8.2.1, all sites should consider the temperature ranges and weather conditions for their site in storing and deploying their FLEX equipment consistent with normal design practices. All sites outside of Southern California, Arizona, the Gulf Coast and Florida are expected to address deployment for conditions of snow, ice, and extreme cold. All sites located north of the 35th Parallel should provide the capability to address extreme snowfall with snow removal equipment. Finally, all sites except for those within Level 1 and 2 of the maximum ice storm severity map contained in Figure 8-2 of NEI 12-06 should address the impact of ice storms.

In its FIP, the licensee describes that the guidelines provided in NEI 12-06, Section 8.2.1, generally exclude the need to consider extreme snowfall at plant sites in the southeastern U.S. below the 35th parallel. The plant site is located at 30°45'26" N latitude and 91°19'54" W longitude and thus the capability to address extreme snowfall with snow removal equipment need not be provided. However, the site is located within the region characterized by EPRI as ice severity level 3, NEI 12-06, Figure 8-2. As such, the site is subject to the potential for considerable amounts of ice accumulation that could cause low to medium damage to electrical transmission lines. Thus, RBS site screens in for an assessment for extreme cold for ice only.

In summary, based on the available local data and Figures 8-1 and 8-2 of NEI 12-06, the plant site can experience significant amounts of ice and extreme cold temperatures; therefore, the licensee has appropriately screened in the hazard.

3.5.5 Extreme Heat

In its FIP, the licensee describes that, as per NEI 12-06 Section 9.2, all sites are required to consider the impact of extreme high temperatures. The climate at RBS can be describes as humid subtropical. Summer daily maximum temperatures average about 91 °F, with rare periods of extremely hot temperatures over 100 °F according to the UFSAR. An extreme high temperature of 110 °F was recorded in August 1909 at the old weather station located in the south end of the Baton Rouge business district.

In summary, based on the available local data and the guidance in Section 9 of NEI 12-06, the plant site does experience extreme high temperatures. The licensee has appropriately screened in the high temperature hazard and characterized the hazard in terms of expected temperatures.

3.5.6 Conclusions

Based on the evaluation above, the NRC staff concludes that the licensee has developed a characterization of external hazards that is consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order in regard to the characterization of external hazards.

3.6 Planned Protection of FLEX Equipment

3.6.1 Protection from External Hazards

In its FIP, the licensee states that equipment used to support Phase 2 of FLEX is stored in two pre-engineered metal storage buildings (North and South storage buildings).

The equipment stored and maintained at the RBS FLEX Storage Building necessary for the implementation of the FLEX strategies in response to a BDBEE at RBS is listed in Table 4 of the FIP which also identifies the quantity, applicable strategy, and capacity/rating for the major FLEX equipment components. The major components are as follows:

Diesel Driven Hale FP2000DI-TC Portable Pump (FLX-P2)
Two (2) 480V Diesel Generators (battery charging)
Three (3) 480V Diesel Generators (1 for FLX-P1; 2 for SPC pump)
Two (2) 480V Diesel Generators with Lighting Stand (Hydrogen Igniter power)
Two (2) Diesel Powered Pumps (1 - Hale IP1000DI-TC and 1 - Hale IP1000DJ-TC)
Two (2) Fuel Trailers
Two (2) Electric Driven Blackmer XRLF1.25B Diesel Fuel Pumps
Two (2) Electrical Trailers
Two (2) Mechanical Trailers
Two (2) Front End Loaders
Two (2) Tow Vehicles
Eight (8) Portable Lighting Towers

In addition to the above, Pump FLX-P1 is permanently staged (but not connected) in the "G" tunnel from the SSW basin to the auxiliary building. This location is a safety-related structure that is protected from the external hazards determined to be applicable to RBS. Protection against seismically-induced flooding in the tunnel is provided by administrative controls to isolate susceptible piping as described in Section 3.2.2.1.1 of this SE. Below are additional details on how FLEX equipment is protected from each of the external hazards.

3.6.1.1 Seismic

In its FIP, the licensee states that large portable FLEX equipment, such as pumps and power supplies, are positioned inside the FLEX storage buildings with enough separation space to protect them during a seismic event. The licensee performed an evaluation that determined the minimum separation distance of the equipment within the buildings to ensure that they will not interact with each other during a seismic event. As long as the equipment is stored at a distance equal to or greater than the minimum distance of 15 in., it is not required to be tied down. Tie down points are provided in the building slab so that equipment may be stored closer together if necessary. These tie downs are to be used to secure any equipment that is not considered stable or that is needed to be stored closer than the minimum separation distance of 15 in.

During the audit process, the licensee stated that the reactions from the excess wind speed loading evaluation govern the design of the building over the smaller SSE loading. The licensee's evaluation [Reference 39] concluded that the wind loading case induced reaction forces in the governing design elements (braces) which were a minimum of double (2x) the magnitude induced by the SSE loading case. Thus, the FLEX storage building should have adequate capacity to provide reasonable protection of the equipment and facilitate its deployment following a seismic event.

3.6.1.2 Flooding

In its FIP, the licensee states that protection of FLEX equipment against external flooding events is provided in accordance with Section 6.2.3.1.1.a of NEI 12-06, which states that equipment is protected from floods if it is stored above the flood elevation from the most recent site flood analysis. Per RBS UFSAR Table 3.4-1, the design-basis flood level at RBS is 96 ft. MSL due to SSE condition combined with a 25 year flood. The northern storage building location is located at an elevation of 132 ft. and the southern storage building location is located at an elevation of 110 ft. well above the maximum site design basis flood level.

3.6.1.3 High Winds

In its FIP, the licensee states that protection of FLEX equipment against high wind hazard events will be performed in accordance with Section 7.3.1.1.c of NEI 12-06, which states that the equipment should be stored in locations that are separated by sufficient distance that minimizes the probability that a single event would damage all FLEX mitigation equipment. The FLEX storage buildings are located at a distance of over 3,000 ft from each other perpendicular to the prominent tornado paths in order to provide adequate tornado separation. This separation assures that at least one of the storage buildings will be available following a BDBEE. In addition, the storage location for FLX-P1 is in the "G" tunnel which is a location protected from the effects of high winds and tornado missiles.

Due to this separation, the buildings are not tornado missile protected. The building design is required to bound American Society of Civil Engineers (ASCE) 7-10, site wind speeds from RBS 200.010, Structural Design Criteria for River Bend Station (other than tornadoes), and ASCE 7-05 to satisfy NEI 12-06 and the local building authority. The bounding 3-second gust, service level wind speed is 116 mph. The storage buildings were conservatively designed to withstand a service level wind speed of 130 mph using the methodology from ASCE 7-05. This wind speed bounds the plant basic wind speed and the local building code wind speed.

3.6.1.4 Snow, Ice, Extreme Cold and Extreme Heat

In its FIP, the licensee states that protection of FLEX equipment from impacts due to extreme cold is performed in accordance with Section 9.3.1 of NEI 12-06, which states that equipment should be maintained at a temperature within a range to ensure its likely function when called upon. In accordance with Section 8.3.1.b of NEI 12-06 the storage of equipment shall be in a structure designed to or evaluated equivalent to ASCE 7-10 for the plant's design-basis for the snow, ice and cold conditions. The plant's design-basis low temperature is 2 °F, per RBS specification 215.200. The indoor cold temperature limit bounds this ambient temperature to ensure the equipment will function when called upon.

Central heating within the storage buildings is not utilized. Electrical receptacles are available for local heating elements, which may be necessary depending on the equipment and fuel storage requirements. A procedure has been developed to provide guidance for protection of stored equipment against cold weather in the case of a loss of power to the storage buildings.

Additionally the procedure provides guidance for determining when action will be required to implement protection of stored equipment against cold weather (i.e. powering block heaters, battery maintainers, etc.).

3.6.2 Reliability of FLEX Equipment

Section 3.2.2 of NEI 12-06 states, in part, that in order to assure reliability and availability of the FLEX equipment, the site should have sufficient equipment to address all functions at all units on-site, plus one spare (i.e., an N+1 capability, where "N" is the number of units on-site). It is also acceptable to have a single resource that is sized to support the required functions for multiple units at a site. In addition, it is also acceptable to have multiple strategies to accomplish a function, in which case the equipment associated with each strategy does not require an additional spare.

Based on the number of portable FLEX pumps, FLEX DGs, and support equipment identified in the FIP, as reviewed above, it is expected that, if implemented appropriately, the licensee's FLEX strategies should include a sufficient number of portable FLEX pumps and generators and equipment for core cooling, RCS makeup, SFP makeup and maintaining containment strategies consistent with the N+1 recommendation in Section 3.2.2 of NEI 12-06.

3.6.3 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should protect the FLEX equipment during a BDBEE consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01 (and the alternative to the guidance to utilize installed plant equipment for Phase 2 and 3), and should adequately address the requirements of the order.

3.7 Planned Deployment of FLEX Equipment

In its FIP, the licensee states that pre-determined haul paths have been identified and documented in the FSGs. Figure 8 in the FIP shows the haul paths from the FLEX storage buildings to the various deployment locations. Vehicle and equipment access to the protected area is via the double gated sally-port at the security building. As part of the security access contingency, the sally-port gates will be manually controlled to allow delivery of FLEX equipment (e.g., generators, pumps) and other vehicles such as debris removal equipment into the protected area.

3.7.1 Means of Deployment

In its FIP, the licensee states that the stored FLEX equipment includes two heavy duty pickup trucks equipped for towing of FLEX equipment and trailers and two front end loaders for debris removal and towing. One truck and one front end loader is stored in each FLEX storage building.

In determining the haul paths, areas with trees, power lines, narrow passages, etc. were avoided where practical. However, high winds can cause debris from distant sources to interfere with planned haul paths. Debris removal equipment is stored inside the FLEX storage buildings to be protected from the severe storm and high wind hazards such that one set of equipment remains functional and deployable to clear obstructions from the pathway between the FLEX storage buildings and its deployment locations. RBS screens out for the snow hazard; thus snow removal is not considered.

3.7.2 Deployment Strategies

In its FIP, the licensee states that the haul paths have been reviewed for potential soil liquefaction and have been determined to be stable following a seismic event.

With regard to flooding effects on deployment, the licensee describes in the FIP that flood depths are generally low (< 0.5 ft) in most deployment paths, but in some areas are significant (> 2 ft.). Procedures and programs (RBS-FSG-005, Revision 0, Initial Assessment and FLEX Equipment Staging) addressing moving FLEX equipment from storage areas account for the flood levels as well as any impact on deployment timing and FLEX equipment locations.

Flood levels in proposed locations of deployed FLEX Phase 2 equipment are expected to have largely receded prior to the time this equipment is connected and credited in the FLEX strategy. Even though the flood reanalysis shows that flood levels at doors to be opened to support the FLEX strategy will recede before the deployment strategy has them opened, RBS-FSG-005 provides direction to utilize sand bagging or other suitable flood protection devices to prevent flood waters from entering open flood doors that may need to remain open for routing of portable electrical cables.

Deployment on-site of equipment in Phase 3 from the Regional Response Center is not expected to be impacted due to recession of flood waters prior to that time.

Regarding deployment of FLEX pumps to the UHS, in its FIP the licensee describes that two pumps are used. The FLX-P1 is the primary pump for providing cooling water to the SPC heat exchangers for SP cooling. It takes suction on the SCT (the UHS) and pumps water through the existing SSW "B" supply header to the SPC heat exchangers. Water is returned to the SCT through the existing SSW return line. The FLX-P1 is permanently staged (but not connected) in the "G" tunnel, 70 ft. elevation near the west end of the "G" tunnel near its connection point. The pump is seismically secured and protected from all external hazards by its location in the seismic category I, "G" Tunnel. Thus deployment of FLX-P1 itself is not a concern, however, FLX-P1 is an electric motor driven pump powered by a single, portable 480 Vac, 500kW FLEX PDG deployed from a FLEX storage building using a primary or alternate power strategy. For the primary strategy, the PDG will be located at grade with cables routed through permanently installed conduit from inside the fuel building, into "G" tunnel and to the pump motor. The FLEX PDG will be deployed to the northwest corner of the fuel building. For the alternate power strategy, a flexible power cable long enough to be routed from the FLX-P1 pump staged in the "G" tunnel to the alternate location for the FLEX PDG is utilized.

The FLX-P2 is the alternate pump for providing cooling water to the SPC heat exchanger for SP cooling. The FLX-P2 is a portable, diesel-driven pump that will be deployed from FLEX storage building 1 to a location at grade adjacent to the SCT pipe chase.

3.7.3 Connection Points

3.7.3.1 Mechanical Connection Points

FLX-P1 Pump

The FLX-P1 is permanently staged (but not connected) in the tunnel from the SSW basin to the auxiliary building known as the "G" Tunnel. The pump will be connected to the SSW system during an ELAP through use of a combination of piping and hoses. The licensee installed a new suction tie-in and isolation valve on line SWP-030- 219-3 for pump suction, and a new line on existing valve SWP-V3099 which connects to the SSW "B" supply line, SWP-030-026-3, for the discharge flow. The licensee uses two parallel 6 in. hoses to connect between the pump and different pipe sections. The seismic design of the tunnel and the potential for flooding is discussed in Section 3.2.2.1.1 of this evaluation

FLX-P2 Pump

If needed, the diesel-driven FLX-P2 can be deployed at grade, southeast of the SSW basin near the "west" (Div. II) SCT pipe chase wall. Alternate SSW connections are provided to allow connection of this pump from outside the pipe chase. A new pipe line and valve was added from line SWP-030-219-3 near the point where it is capped off at the west end of the "G" tunnel to the west pipe chase and up to grade level. At grade level, a penetration through the west chase outside wall was made to allow connection to the FLX-P2 pump suction. Another line was added from grade level, through a penetration in the west pipe chase wall, down the chase to the "G" tunnel. The FLX-P2 pump discharge can be connected to this line from outside the pipe chase. Inside the “G” tunnel, this line is connected by 6" hoses to the new line which connects to valve SWP-V3099 and the SSW supply line. The seismic design of the tunnel and the potential for flooding id discussed in Section 3.2.2.1.1 of this evaluation.

FLX-P3 Pump

Core Cooling – The FLX-P3 pump takes a suction directly from the SCT basin and discharges water to the RPV via a fire hose to a LPCS flushing line connection, through valves E21-VF025 and E21- MOVF005. The flushing connection is located on a platform (133 ft elevation) in the northwest crescent of the auxiliary building. Since the connection is located in the seismic category I building, it is protected from all hazards.

The SFP Cooling – For SFP cooling the discharge of the FLX-P3 pump is connected to the 2" drain line off of line SFC-010-36-3 downstream of isolation drain valve SFC-V66. The Connection is located in the Seismic Category 1 fuel handling building and is protected from all applicable hazards.

3.7.3.2 – Connection Points (Electrical)

Primary Strategy to Power the SPC Pumps – The licensee stated in its FIP that the SPC pumps will be powered by a portable 500kW FLEX DG that is positioned in the “west canyon” outside the auxiliary building. Modifications to the plant were implemented to facilitate the connection of the PDG to the SPC pumps. This includes installation of a PDG connection cabinet (SPCRCPT1, located adjacent to door AB098-08), a circuit breaker/disconnect switch (SPC-

SW1) above the PDG connection cabinet, motor protection (SPC-MST1, 70ft elevation in the auxiliary building west stairwell) and separate transfer switches (SPC-TRS1 and SPC-TRS2) for each SPC pump. Permanent conduit was installed for the wiring between the connection cabinet, circuit breaker and motor protector. The transfer switches (SPC-TRS1 and SPC-TRS2) are located in the SPC equipment room (elevation 70 ft). Flexible cables for connecting the motor protection cabinet to one of the SPC pump transfer switches are staged in a cable storage box in the SPC equipment room.

Alternate Electrical Connections for SPC pumps – The alternate electrical connection for powering the SPC pumps is provided by routing cable for a PDG located in the east canyon into the auxiliary building stairwell (door AB098-03), through the auxiliary building, and then into the SPC equipment room for connection to one of the SPC pump transfer switches.

Primary Electrical Connection for Battery Chargers – Phase 2 electrical power is provided by using a FLEX PDG to repower the Division I battery charger ENB-CHGR1A. Modifications to the plant were implemented to facilitate the connection of the PDG to the battery charger. The modifications include install the following:

- Installation of PDG connection cabinet (EJS-RCPT1, located in the CB 98 ft elevation, west corridor)
- Installation of a circuit breaker/disconnect switch (EJS-SW1, located adjacent to connection cabinet EJS-RCPT1)
- Installation and termination of new permanent cable and conduit between the connection cabinet and disconnect switch
- Revising the settings for spare breaker EJS-SWG1AACB011 and relabeling.
- Installation and termination of new permanent cable, conduit between the new disconnect switch and switchgear breaker EJS-SWG1A-ACB011.

This configuration permits the powering of charger ENBCHGR1A, MCR Appendix R backup lighting receptacle POP-LTGR02, and battery room exhaust fan motor HVCFN3A (or HVCFN3D) from the existing spare breaker EJSSWG1A- ACB011, which will be back-fed from a FLEX diesel generator as part of the FLEX implementation plan.

Alternate Electrical Connection for Battery Chargers - Alternate Phase 2 electrical power is provided by using a FLEX PDG to repower the non-divisional backup swing battery charger BYS-CHGR1D. This capability has been implemented with the following modifications.

- Installation of PDG connection cabinet (BYS-RCPT7, located on 98 ft elevation of the CB Cable Chase II).
- Installation of a permanent circuit breaker disconnect switch (BYS-SW7, located adjacent to BYS-RCPT7).
- Installation of a permanent transfer switch (BY-STRS5).
- Installation and termination of new permanent cable and conduit between the connection cabinet and the breaker disconnect switch.
- Installation and termination of new permanent cable and conduit between the breaker disconnect switch and the interior transfer switch.

- Disconnecting the power feed cable at battery charger BYS-CHGR1D and rerouting it through new conduit to the new transfer switch.
- Installation and termination of new permanent cable and conduit between the new transfer switch and backup battery charger BYS-CHGR1D. This configuration allows battery charger BYS-CHGR1D to continue to receive power from transfer switch BYS-TRS4 during normal operation, and during a BDBEE, the battery charger will receive power from the FLEX PDG staged outside the CB east wall. Charger BYS-CHGR1D can provide power to any one of the three Class IE Division dc buses or any one of three non-safety related buses through existing switchgear. For FLEX it is connected to the Division 1 dc bus. To ensure the new FLEX system that will be attached to switchgear BYS-SWG01D and battery charger BYS-CHGR1D can remain functional, a seismic qualification evaluation was performed to verify the following seismic / structural parameters.
- The seismic qualification level of panel BYS-SWG01D including modifications that altered and/or replaced components and sub-components in the panel.
- The seismic qualification level of battery charger BYS-CHGR1D including modifications that altered and/or replaced components and sub-components in the battery charger.
- The installation details of the non-safety related commodities and components installed adjacent to BYS-SWG01D and BYS-CHGR1D on the 116 ft. elevation of the CB. The objective is to ensure that during a seismic event no adverse interaction occurs between these units and the non-safety related commodities installed close by. This evaluation confirmed that panel BYS-SWG01D and battery charger BYS-CHGR1D are seismically qualified to RBS requirements and have been maintained as safety related seismic equipment. This evaluation confirmed that structural adequacy of panel BYS-SWG01D, battery charger BYS-CHGR1D and the components installed in them will be maintained before, during and after a seismic event. Therefore, there is no concern for seismic interaction between the safety related seismic equipment provided for the standby distribution system and standby battery charger (BYS-SWG01D and BYS-CHGR1D) and the non-safety related commodities installed close by.

3.7.4 Accessibility and Lighting

In its FIP, the licensee describes that following the BDBEE, emergency lighting is retained for the MCR via Appendix R lighting. Battery-powered Appendix R lighting will be available during Phase 1 as required by 10 CFR 50 Appendix R. Once the PDG is connected and supplying power to EJS-SWG1A, MCR lighting will be restored via power from EHS-MCC14A, which powers the Division I battery room exhaust fans and backup lighting in the MCR. Portable lighting will be available for operators in order to perform the functions required during Phase 1 and subsequent phases of operation in areas where there is not Appendix R lighting.

Emergency portable LED lights with stands are available for use during an ELAP event and are available in the technical support center (TSC) and operations support center (OSC). Additional lighting stands are stored in the FLEX storage buildings. The preferred deployed locations of the portable diesel driven light towers are the east and west sides of the CB, west side of the auxiliary building, and south east corner of the SCT. The portable FLEX pumps have LED lights mounted on them for area lighting. The large PDGs have tripod LED lights stored on them, which will be also used for area lighting.

In addition to installed Appendix "R" lighting, the portable LED lights and portable light towers, the FLEX storage buildings will also include a stock of flashlights and head lights to further assist the staff responding to a BDBEE during low light conditions. Flashlights and head lights are also stored in the OSC/TSC lockers.

3.7.5 Access to Protected and Vital Areas

In its FIP, the licensee describes that the ability to open doors for ingress and egress, ventilation, or routing of temporary cables/hoses is necessary to implement the FLEX coping strategies. Security doors and gates that rely on electric power to operate opening and/or locking mechanisms are barriers of concern. The security force will implement an access contingency upon loss of the security diesel and all ac/dc power as part of the security plan. Access to the owner controlled area, site protected area, and areas within the plant structures will be controlled under this access contingency as implemented by security personnel.

3.7.6 Fueling of FLEX Equipment

In its FIP, the licensee describes that the FLEX strategies for maintenance and/or support of safety functions involve several elements including the supply of fuel to necessary diesel powered generators, pumps, hauling vehicles, etc. The general coping strategy for supplying fuel oil to diesel driven portable equipment (i.e., pumps and generators) being utilized to cope with an ELAP/LUHS, is to draw fuel oil out of any available, existing diesel fuel oil tank on the RBS site.

The primary source of fuel oil for portable equipment is the three EDG fuel oil storage tanks. Each tank contains a minimum volume of 38,996 gallons. These tanks are contained in the diesel building and therefore are protected from all hazards.

The quality of fuel oil in EDG fuel oil storage tanks is maintained in accordance with the diesel fuel oil testing program. Fuel oil in the fuel tanks of portable diesel engine driven FLEX equipment will be maintained in the preventative maintenance program in accordance with the manufacturer's guidance and existing site maintenance practices.

Fuel oil will be transported to FLEX equipment in 500 gallon fuel tanks mounted on a portable trailer. This trailer will be deployed to the east side of the Division 2 EDG room. The primary strategy involves repowering an existing fuel transfer pump to fill the trailer mounted fuel tank. The alternate strategy utilizes an electric-driven portable pump and hose to fill the portable fuel tank. The portable trailer will be towed by a pickup truck to the refueling staging area. Fuel will be pumped from the trailer mounted fuel tank to the diesel engine driven FLEX equipment by an electric fuel pump on the trailer.

Based on a fuel consumption study, the total diesel fuel consumption for all FLEX equipment during the initial 72 hours is 10,146 gallons. The fuel truck has sufficient capacity to support continuous operation of the major FLEX equipment expected to be deployed and placed into service following a BDBEE. At this conservative fuel consumption, the three EDG fuel oil storage tanks, which are protected from BDBEEs, have adequate capacity to provide the on-site FLEX equipment with diesel fuel for greater than 30 days.

3.7.7 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should allow deploying the FLEX equipment following a BDBEE consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01 (and the alternative to the guidance to utilize installed plant equipment for Phase 2 and 3), and should adequately address the requirements of the order.

3.8 Considerations in Using Offsite Resources

3.8.1 River Bend Station SAFER Plan

There are two NSRCs (Memphis area and Phoenix area) established to support nuclear power plants in the event of a BDBEE. In its FIP, the licensee stated that it has established contracts with PEICo to participate in the process for support from the NSRCs, as required. Each NSRC holds five sets of equipment, four of which will be able to be fully deployed to River Bend when requested. The fifth set allows removal of equipment from availability to conduct maintenance cycles. In addition, RBS BDBEE equipment hose and cable end fittings are standardized with the equipment supplied from the NSRC.

By letter dated September 26, 2014 [Reference 23], the NRC staff issued its staff assessment of the NSRCs established in response to Order EA-12-049. In its assessment, the NRC staff concluded that SAFER has procured equipment, implemented appropriate processes to maintain the equipment, and developed plans to deliver the equipment needed to support site responses to BDBEEs, consistent with NEI 12-06 guidance; therefore, the staff concluded in its assessment that licensees can reference the SAFER program and implement their SAFER response plans to meet the Phase 3 requirements of Order EA-12-049.

3.8.2 Staging Areas

In general, up to four staging areas for NSRC supplied Phase 3 equipment are identified in the SAFER Plans for each reactor site. These are a Primary (Area C) and an Alternate (Area D, if needed) which are offsite areas (within 25 miles of the plant) for receipt of ground transported or airlifted equipment from the NSRCs in Phoenix, Arizona or Memphis, Tennessee. From Staging Areas C and/or D, a near- or on-site Staging Area B is established for interim staging of equipment prior to it being transported to the final location for implementation in Phase 3 at Staging Area A.

For RBS, the local assembly area is the Livingston Parish Fair Grounds. The alternate assembly area is the Crosby Municipal Airport in Crosby, Mississippi. From these sites, equipment can be taken to the RBS site and staged south of the north FLEX storage building by helicopter if ground transportation is unavailable. Communications will be established between the site and the SAFER team via satellite phones and required equipment moved to the site as needed. First arriving equipment will be delivered to the site within 24 hours from the initial request. The order at which equipment is delivered is identified in the RBS's "SAFER Response Plan."

3.8.3 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should allow utilization of offsite resources following a BDBEE consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01 (and the alternative to the guidance to utilize installed plant equipment for Phase 2 and 3), and should adequately address the requirements of the order.

3.9 Habitability and Operations

3.9.1 Equipment Operating Conditions

3.9.1.1 Loss of Ventilation and Cooling

Following a BDBEE and subsequent ELAP event at River Bend, ventilation that provides cooling to occupied areas and areas containing required equipment will be lost. The key areas identified for all phases of execution of the FLEX strategy activities are the RCIC Pump Room, MCR, Standby Switchgear Rooms, dc Equipment Room and Standby Battery Rooms.

RCIC Pump Room

The licensee's Phase 1 core cooling FLEX strategy relies on the RCIC pump as the motive force for providing water to the RPV. The RBS FLEX strategy includes a RCIC pump suction swap from the Suppression Pool to the Upper Containment Pool at 4 hours. The NRC staff reviewed RBS Calculation G13.18.12.4-040, "Reactor Core Isolation Cooling Room Heat up for Extended Loss of AC Power (FLEX)," Rev. 0, and ENTGRB125-CALC-004, "River Bend Station RCIC Room Heat up for ELAP," Rev 0. The analysis considered the heat input from the gland seal leakage and the effects of components in the RCIC room. This calculation determined that the maximum RCIC room temperature of 174 °F at 72 hours remains below the allowable room temperature criteria of 200 °F and that no mitigating actions are required including any forced ventilation or the opening of the RCIC room door in order to meet design limits. The licensee described that there was no impact from the elevated temperature (174 °F) on the RCIC electronic turbine governor functionality since the RCIC electronic turbine governor is not located in the RCIC room at RBS and as such, performance of the RCIC electronic governor will not be affected by the elevated temperature in the RCIC Pump room due to loss of ventilation during ELAP. Based on the above, the staff finds it reasonable that the RCIC pump will remain available during an ELAP event with loss of normal ventilation.

Main Control Room

The NRC staff reviewed RBS Calculation G13.18.12.4-042, "Main Control Room (MCR) Heat up for Extended Loss of AC Power (FLEX)," Rev. 0, which modeled the MCR temperature transient when all MCR cooling is lost due to an ELAP event. The Main Control Room temperature is calculated for four cases. Case 1 assumptions include operator actions to follow the existing AOPs to open the control room cabinet doors and remove ceiling tiles. Subsequent cases use an additional operator action to set up a portable exhaust fan to blow air out through the control building roof. The results show that ventilation rate of 2000 cfm is required to keep the MCR temperature from rising above 110°F at 72 hours. The ventilation can be delayed until 30 hours after the start of the ELAP.

Based on MCR temperatures remaining below 120 °F (the temperature limit, as identified in NUMARC-87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," Rev. 1, for electronic equipment to be able to survive indefinitely), the NRC staff expects that the equipment in the MCR should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Standby Battery Rooms

The NRC staff reviewed RBS Calculation G13.18.12.4-037, "Standby Battery Rooms: A, B, and C Heat Up for Extended Loss of AC Power (FLEX)," Rev. 0. This calculation determined that by opening the battery room doors within 30 minutes following an ELAP, the maximum temperature reached in any one battery room is approximately 130°F at 72 hours. Only Division 1 and 2 Batteries are credited for FLEX strategy. The licensee also stated that RBS has performed evaluations of the ability of equipment in the CB to survive and function at temperatures higher than their design temperatures. The RBS battery qualification report 6244.521-078-005C, "Battery Qualification Report," Rev. 2, documents testing battery cells at 140°F for over 30 hours as part of the battery qualification and determined that there was no adverse effects on the cells. This envelops the plant maximum design temperature and the actual maximum recorded temperature. The NRC staff relied on licensee evaluations which determined that there were no failure or adverse effects on cells due to higher temperature. In addition, the RBS Gothic analysis for these rooms is conservative as follows: 1) A constant heat load based on fully discharging batteries for the entire 72 hours is assumed; 2) Gothic analysis does not credit the battery room exhaust fans which will become operational once the PDG is providing power to bus EJS-SWG1A; and 3) the Gothic model assumed an initial temperature of 104 °F in the battery rooms. The maximum design temperature of the battery rooms is 90 °F. When the licensee used a more realistic but still conservative temperature of 90 °F, it resulted in a lower temperature not exceeding 120 °F. Based on the above, the licensee determined that batteries are expected to perform their functions in the maximum temperatures predicted by the Gothic analysis assuming that operators will open doors to the battery rooms within 30 minutes following ELAP consistent with RBS Procedure AOP-0060, "Loss of Control Building Ventilation," Rev. 9. Exhaust fans in the battery room energized by the equipment from NSRC is expected to be able to provide sufficient room cooling at 72 hours and therefore equipment in those battery rooms should be capable of performing their intended functions.

The potential buildup of hydrogen in the battery rooms and off-gasses of hydrogen from batteries is addressed below in Section 3.9.1.3 of this SE.

Standby Switchgear Rooms A, B, and C

The NRC staff reviewed RBS Calculation G13.18.12.4-038, "River Bend Station Standby Switchgear Rooms A, B, C Heat up for Extended Loss of AC Power (FLEX)," Rev. 0. This calculation determined that one of the Switchgear Rooms will see a maximum temperature (128.8 °F) in 72 hours following ELAP. In the course of the ongoing audit process, the licensee stated that only the Division 1 switchgear room is credited for the FLEX strategy. The licensee evaluation of the qualification report for a sample MCC, including thermally aging up by exposing sample breakers to at least 239 °F followed by testing in which the breakers on the sample MCC were performed, concluded that the MCCs will perform their intended function with no failures. The RBS qualification report 6242.533-265-015A, "Qualification Report for Standby 480V Switchgear," dated June 18, 1980, documents that these switchgears have been qualified for 55 °C (131 °F) for 40 years, which bounds switchgear room maximum analyzed temperature of 128.8 °F. In addition, the licensee stated in its response, that the RBS Gothic analysis is conservative as follows: 1) Two-thirds of the room heat load is due to an alternate inverter which is not normally operating; the primary inverter is located in the dc equipment room; 2) The Gothic model assumed an initial temperature of 104 °F, the maximum design temperature in the switchgear rooms, while the more realistic and still conservative, initial temperature is 90 °F.

The use of more realistic but still conservative temperature of 90 °F will result in lower temperatures, not exceeding 120 °F. Based on the above, the licensee determined that electrical equipment in the standby switchgear rooms is expected to survive and perform its function in the maximum temperature (128.8 °F) predicted by the Gothic analysis assuming that the operator will open switchgear room doors consistent with RBS procedure AOP-0060. Equipment from the NSRC will be onsite at 72 hours which will be able to provide sufficient room cooling should additional buses in the rooms be repowered.

Based on the above, the NRC staff finds that the equipment in the Standby Switchgear Rooms should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

DC Equipment Room A

The NRC staff reviewed RBS Calculation G13.18.12.4-046, “River Bend Station DC Equipment Room A Heat up for Extended Loss of AC Power (FLEX),” Rev. 0. This calculation determined that the maximum temperature in dc equipment room A will be below 130 °F at 72 hours following an ELAP. The room temperature transient analysis indicated that the room will see a maximum temperature of approximately 130 °F, assuming an initial temperature of 104 °F. However, use of a realistic initial temperature in the room of 90 °F resulted in a maximum room temperature lower than 120 °F. The licensee evaluation of the above calculation for the battery charger and inverter in the dc equipment room, concluded that these electrical equipment in the dc equipment room A will function in the maximum design temperature predicted by the Gothic analysis. This calculation credits mitigating actions such as opening of battery and inverter room doors at 30 minutes per RBS procedure AOP-0060, and if necessary, starting a portable fan once battery charging begins 8 hours after the BDBEE/ELAP. The licensee’s evaluation concluded that the room temperature will be below 130 °F with a 2500 cubic feet per minute (cfm) fan, while a 5000 cfm fan will maintain a lower temperature of 125 °F.

The components in the Division dc equipment room credited for FLEX are the Division I Battery Charger and Division I Inverter. The Gothic-analyzed maximum dc equipment room temperature (130°F) remains lower than the 150 °F maximum temperature limit, as identified in NUMARC-87-00, “Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors,” November 1987. Therefore, the NRC staff expects that the electrical equipment in the dc equipment room will not be adversely impacted by the higher temperature predicted in the RBS Gothic analysis due to a loss of ventilation, as a result of an ELAP event, assuming operator actions to open room doors at 30 minutes and if necessary, powering a specified portable fan once battery charging begins 8 hours after the BDBEE/ELAP.

The NRC staff reviewed the licensee environmental qualification (EQ) evaluation "RBS-Equipment Survivability for BDBEE/ELAP Profile," for the electrical equipment (such as SRV solenoids and hydrogen igniters) and required instruments within the containment. The EQ evaluation shows that the electrical equipment in containment will function in the high temperature environment for as long as it is needed to provide the FLEX function.

As part of its evaluation, the licensee reviewed the selected equipment subjected to FLEX post-BDBEE ambient conditions in the drywell, suppression pool and containment (i.e. wetwell) to assess the functionality of the selected instruments/devices under elevated temperatures and pressures under the post-beyond-design-basis condition for 180 hours (7.5 days). The selected electrical equipment and instruments within the containment are those that FLEX strategies depend on to be functional after a BDBEE.

The licensee demonstrated through evaluation of the existing EQ testing data and associated analysis that the containment electrical equipment and required instruments being credited for use in response to a BDBEE will operate and function in an ELAP environment and will remain functional during the projected BDBEE ELAP mission time. The affected equipment were evaluated for 180 hours (7.5 days) which adequately bounds the BDBEE scenario as the FLEX strategy provides guidance for maintaining containment cooling during Phase 3, with the necessary equipment delivered prior to 72 hours following start of the event. The Phase 3 equipment includes turbine generators which will be used to repower the SCT fans to improve containment heat removal and equipment for providing makeup water to the cooling tower basin.

Based on its review of the essential station equipment required to support the FLEX mitigation strategy, which are primarily located in the MCR, RCIC room, Battery rooms, Switchgear rooms and dc equipment room A, the NRC staff expects that the equipment should perform their required functions at the expected temperatures as a result of loss of ventilation during an ELAP.

3.9.1.2 Loss of Heating

NEI 12-06, Section 3.2.2, guideline (12) states that heat tracing is used at some plants to ensure cold weather conditions do not result in freezing important piping and instrumentation systems with small diameter piping. In the RBS FIP, the licensee stated that the FLEX strategy does not have dependency on heat tracing for any required equipment after the initiation of the event. The FLEX equipment is protected from low temperatures and freezing during normal plant operation using electric heaters.

The battery rooms are normally maintained at approximately 77 °F. In the event of an ELAP, the battery room temperatures are expected to rise with loss of ventilation. River Bend is located in the Deep South just north of Baton Rouge, LA and does not experience extreme low temperatures. However, during cold weather, the battery rooms would be at their normal operating temperature at the onset of the event and the temperature of the electrolyte in the cells would buildup due to heat generated by the battery discharging and during re-charging. The battery rooms are located substantially internal to the CB, in an environment without normal plant cooling systems running, and would not be exposed to extreme low temperatures.

In NUMARC 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," November 1987, states that battery capacity is reduced if the battery electrolyte temperature drops significantly below design temperature. Class 1E batteries are housed in a class 1E structures, which are not subject to the direct effects of the external environment. Therefore, temperature drop is not significant over station blackout period. Also the mass of battery electrolyte is sufficient to resist temperature drop due to low battery room temperatures because battery cell materials are not an efficient thermal conductor. Therefore, a decrease in battery capacity due to temperature decreases in electrolyte under station blackout conditions is not a concern.

Based on its review of the licensee's battery room assessment, the NRC staff expects that the RBS safety-related batteries should perform their required functions at the expected temperatures as a result of loss of heating during an ELAP event, and that the FLEX equipment should also perform its required function.

3.9.1.3 Hydrogen Gas Control in Vital Battery Rooms

The licensee stated in its FIP, that an additional ventilation concern applicable to Phase 2 is the potential buildup of hydrogen in the battery rooms. Off-gassing of hydrogen from batteries is only a concern when the batteries are charging. Once a 480 Vac power supply is restored in Phase 2 and the Division I batteries begin recharging, the ventilation fan for the Division I battery room is also re-powered and will prevent any significant hydrogen accumulation. The RBS Calculation G13.18.2.1-092, "Control Building Div. I and II Battery Rooms Hydrogen Concentration," Rev. 0, demonstrated that hydrogen accumulation in the vital battery rooms will remain below 1 percent during an ELAP as a result of a BDBEE with the existing ventilation in the battery rooms. If the alternate battery charging strategy does not repower the bus that provides power to the fan, then a portable fan and flexible duct can provide ventilation for the room.

Based on its review, the NRC staff concludes that hydrogen accumulation in the safety-related battery rooms should not reach the typical combustibility limit for hydrogen (4 percent) during an ELAP since the licensee plans to repower the battery room exhaust fans when the battery chargers are repowered during Phase 2.

3.9.2 Personnel Habitability

3.9.2.1 Main Control Room

The NRC staff reviewed calculation G13.18.12.4-042, "Main Control Room (MCR) Heat up for Extended Loss of AC Power (FLEX)," Rev. 0, which modeled the MCR temperature transient when all MCR cooling is lost due to an SBO event. The calculation demonstrates that a 2000 cfm exhaust fan, deployed within 30 hours following the onset of the event, in addition to the current SBO coping measures (opening cabinet doors and removing ceiling tiles) is sufficient to maintain the MCR temperature below 110 °F for the duration of an SBO event. The portable fan is assumed to be placed outside the control room to induce a flow into the stairwell and out through the roof. Any heat generated by the fan motor is assumed to be removed immediately by the air flow in the stairwell. Two fans that meet the performance requirements will be stored in accordance with FLEX equipment.

Based on MCR temperatures remaining below 110 °F (the temperature limit, as identified in NUMARC-87-00, for personnel habitability), the NRC staff expects that the personnel in the MCR should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

3.9.2.2 Spent Fuel Pool Area

Per NEI 12-06 guidance, a baseline capability for Spent Fuel Cooling is to provide a vent pathway for steam and condensate from the SFP. In order to establish a vent pathway for steam and condensate, the double doors on the 95 ft. elevation (door F95-1) to the new fuel receiving area will be opened. Door F113-2 will be opened to the stairwell and door F171-1 will be opened on the roof. Because cooler air will be allowed to enter the fuel building through the F95-1 doors, a chimney effect will be established through the stairwell to the roof. These actions will be performed at 8 hours following the onset of the event, which is prior to conditions on the refueling floor degrading to the point that habitability is affected, due to boiling in the SFP.

In addition, the licensee's strategy is designed to complete hose deployment and spay nozzle setup on the SFP refueling floor before conditions degrade to the point that habitability is affected, due to boiling in the SFP.

3.9.2.3 Other Plant Areas

Protection of FLEX equipment from impacts due to extreme high temperatures is performed in accordance with Section 9.3.1 of NEI 12-06, which states that equipment should be maintained at a temperature within a range to ensure its likely function when called upon. The extreme high ambient temperature of 110 °F is found in RBS specification 215.200. The indoor temperature limit of the FLEX storage buildings is a maximum of 120 °F based on guidance from equipment vendors whom have provided acceptable storage temperatures for typical components within major FLEX equipment. Electrical equipment installed in the storage buildings is designed and sized to operate within the extreme temperature conditions of the storage buildings.

As stated in the FIP, the FLEX storage building ventilation consists of natural circulation through louvers or the use of fans.

3.9.3 Conclusions

Based on the evaluations above, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should maintain or restore equipment and personnel habitability conditions following a BDBEE consistent with NEI 12-06, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.10 Water Sources

Table 2 in the FIP, "Water Sources," lists all the available water sources for the RPV and SFP, the minimum nominal volume, water chemistry (clean or unclean), seismic qualification, and whether the source is protected against flood, high winds, and wind driven missiles.

3.10.1 Reactor Coolant System Make-Up

In its FIP, the licensee states that even though RCIC is normally aligned to the CST, the CST is not credited for FLEX because the tank is not seismically designed or protected from missiles. However, the CST could be utilized as the initial source of RPV makeup if the ELAP/LUHS initiating event is not due to a seismic or missile generating event. The SP is the initial source of water for RCIC for ELAP/LUHS events which result in the loss of the CST. At approximately 4 hours, RCIC suction is transferred to the UCP because of increasing SP temperature. The available volume in the UCP is depleted at approximately 34 hours. At approximately 8 hours SP cooling is initiated using a SPC pump and the SPC heat exchanger with cooling water provided by the FLEX 1 or FLEX 2 pump from the SCT basin. The primary strategy for core cooling after the UCP depletes is realignment of the SPC heat exchanger discharge line from the SP to the RPV. This alignment satisfies both the core cooling function and the containment heat removal function. An alternate path for core cooling if the SPC RPV injection path is not available is injection of SCT basin water through the LPCS injection line to the RPV using the FLEX 3 pump. The SP, UCP, and SCT basin are all Seismic Category I.

3.10.2 Suppression Pool Make-Up

The SP is the initial source of water for RCIC for ELAP/LUHS events, which result in the loss of the CST. At approximately 4 hours, RCIC suction is transferred to the UCP because of increasing SP temperature. The available volume in the UCP is depleted at approximately 34 hours. At approximately 8 hours SP cooling is initiated using a SPC pump and the SPC heat exchanger with cooling water provided by the FLEX 1 or FLEX 2 pump from the SCT basin. The primary strategy for core cooling after the UCP depletes is realignment of the SPC heat exchanger discharge line from the SP to the RPV. This alignment satisfies both the core cooling function and the containment heat removal function.

3.10.3 Spent Fuel Pool Make-Up

In its FIP, the licensee states that makeup water to the SFP is provided from the SCT basin by the FLX-P3 pump. The required makeup due to boil off is less than 60 gpm starting at approximately 8 hours. River Bend also has the capability of spray cooling at 200 gpm (or 250 gpm if overspray is an issue) to the SFP, as stipulated in NEI 12-06.

Because of the water loss from the SCT basin due to evaporation, makeup to the SFP and, if required, alternate makeup to the RPV, and makeup water to the SCT basin must be established at 72 hours following the ELAP/LUHS. River Bend has contracted with a vendor to provide resources for water makeup to the SCT basin. During the FLEX response, RBS operators will coordinate with the vendor for makeup to the SCT basin. Potential water sources onsite will be prioritized as the source of water based on the conditions following the event. The following onsite sources will be considered:

- Two fire protection storage tanks;
- Circulating water system flume and cooling towers; and
- Two clarifiers.

If these sources are not available, the contractor is capable of providing 20,000 gallons of makeup water per hour using vacuum trucks beginning 72 hours following the ELAP/BDBEE. The trucks will take their suction from the old ferry landing in St. Francisville or from nearby, alternate Mississippi River access points, if necessary. There are also multiple routes available for delivering water and equipment. For long-term makeup, the vendor will locate a portable pump near the Mississippi River and run 8 in. high pressure lay-flat hose from the river to the SCT basin.

3.10.4 Containment Cooling

In its FIP, the licensee states that the SP is the initial source of water for RCIC for ELAP/LUHS events which result in the loss of the CST. At approximately 4 hours, RCIC suction is transferred to the UCP because of increasing SP temperature. The available volume in the UCP is depleted at approximately 34 hours. At approximately 8 hours SP cooling is initiated using a SPC pump and the SPC heat exchanger with cooling water provided by the FLX-P1 or FLX-P2 from the SCT basin. The primary strategy for core cooling after the UCP is depleted is the realignment of the SPC heat exchanger discharge line from the SP to the RPV. This alignment satisfies both the core cooling function and the containment heat removal function.

3.10.5 Conclusions

Based on the evaluation above, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should maintain satisfactory water sources following a BDBEE consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01 (and the alternative to the guidance to utilize installed plant equipment for Phase 2 and 3), and should adequately address the requirements of the order.

3.11 Shutdown and Refueling Analyses

Order EA-12-049 requires that licensees must be capable of implementing the mitigation strategies in all modes. In general, the discussion above focuses on a BDBEE occurring during power operations. This is appropriate, as plants typically operate at power for 90 percent or more of the year. When the BDBEE occurs with the plant at power, the mitigation strategy initially focuses on the use of a pump coupled to a steam-powered turbine to provide the water initially needed for decay heat removal. If the plant has been shut down and all or most of the fuel has been removed from the RPV and placed in the SFP, there may be a shorter timeline to implement the make-up of water to the SFP. However, this is balanced by the fact that if immediate cooling is not required for the fuel in the reactor vessel, the operators can concentrate on providing make-up to the SFP. In its FIP, the licensee described that SFP inventory make-up flow is estimated to be required at 80 hours, and UCP inventory makeup flow is required at approximately 106 hours after the event, assuming the design-basis heat load, to ensure that the racks remain covered and the licensee has stated that they have the ability to implement make-up to the SFP and UCP within that time.

When a plant is in a shutdown mode in which steam is not available to operate the steam-powered pump such as RCIC (which typically occurs when the RCS has been cooled below about 300 °F), another strategy must be used for decay heat removal. On September 18, 2013, NEI submitted to the NRC a position paper entitled "Shutdown/Refueling Modes" [Reference 28], which described methods to ensure plant safety in those shutdown modes. By letter dated September 30, 2013 [Reference 40], the NRC staff endorsed this position paper as a means of meeting the requirements of the order.

The position paper provides guidance to licensees for reducing shutdown risk by incorporating FLEX equipment in the shutdown risk process and procedures. Considerations in the shutdown risk assessment process include maintaining necessary FLEX equipment readily available and potentially pre-deploying or pre-staging equipment to support maintaining or restoring key safety functions in the event of a loss of shutdown cooling. The NRC staff has concluded that the position paper provides an acceptable approach for demonstrating that the licensees are capable of implementing mitigating strategies in shutdown and refueling modes of operation. In its FIP, the licensee stated that it conforms to the provisions of the NRC endorsed NEI position paper on Shutdown/Refueling Modes. Further, the licensee has revised the administrative program, EN-OU-108, "Shutdown Safety Management Program," Rev.8, as well as procedure OSP-0037, "Shutdown Operations Protection Plan,' Rev. 34, to include considerations for pre-staging or deploying FLEX equipment.

Based on the licensee's incorporation of the use of FLEX equipment in the shutdown risk process and procedures, the NRC staff concludes that the licensee has developed guidance that if implemented appropriately should maintain or restore core cooling, SFP cooling, and containment following a BDBEE in shutdown and refueling modes consistent with NEI 12-06 guidance as endorsed by JLD-ISG-2012-01 (and the alternative to the guidance to utilize installed plant equipment for Phase 2 and 3), and should adequately address the requirements of the order.

3.12 Procedures and Training

In its FIP, the licensee explained that the inability to predict actual plant conditions that require the use of FLEX equipment makes it impossible to provide specific procedural guidance. As such, the FSGs will provide guidance that can be employed for a variety of conditions. Clear criteria for entry into FSGs will ensure that FLEX strategies are used only as directed for BDBEE conditions, and are not used inappropriately in lieu of existing procedures. When FLEX equipment is needed to supplement EOPs or Abnormal Operating Procedures (AOPs), the EOP, AOP, Severe Accident Mitigation Guidelines (SAMGs), or Extreme Damage Mitigation Guidelines (EDGMs) will direct the entry into and exit from the appropriate FSG procedure.

The FSGs will provide available, pre-planned FLEX strategies for accomplishing specific tasks in the EOPs or AOPs. The FSGs will be used to supplement (not replace) the existing procedure structure that establishes command and control for the event.

Procedural Interfaces have been incorporated into Procedure AOP-0050, Station Blackout, to the extent necessary to include appropriate reference to FSGs and provide command and control for the ELAP. Additionally, procedural interfaces have been incorporated into AOP-0028, "Seismic Event", and AOP-0029, "Severe Weather" to include appropriate reference to FSGs.

With regard to training, in its FIP the licensee describes that Entergy's Nuclear Training Program has been revised to assure personnel proficiency in the mitigation of BDBEEs is adequate and maintained. These programs and controls were developed and have been implemented in accordance with the Systematic Approach to Training process.

Initial training has been provided and periodic training will be provided to site emergency response leaders on BDB emergency response strategies and implementing guidelines. Personnel assigned to direct the execution of mitigation strategies for BDBEEs have received the necessary training to ensure familiarity with the associated tasks, considering available job aids, instructions, and mitigating strategy time constraints.

Based on the description above, the NRC staff finds that the licensee has adequately addressed the procedures and training associated with FLEX. The procedures have been issued in accordance with NEI 12-06, Section 11.4, and a training program has been established and will be maintained in accordance with NEI 12-06, Section 11.6.

3.13 Maintenance and Testing of FLEX Equipment

As a generic issue, NEI submitted a letter dated October 3, 2013 [Reference 41], which included EPRI Technical Report 3002000623, "Nuclear Maintenance Applications Center: Preventive Maintenance Basis for FLEX Equipment." By letter dated October 7, 2013 [Reference 42], the NRC endorsed the use of the EPRI report and the EPRI database as providing a useful input for licensees to use in developing their maintenance and testing programs. Preventative maintenance templates for the major FLEX equipment including the portable diesel pumps and generators have also been issued.

In its FIP, the licensee describes that maintenance and testing of FLEX equipment is governed by the Entergy Preventive Maintenance (PM) program. The Entergy PM program utilizes the EPRI Preventive Maintenance Basis Database as an input in development of fleet specific Entergy PM Basis Templates. Based on this, the Entergy fleet PM program for FLEX equipment follows the guidance NEI 12-06, Section 11.5.

The PM programs have been developed for both the “Standby” condition and the “Deployed” condition for the FLEX Portable and Support Equipment.

The Entergy PM basis templates include activities such as:

- Periodic Static Inspections;
- Operational Inspections;
- Fluid analysis;
- Periodic functional verifications; and
- Periodic performance validation tests.

The Entergy PM basis templates provide assurance that stored or prestaged FLEX equipment is being properly maintained and tested. In those cases where EPRI templates were not available for the specific component types, PM actions were developed based on manufacturer provided information/ recommendations.

Additionally, the Entergy Emergency Response Organization performs periodic facility readiness checks for equipment that is outside the jurisdiction of the normal PM program and considered a functional aspect of the specific facility (Emergency Planning communications equipment such as uninterruptible power supplies, radios, batteries, battery chargers, satellite phones, etc.).

These facility functional readiness checks provide assurance that the Emergency Planning communications equipment outside the jurisdiction of the PM Program is being properly maintained and tested.

The NRC staff finds that the licensee has adequately addressed equipment maintenance and testing activities associated with FLEX equipment because a maintenance and testing program has been established in accordance with NEI 12-06, Section 11.5.

3.14 Alternatives to NEI 12-06, Revision 0

The RBS has proposed an alternative core and containment heat removal strategy to satisfy the requirements of Order EA-12-049. Specifically, RBS will utilize FLEX equipment to repower the permanently installed SPC and Alternate Decay Heat Removal pumps to circulate suppression pool water through the shell side of the SPC Heat Exchanger. The tube side of the heat exchanger will be supplied with cooling water from the SCT basin. This is an alternative from the guidance in NEI 12-06, Rev. 0, Section 3.2.2. The licensee identified this as an alternative approach due to the reliance on permanently installed plant components in lieu of reliance on deployment and alignment of a portable FLEX equipment. The licensee identified that the installed equipment used in the RBS FLEX strategies are installed in Seismic Category I structures. In addition to the seismic hazard, these structures provide protection from external flood, ice, high wind and extreme high temperature hazards.

Given that the installed equipment is located in a structure that is robust to the hazards considered within the scope of Order EA-12-049, the NRC staff found the proposed alternative to be acceptable. The NRC staff expects that although the guidance of NEI 12-06 has not been met, if the alternative is implemented as described by the licensee, the requirements of the order should be met.

3.15 Conclusions for Order EA-12-049

Based on the evaluations above, the NRC staff concludes that the licensee has developed guidance to maintain or restore core cooling, SFP cooling, and containment following a BDBEE which, if implemented appropriately, should adequately address the requirements of Order EA-12-049.

4.0 TECHNICAL EVALUATION OF ORDER EA-12-051

By letter dated February 28, 2013 [Reference 24], the licensee submitted its OIP for RBS in response to Order EA-12-051. By letter dated July 3, 2013 [Reference 25], the NRC staff sent a Request for Additional Information (RAI) to the licensee. The licensee provided a response by letter dated July 25, 2013 [Reference 26]. By letter dated November 25, 2013 [Reference 27], the NRC staff issued an ISE and RAI to the licensee. By letter dated February 18, 2015 [Reference 17], the NRC issued an audit report on the licensee's progress. Refer to Section 2.2 above for the regulatory background for this section.

By letters dated August 28, 2013 [Reference 29], February 26, 2014 [Reference 30], August 28, 2014 [Reference 31], and February 25, 2015 [Reference 32], the licensee submitted status reports for the Integrated Plan. The Integrated Plan describes the strategies and guidance to be implemented by the licensee for the installation of reliable SFP level instrumentation which will function following a BDBEE, including modifications necessary to support this implementation, pursuant to Order EA-12-051. By letter dated May 18, 2015 [Reference 35], the licensee reported that full compliance with the requirements of Order EA-12-051 had been achieved.

The licensee has installed a SFP level instrumentation system designed by Mohr Test and Measurement, LLC. The NRC staff reviewed the vendor's SFP level instrumentation system design specifications, calculations and analyses, test plans, and test reports. The staff issued a vendor audit report on August 27, 2014 [Reference 34]. The vendor issued a design change to the display unit after River Bend Station took delivery from Mohr. The NRC staff confirmed that the equipment was returned to Mohr for upgrade prior to installation by Entergy email dated December 18, 2015 [Reference 33].

4.1 Levels of Required Monitoring

Attachment 2 of Order EA-12-051 states in part:

> All licensees identified in Attachment 1 to this Order shall have a reliable indication of the water level in associated spent fuel storage pools capable of supporting identification of the following pool water level conditions by trained personnel: (1) level that is adequate to support operation of the normal fuel pool cooling system [Level 1], (2) level that is adequate to provide substantial radiation shielding for a person standing on the SFP operating deck [Level 2], and (3) level where fuel remains covered and actions to implement make-up water addition should no longer be deferred [Level 3].

In its OIP, the licensee described the proposed Level 1. The licensee stated that the elevation associated with Level 1 is 110 ft 0 in, and provided justification regarding cooling system operation. By letter dated July 25, 2013, the licensee clarified that the elevation associated with Level 2 is 107 ft 10-5/16 in. The previous Level 2 elevation was 10 ft above the top of the spent fuel rack at 94 ft 10-5/16 in. The Level 2 elevation is raised to 107 ft 10-5/16 in. to account for non-special nuclear material stored above the highest point of the spent fuel racks. The licensee designated Level 3 at an elevation of 85 ft 10-5/16 in., which is the highest point of any spent fuel storage rack seated in the SFP. The licensee's letter dated July 25, 2013, also provided a figure depicting the SFP with the approximate locations identified as Levels 1, 2 and 3 consistent with the licensee's proposed elevations. The NRC staff confirmed the elevations during the RBS on-site audit.

Based on the discussion above, the NRC staff finds that, if implemented appropriately, the licensee's proposed Levels 1, 2 and 3 appear to be consistent with NEI 12-02, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2 Evaluation of Design Features

Order EA-12-051 required that the spent fuel pool level instrumentation shall include specific design features, including specifications on the instruments, arrangement, mounting, qualification, independence, power supplies, accuracy, testing, and display. Refer to Section 2.2 above for the requirements of the order in regard to the design features. Below is the the NRC staff's assessment of the design features of the spent fuel pool instrumentation (SFPI).

4.2.1 Design Features: Instruments

In its OIP, the licensee stated that both the primary and backup Instrument channels are permanent, fixed channels and provide a single continuous span from above Level 1 to within 1 ft of the top of the spent fuel racks.

In its letter dated July 25, 2013, the licensee provided a sketch depicting the elevations identified as Levels 1, 2 and 3 and the SFP level instrumentation minimum sensor range. The NRC staff reviewed this sketch and notes that sensor range goes from an elevation of 112 ft. 7-1/4 in, above Level 1, to elevation 85 ft 7-5/16 in, below Level 3, covering the full range from Level 1 to Level 3.

Based on the evaluation above, the NRC staff finds that the licensee's design, with respect to the number of channels and measurement range for its SFP, appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.2 Design Features: Arrangement

In its OIP, the licensee provided a simplified sketch of the SFP instrument locations and approximate cable routing. The NRC staff reviewed this sketch and notes that the proposed location of the SFP level instrumentation is at the northeast and northwest corners of the SFP. By letter dated August 28, 2014, the licensee provided an updated sketch that depicted changes to the cable routings. The NRC staff verified the proposed locations during the on-site audit. The NRC staff concludes that there is sufficient channel separation within the SFP area between the primary and back-up level instruments, sensor electronics, and routing cables to provide reasonable protection against loss of indication of SFP level due to missiles that may result from damage to the structure over the SFP.

Based on the evaluation above, the NRC staff finds that, if implemented appropriately, the licensee's proposed arrangement for the SFP level instrumentation appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.3 Design Features: Mounting

The NRC staff reviewed Entergy Engineering Report No. RBS-IC-14-00001, Rev. 0, "Seismic induced Hydraulic Response in the Riverbend Spent Fuel Pool," and calculation G13.18.1.3-041 Rev 0, "SFPI Probe Mounting Bracket Design." The NRC Staff confirmed that the probe support bracket was sufficient to withstand the seismic loading including the hydro-dynamic effects of pool sloshing. The NRC staff also confirmed that the anticipated seismic forces for the electronics and battery enclosures are enveloped by the seismic testing performed by the vendor.

Based on the discussion above, the NRC staff finds that, if implemented appropriately, the licensee's proposed mounting design is consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.4 Design Features: Qualification

4.2.4.1 Augmented Quality Process

Appendix A-1 to NEI 12-02 describes a quality assurance process for non-safety systems and equipment that is not already covered by existing quality assurance requirements. Per JLD-ISG-2012-03, the NRC staff found the use of this quality assurance process to be an acceptable means of meeting the augmented quality requirements of Order EA-12-051.

In its OIP, the licensee stated that instrument channel reliability shall be established by use of an augmented quality assurance process similar to that described in NEI 12-02.

Based on the evaluation above, the NRC staff finds that, if implemented appropriately, this approach appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.4.2 Instrument Channel Reliability

NEI 12-02 states:

> The instrument channel reliability shall be demonstrated via an appropriate combination of design, analyses, operating experience, and/or testing of channel components for the following sets of parameters, as described in the paragraphs below:
>
> - conditions in the area of instrument channel component use for all instrument components,
> - effects of shock and vibration on instrument channel components used during any applicable event for only installed components, and
> - seismic effects on instrument channel components used during and following a potential seismic event for only installed components.

Equipment reliability performance testing was performed to (1) demonstrate that the SFP instrumentation will not experience failures during BDB conditions of temperature, humidity, emissions, surge, and radiation, and (2) to verify those tests envelope the plant-specific requirements.

The NRC staff reviewed the SFP level instrumentation qualification testing during the on-site vendor audit at Mohr Industries. During the on-site audit at RBS, the NRC staff verified proposed and installed equipment locations and verified the anticipated conditions at these locations to ensure they are enveloped by the vendor's qualification testing. The NRC staff confirmed site-specific information in its reviews of calculation G13.18.1.3-040 Rev 0, "SFPI Electrical Equipment Support Qualification," Entergy Engineering report No. RBS-IC-14-00001, Rev. 0, "Seismic induced Hydraulic Response in the Riverbend Spent Fuel Pool," and calculation G13.18.1.3-041 Rev 0, "SFPI Probe Mounting Bracket Design."

Based on the evaluation above, the NRC staff finds that the licensee's proposed instrument qualification process appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.5 Design Features: Independence

In its OIP, the licensee provided a simplified sketch of the SFP instrument locations and approximate cable routing. The NRC staff reviewed this sketch and notes that the proposed location of the SFP level instrumentation is at the northeast and northwest corners of the SFP. By letter dated August 28, 2014, the licensee provided an updated sketch that showed changes to the cable routings. The staff verified the proposed locations during the on-site audit.

The NRC staff concludes that there is sufficient channel separation within the SFP area between the primary and back-up level instruments, sensor electronics, and routing cables to provide reasonable protection against loss of indication of SFP level due to missiles that may result from damage to the structure over the SFP.

In its July 25, 2013, RAI response [Reference 26], RBS described the independence of the power source for each SFPI channel. The NRC staff verified the independence of the busses and power panels during the on-site audit.

Based on the evaluation above, the NRC staff finds that the licensee's proposed design, with respect to instrument channel independence, appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.6 Design Features: Power Supplies

By letter dated August 28, 2014 [Reference 31], the licensee confirmed the specific, independent, lighting panels and 480v busses used to power the primary and back-up instruments. During the on-site audit, the NRC staff confirmed that the power sources were independent during the SFP level instrumentation walkdown.

Battery backup capabilities were verified during the vendor audit at Mohr industries including the length of time the batteries would maintain the level instrument functionality. The NRC staff included a summary of the battery backup evaluation and documents reviewed in the vendor audit report dated August 27, 2014 [Reference 34].

Based on the evaluation above, the NRC staff finds that the licensee's proposed power supply design appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.7 Design Features: Accuracy

Mohr document No. 1-0410-3, "MOHR EFP-IL SFPI Proof of Concept Report," Rev. 0, dated October 17, 2012, states, in part, that the effects of temperature and humidity are insignificant with regard to measurement accuracy. The instrument accuracy is approximately 0.04 to 0.5 in. The results from testing performed on the probe at 500 °F in saturated steam (100 percent relative humidity) showed a system accuracy of approximately 0.5 in. The Mohr Document No.

1-0410-15, "MOHR EFP-IL-SFPI System Uncertainty Analysis," states, in part, that the EFP-IL-SFPI system, configured with a maximum length of transmission cable of 1000 ft., stays within the level measurement accuracy of+/- 3 in. The EFP-IL-SFPI system error is highest, but still acceptable at the bottom of the probe near the top of the fuel rack.

The Mohr Document No. 1-0410-10, "MOHR EFP-IL SFPI System Power Interruption Report," Rev. 1, dated January 10, 2014, describes power interruption testing on the EFP-IL signal processing unit and battery. Test results indicate that no deficits were identified with respect to maintenance of reliable function, accuracy, or calibration as a result of power interruption.

The staff included a summary of the SFPI accuracy evaluation and documents reviewed in the vendor audit report dated August 27, 2014 [Reference 34].

Based on the evaluation above, the NRC staff finds that the licensee's proposed instrument accuracy appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.8 Design Features: Testing

In its SFPI compliance letter [Reference 35], RBS stated:

> The Mohr Level Indication System is a microprocessor based instrument (signal processor is located within the level indicator) that performs continuous system auto-calibration. The system includes diagnostic and calibration features that are accessible at the level indicator. Instructions for performing routine testing and calibration of the capable of being calibrated without being removed from the fuel pool. The new SFP level instrumentation is installed in accordance with the testing guidance provided in NEI 12-02, Rev. 1 Section 3.8, and the system is in compliance with the regulatory requirements of NRC Order EA-12-051, Section 1.8.

The NRC staff reviewed the Mohr system's calibration function and testability including Mohr procedures during the on-site vendor audit at Mohr Industries LLC. The NRC staff included a summary of the testing and calibration evaluation and documents reviewed in the audit report dated August 27, 2014 [Reference 34].

Based on the evaluation above, the NRC staff finds that the licensee's proposed SFP instrumentation design allows for testing consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.9 Design Features: Display

The NRC staff reviewed the response in the August 28, 2014, six month update [Reference 31]. The NRC staff also confirmed the response during the SFP level instrumentation walkdown during the onsite FLEX audit. The SFP level instrumentation display indicators are located at the 98 ft. elevation of the CB, west hallway, two flights of stairs below the control room. Both displays are located near the Division 2 remote shutdown panel. The access time was less than 5 minutes.

The CB is a mild radiation environment during normal operation. High temperatures under BDB conditions impact habitability at the display indicators. The licensee stated in its August 28, 2014, letter, that habitability will be assured through heat stress countermeasures and rotation of personnel.

Based on the evaluation above, the NRC staff finds that the licensee's proposed location and design of the SFP instrumentation displays appear to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.3 Evaluation of Programmatic Controls

Order EA-12-051 specified that the spent fuel pool instrumentation shall be maintained available and reliable through appropriate development and implementation programmatic controls, including training, procedures, and testing and calibration. Below is the NRC staff's assessment of the programmatic controls for the spent fuel pool instrumentation.

4.3.1 Programmatic Controls: Training

In its OIP dated February 28, 2013 [Reference 24], the licensee stated, in part, that:

> The Systematic Approach to Training (SAT) will be used to identify the population to be trained and to determine both the initial and continuing elements of the required training. Training will be completed prior to placing the instrumentation in service.

In its compliance letter dated May 18. 2015 [Reference 35], the licensee stated that operations personnel have been trained in the use of the primary and backup instrument channels, including the provision for connecting alternate power.

The NRC staff previously determined, as stated in the November 25, 2013 Interim Staff Evaluation for Riverbend [Reference 27], the licensee's OIP statement appeared to meet the NEI 12-02 guidance. The NRC staff found the licensee's May18 compliance letter statement regarding completion of training appears to meet the NEI 12-02 guidance to complete training prior to placing the instrument in service.

Based on the evaluation above, the NRC staff finds that the licensee's plan to train personnel in the operation, maintenance, calibration, and surveillance of the SFP level instrumentation, including the approach to identify the population to be trained, appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.3.2 Programmatic Controls: Procedures

The NRC staff review during the on-site audit and audit of documents provided by the licensee through an electronic reading room, confirmed that the licensee incorporated vendor technical and operating procedure manuals into the plant documentation control system. In addition, the Technical Requirements Manual (TRM) was updated to support FLEX functions. Continuous monitoring is implemented in the plant operator logs.

Based on the evaluation above, the NRC staff finds that the licensee's procedure development appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and adequately address the requirements of the order.

4.3.3 Programmatic Controls: Testing and Calibration

In its compliance letter dated May 18. 2015 [Reference 35], the licensee stated a new section has been added to the TRM to control functionality and actions for non-functionality along with implementation of a TRM channel functional test procedure and a PM task to control maintenance scheduling.

By letter dated July 25, 2013 [Reference 26], the licensee stated that for one channel out of service, the channel should be restored to functional within 90 days. The compensatory action is to provide an alternate method and report to the on-site safety review committee. With two channels that are out of service, actions to restore a channel to service are to be initiated within 24 hours with the channel returned to functional within 72 hours. The licensee clarified the compensatory actions in Attachment 2 of the May 18, 2015, compliance letter, stating that it will not report to the on-site safety review committee.

Based on the evaluation above, the NRC staff finds that the licensee's proposed testing and calibration plan appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.4 Conclusions for Order EA-12-051

In its letter dated May 18, 2015 [Reference 35], the licensee stated that it would meet the requirements of Order EA-12-051 by following the guidelines of NEI 12-02, as endorsed by JLD-ISG-2012-03. In the evaluation above, the NRC staff finds that, if implemented appropriately, the licensee has conformed to the guidelines of NEI 12-02, as endorsed by JLD- ISG-2012-03. In addition, the NRC staff concludes that if the SFP level instrumentation is installed at River Bend Station according to the licensee's proposed design, it is expected to adequately address the requirements of Order EA-12-051.

5.0 CONCLUSION

In August 2013 the NRC staff started audits of the licensee's progress on Orders EA-12-049 and EA-12-051. The staff conducted an onsite audit in October 2014 [Reference 17]. The licensee reached its final compliance date on September 29, 2015, and has declared that the reactor is in compliance with the orders. The purpose of this safety evaluation is to document the strategies and implementation features that the licensee has committed to. Based on the evaluations above, the NRC staff concludes that the licensee has developed guidance and proposed designs that if implemented appropriately should adequately address the requirements of Orders EA-12-049 and EA-12-051. The NRC staff will conduct an onsite inspection to verify that the licensee has implemented the strategies and equipment to demonstrate compliance with the orders.

6.0 REFERENCES

1. SECY-11-0093, "Recommendations for Enhancing Reactor Safety in the 21st Century, the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," July 12, 2011 (ADAMS Accession No. ML11186A950)

2. 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," February 17, 2012 (ADAMS Accession No. ML12039A103)

3. SRM-SECY-12-0025, "Staff Requirements – 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," March 9, 2012 (ADAMS Accession No. ML120690347)

4. Order EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," March 12, 2012 (ADAMS Accession No. ML12054A736)

5. Order EA-12-051, "Issuance of Order to Modify Licenses With Regard To Reliable Spent Fuel Pool Instrumentation," March 12, 2012 (ADAMS Accession No. ML12054A679)

6. Nuclear Energy Institute document NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0, August 21, 2012 (ADAMS Accession No. ML12242A378)

7. JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," August 29, 2012 (ADAMS Accession No. ML12229A174)

8. Nuclear Energy Institute document NEI 12-02, "Industry Guidance for Compliance with NRC Order EA-12-051, To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," Revision 1, dated August 24, 2012 (ADAMS Accession No. ML12240A307)

9. JLD-ISG-2012-03, "Compliance with Order EA-12-051, Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," August 29, 2012 (ADAMS Accession No. ML12221A339)

10. River Bend, Unit 1, Overall Integrated Plan in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," dated February 28, 2013 (ADAMS Accession No. ML13066A738).

11. Entergy Operations Inc. River Bend, Unit 1 – "Six-Month Status Report In-Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events," dated August 28, 2013 (ADAMS Accession No. ML13247A414)

12. Entergy Operations Inc. River Bend Station Unit 1 – "Entergy's Second Six-Month Status Report In-Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events," dated February 26, 2014 (ADAMS Accession No. ML14064A202)

13. Entergy Operations Inc. River Bend Station Unit 1 – "Third Six-month Status Report In-Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events," dated August 28, 2014 (ADAMS Accession No. ML14253A210)

14. Entergy Operations Inc. River Bend Station Unit 1 – "Fourth Six-month Status Report In-Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events," dated February 25, 2015 (ADAMS Accession No. ML15062A032)

15. Letter from Jack R. Davis (NRC) to All Operating Reactor Licensees and Holders of Construction Permits, "Nuclear Regulatory Commission Audits of Licensee Responses to Mitigation Strategies Order EA-12-049," August 28, 2013 (ADAMS Accession No. ML13234A503)

16. NRC Letter from Jeremy S. Bowen to Vice President, Operations dated February 25, 2014 regarding River Bend Station – "Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049 (Mitigating Strategies)" (ADAMS ADAMS Accession No. ML13365A281)

17. NRC Letter from John D. Hughey to Vice President, Operations dated February 18, 2015 regarding River Bend Station Unit 1 – "Report for the Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Pool Instrumentation Related to Orders EA-12-049 and EA-12-051" (ADAMS Accession No. ML15026A645)

18. Entergy Operations Inc. River Bend Station Unit 1 – "Completion of Required Action by NRC Order EA-12-049, Issuance of Order to Modify Licenses With regard To Requirements for Mitigation Strategies for Beyond-Design-Basis-External Events," dated September 29, 2015 (ADAMS Accession No. ML15279A345)

19. U.S. Nuclear Regulatory Commission, "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," March 12, 2012, (ADAMS Accession No. ML12053A340)

20. SRM-COMSECY-14-0037, "Staff Requirements – COMSECY-14-0037 – Integration of Mitigating Strategies For Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," March 30, 2015, (ADAMS Accession No. ML15089A236)

21. Entergy Operations Inc. River Bend Station Unit 1 – "Flood Hazard Reevaluation Report Response to Request for Information Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident River Bend Station - Unit 1," dated March 12, 2014 (ADAMS Accession No. ML14073A647)

22. Entergy Operations Inc. River Bend Station Unit 1 – "Seismic Hazard and Screening Report (CEUS Sites), Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," dated March 26, 2014 (ADAMS Accession No. ML14091A426)

23. Letter from Jack R. Davis (NRC) to Joseph E. Pollock (NEI), "Staff Assessment of National SAFER Response Centers Established In Response to Order EA-12-049," September 26, 2014 (ADAMS Accession No. ML14265A107)

24. Entergy Operations Inc. River Bend Station Unit 1 – "River Bend Station Overall Integrated Plan In Response To March 12, 2012, Commission Order Modifying License With Regard To Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," February 28, 2013 (ADAMS Accession No. ML130660550)

25. U.S. NRC, "River Bend Station, Unit 1 - Request For Additional Information Regarding Overall Integrated Plan For Reliable Spent Fuel Pool Instrumentation (ORDER EA-12-051)," dated July 3, 2013 (ADAMS Accession No. ML13179A193)

26. Entergy Operations Inc. River Bend Station Unit 1 – "Response to Request for Additional Information (RAI) for the Overall Integrated Plan (OIP) in Response to the Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool (SFP) Instrumentation," July 25, 2013 (ADAMS Accession No. ML13217A092)

27. U.S. NRC, "River Bend Station, Unit 1 -Interim Staff Evaluation and Request for Additional Information Regarding Overall Integrated Plan for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," November 25, 2013 (ADAMS Accession No. ML13316C065)

28. NEI Position Paper: "Shutdown/Refueling Modes", dated September 18, 2013 (ADAMS Accession No. ML13273A514)

29. Entergy Operations Inc. River Bend Station Unit 1 – "Entergy's First Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," August 28, 2013 (ADAMS Accession No. ML13247A416)

30. Entergy Operations Inc. River Bend Station Unit 1 – "Entergy's Second Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," February 26, 2014 (ADAMS Accession No. ML14064A263)

31. Entergy Operations Inc. River Bend Station Unit 1 – "Entergy's Third Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," August 28, 2014 (ADAMS Accession No. ML14253A209)

32. Entergy Operations Inc. River Bend Station Unit 1 – “Entergy's Fourth Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051),” February 25, 2015 (ADAMS Accession No. ML15062A031)

33. Email from Danny Williamson (Entergy) to John Hughey (NRC), “Spent Fuel Pool Level Instruments,” December 18, 2015 (ADAMS Accession No. ML16012A124)

34. U.S. NRC, “Donald C. Cook Nuclear Plant, Units 1 And 2- Report For The Onsite Audit of Mohr Regarding Implementation of Reliable Spent Fuel Pool Instrumentation Related To Order EA-12-051,” August 27, 2014 (ADAMS Accession No. ML14216A362)

35. Entergy Operations Inc. River Bend Station Unit 1 – “Completion of Required Action by NRC Order EA-12-051 Reliable Spent Fuel Pool Level (SFP) Instrumentation,” dated May 18, 2015 (ADAMS Accession No. ML15154A837)

36. NRC letter, River Bend Station, Unit 1 - Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request- Flood-causing Mechanism Reevaluation, dated September 4, 2015 (ADAMS Accession No. ML15212A727)

37. NRC letter, River bend Station, Unit 1 - Staff Review of High Frequency Confirmation Associated with Reevaluated Seismic Hazard in Response to March 12, 2012, 50.54(f) Request for Information, dated February 18, 2016 (ADAMS Accession No. ML15364A544)

38. Entergy River Bend Station, Fifth 6-month Status Report, dated August. 26, 2015 (ADAMS Accession No. ML15253A371)

39. E-Mail dated January 25, 2016, from Entergy to NRC, “River Bend FLEX Building ASCE 7-10 Seismic Design Loading Evaluation” (ADAMS Accession No. ML16033A403)

40. Letter from Jack R. Davis (NRC) to Joseph E. Pollock (NEI), regarding NRC endorsement of NEI Position Paper: “Shutdown/Refueling Modes”, dated September 30, 2013 (ADAMS Accession No. ML13267A382)

41. Letter from Nicholas Pappas (NEI) to Jack R. Davis (NRC) regarding FLEX Equipment Maintenance and Testing dated October 3, 2013 (ADAMS Accession No. ML13276A573)

42. Letter from Jack R. Davis (NRC) to Joseph E. Pollock (NEI), regarding NRC endorsement of the use of the EPRI FLEX equipment maintenance report, dated October 7, 2013 (ADAMS Accession No. ML13276A224)

43. U.S. Nuclear Regulatory Commission, "Mitigation of Beyond-Design-Basis Events," *Federal Register*, Vol. 80, No. 219, November 13, 2015, pp. 70610-70647

44. COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," November 21, 2014 (ADAMS Accession No. ML14309A256)

45. Letter from William Dean (NRC) to Power Reactor Licensees, "Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design Bases External Events," September 1, 2015 (ADAMS Accession No. ML15174A257)

46. Nuclear Energy Institute document NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 2, dated December 31, 2015 (ADAMS Accession No. ML16005A625)

47. JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," Revision 1, dated January 22, 2012 (ADAMS Accession No. ML15357A163)

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Date: August 11, 2016

2015 (ADAMS Accession No. ML15026A645), the NRC staff issued an ISE and audit report, respectively, on the licensee's progress. By letter dated March 26, 2014 (ADAMS Accession No. ML14083A620), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-051 in accordance with NRC NRR Office Instruction LIC-111, similar to the process used for Order EA-12-049. By letter dated May 18, 2015 (ADAMS Accession No. ML15154A837), Entergy submitted a compliance letter and FIP in response to Order EA-12-051. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-051.

The enclosed safety evaluation provides the results of the NRC staff's review of Entergy's strategies for River Bend. The intent of the safety evaluation is to inform Entergy on whether or not its integrated plans, if implemented as described, provide a reasonable path for compliance with Orders EA-12-049 and EA-12-051. The staff will evaluate implementation of the plans through inspection, using Temporary Instruction 191, "Implementation of Mitigation Strategies and Spent Fuel Pool Instrumentation Orders and Emergency Preparedness Communications/Staffing/ Multi-Unit Dose Assessment Plans" (ADAMS Accession No. ML14273A444). This inspection will be conducted in accordance with the NRC's inspection schedule for the plant.

If you have any questions, please contact John Hughey, Orders Management Branch, River Bend Project Manager, at 301-415-3204 or at John.Hughey@nrc.gov.

Sincerely,
/RA/
Mandy Halter, Acting Chief
Orders Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket No.: 50-458

Enclosure:
Safety Evaluation
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ADAMS Accession No. ML15292A508 *** via e-mail**

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