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

May 9, 2018

Mr. Bryan Hanson
Senior Vice President
Exelon Generation Company, LLC
President and Chief Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3 – SAFETY EVALUATION REGARDING IMPLEMENTATION OF MITIGATING STRATEGIES AND RELIABLE SPENT FUEL POOL INSTRUMENTATION RELATED TO ORDERS EA-12-049 AND EA-12-051 (CAC NOS. MF0845, MF0846, MF0849, AND MF0850; EPID NOS. L-2013-JLD-0017 AND L-2013-JLD-0018)

Dear Mr. Hanson:

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. ML13059A305), Exelon Generation Company, LLC (Exelon, the licensee) submitted its OIP for Peach Bottom Atomic Power Station, Units 2 and 3 (Peach Bottom), 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 November 22, 2013 (ADAMS Accession No. ML13220A105), and September 23, 2015 (ADAMS Accession No. ML15254A135), the NRC issued an Interim Staff Evaluation (ISE) and an audit report, respectively, on the licensee's progress. By letter dated January 6, 2017 (ADAMS Accession No. ML17006A167), Exelon reported that Peach Bottom, Unit 2, was in full compliance with Order EA-12-049. By letter dated January 5, 2018 (ADAMS Accession No. ML18005A701), Exelon reported that Peach Bottom, Unit 3 was in full compliance with Order EA-12-049, and submitted a Final Integrated Plan for Peach Bottom, Units 2 and 3.

By letter dated February 28, 2013 (ADAMS Accession No. ML13059A390), the licensee submitted its OIP for Peach Bottom, Units 2 and 3, 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 letters dated October 30, 2013 (ADAMS Accession No. ML13295A303), and September 23, 2015 (ADAMS Accession No. ML15254A135), the NRC staff issued an ISE and an 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 December 15, 2015 (ADAMS Accession No. ML15352A135), Exelon submitted a compliance letter in response to Order EA-12-051. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-051 at Peach Bottom, Units 2 and 3.

The enclosed safety evaluation provides the results of the NRC staff's review of Exelon's strategies for Peach Bottom, Units 2 and 3. The intent of the safety evaluation is to inform Exelon on whether or not its integrated plans, if implemented as described, appear to adequately address the requirements of Orders EA-12-049 and EA-12-051. The staff will evaluate implementation of the plans through inspection, using Temporary Instruction 2515-191, "Inspection of the Implementation of Mitigation Strategies and Spent Fuel Pool Instrumentation Orders and Emergency Preparedness Communication/Staffing/Multi-Unit Dose Assessment Plans" (ADAMS Accession No. ML15257A188). This inspection will be conducted in accordance with the NRC's inspection schedule for the plant.

If you have any questions, please contact Peter Bamford, Beyond-Design-Basis Management Branch, Peach Bottom Project Manager, at 301-415-2833, or by e-mail at Peter.Bamford@nrc.gov.

Sincerely,

Mohamed K. Shams, Chief
Beyond-Design-Basis Management Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket Nos.: 50-277 and 50-278

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

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

EXELON GENERATION COMPANY, LLC

PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3

DOCKET NOS. 50-277 AND 50-278

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 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, "Order Modifying 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 applied 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, "Order Modifying 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 applied to all holders of operating licenses and 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

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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 the Commission in 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 Order EA-12-049. The NRC staff reviewed NEI 12-06 and on August 29, 2012, issued its final version of Japan Lessons-Learned Division (JLD)[1] 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.

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[1] Revision 0 was issued by the Japan Lessons-Learned Project Directorate, which also used the term "JLD." No distinction is made in this safety evaluation between documents issued by the two organizations because the Japan Lessons-Learned Division continued the numbering scheme used by the Japan Lessons-Learned Project Directorate.

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], Exelon Generation Company, LLC (Exelon, the licensee) submitted an Overall Integrated Plan (OIP) for Peach Bottom Atomic Power Station, Units 2 and 3 (Peach Bottom, PBAPS), in response to Order EA-12-049. By letters dated August 28, 2013 [Reference 11], February 28, 2014 [Reference 12], August 28, 2014 [Reference 13], February 27, 2015 [Reference 14], August 28, 2015 [Reference 15], February 26, 2016 [Reference 16], August 26, 2016 [Reference 17], February 28, 2017 [Reference 18], and August 28, 2017 [Reference 19], the licensee submitted six-month updates to the OIP. By letter dated August 28, 2013 [Reference 20], 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" [Reference 21]. By letters dated November 22, 2013 [Reference 22], and September 23, 2015 [Reference 23], the NRC issued an Interim Staff Evaluation (ISE) and audit report, respectively, on the licensee's progress. By letter dated January 6, 2017 [Reference 24], Exelon reported that Peach Bottom, Unit 2, was in full compliance with Order EA-12-049. By letter dated January 5, 2018 [Reference 25], Exelon reported that Peach Bottom, Unit 3 was in full compliance with Order EA-12-049, and submitted a Final Integrated Plan (FIP) for Peach Bottom, Units 2 and 3.

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 a loss of normal access to the UHS. Thus, the ELAP with loss of normal access to the UHS 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 shut down 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.

Peach Bottom is a General Electric (GE) boiling-water reactor (BWR) Model 4, with a Mark I containment. The licensee's three-phase approach to mitigate a postulated ELAP event, as described in the FIP, is summarized below.

At the onset of an ELAP both reactors are assumed to trip from full power. The main condenser is unavailable as a heat sink due to the loss of flow from the circulating water system. 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 located in the primary containment. Makeup to the RPV is provided by the reactor core isolation cooling (RCIC) turbine-driven pump. Because the condensate storage tanks (CSTs) are not robust, the licensee's mitigating strategy assumes that the RCIC pump suction realigns to the suppression pool. Within approximately 20 minutes, the operators take manual control of the SRVs and begin a controlled cooldown and depressurization of the RPV. The cooldown is stopped when reactor pressure reaches a control band of 200 to 300 pounds per square inch gauge (psig) to ensure sufficient steam pressure to operate the RCIC pump. When the drywell reaches a predetermined pressure setpoint, the wetwell vent to atmosphere is opened to mitigate the suppression pool temperature rise and allow the RCIC system to continue to function. The RPV makeup will continue to be provided from the RCIC system until the gradual reduction in RPV pressure resulting from diminishing decay heat requires a transition to Phase 2 methods. When RCIC operation is no longer viable, RPV makeup comes from a portable diesel-driven pump that is supplied from either the Emergency Cooling Tower (ECT) basin or the UHS for the plant, the Susquehanna River.

Both reactors have Mark I containments which are inerted with nitrogen when the reactor is at power. The licensee performed a containment evaluation and determined that opening the suppression pool vent to atmosphere will allow containment temperature and pressure to stay within acceptable levels until a combination of existing plant systems and those restored by off-site equipment and resources can be deployed to provide indefinite coping.

Each reactor has a SFP in its Reactor Building. To maintain SFP cooling capabilities, the licensee establishes the water injection lineup before the environment on the SFP operating deck degrades due to boiling in the pool. The SFP will initially heat up due to the unavailability of the normal cooling system. The licensee has calculated that boiling could start as soon as 2.46 hours after the loss of power, assuming a limiting case of a full core offload. With this assumed heat load, the pool water level would drop to the top of the fuel racks in approximately 35 hours. The licensee determined that habitability on the pool operating deck area could become compromised as early as 5.5 hours after the ELAP, so equipment setup in the vicinity of the SFP is planned prior to that time.

The licensee has multiple strategies to provide water makeup to the SFP. The same diesel-driven pump and water sources that are used for RPV makeup are used to provide SFP makeup. The pump discharge is routed to the SFP by using a combination of hoses and installed plant systems, or solely by hoses for direct makeup or spray.

The operators will perform DC bus load stripping to ensure safety-related battery life is extended to allow time for the deployment of a FLEX diesel generator (DG). An initial load stripping is initiated within approximately 15 minutes of the event and a deeper load shed is initiated approximately 60 minutes into the event. The licensee estimates that the load shed activities will be completed within 90 minutes of the event initiation. Following the load shed and prior to battery depletion at approximately 7.25 hours, a 500-kilowatt (kW), 480 volt alternating current (VAC) DG will be deployed for each unit. These DGs will be used to repower essential battery chargers and are expected to be operational within approximately 7 hours of ELAP initiation. In addition, a National SAFER [Strategic Alliance for FLEX Emergency Response] Response Center (NSRC) will provide high capacity pumps and large combustion turbine generators (CTGs) which could be used to provide spares or backups to the Phase 2 equipment and to restore selected plant systems.

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

Order EA-12-049 requires licensees to maintain or restore cooling to the reactor core in the event of an ELAP concurrent with a loss of normal access to the UHS. 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 with loss of normal access to the UHS) 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 with loss of normal access to the UHS event presumes that, per endorsed guidance from NEI 12-06, both units would have been operating at full power prior to the event. Therefore, the suppression pool may be credited as the heat sink for core cooling during the ELAP with loss of normal access to the UHS event. Maintenance of sufficient RPV inventory, despite steam release from the SRVs and ongoing system leakage expected under ELAP conditions, is accomplished through a combination of installed systems and FLEX equipment. The licensee's strategy for ensuring compliance with Order EA-12-049 for conditions where one or both applicable units are shut down or being refueled is reviewed separately in Section 3.11 of this safety evaluation.

3.2.1 Core Cooling Strategy and RPV Makeup

3.2.1.1 Phase 1

According to the licensee's FIP, the injection of cooling water into the RPV will be accomplished through the RCIC system. Because the turbine for the RCIC pump is driven by steam from the RPV, operation of the RCIC system further assists the SRVs with RPV pressure control. The RCIC system suction is initially lined up to the CSTs. However, the CSTs are not considered to be fully protected for the seismic and tornado/missile events. Thus, if the CSTs are not available, the RCIC pump suction will be swapped to the suppression pool, the protected source of water for the ELAP event. The RCIC system is protected from all applicable hazards.

According to the licensee's FIP, pressure control of the RPV is accomplished using the pneumatically-operated SRVs whose solenoids are powered from the 125 Volts-DC (VDC) buses. Within approximately 20 minutes after the initiation of the event, operators will utilize the SRV's to depressurize the RPV to 500 psig. After this point, the RPV temperature and pressure is further lowered at a cooldown rate of less than 100 degrees Fahrenheit (°F) per hour until a control band of between 200 and 300 psig is established. This control band allows for continued operation of the RCIC system. A backup nitrogen system is aligned to allow the continued operation of the SRVs for at least 72 hours after the initiation of the ELAP event.

According to the licensee's FIP, station batteries and the Class 1E 125 VDC distribution system provide power to RCIC systems and instrumentation. The sequence of events in the FIP indicates that the DC load shedding occurs in two phases, with the first phase beginning at approximately 15 minutes into the event, and the second phase completing approximately 90 minutes into the event. This load shedding will extend the battery capacity to power the Phase 1 systems and instrumentation until the FLEX DGs are able to be deployed.

3.2.1.2 Phase 2

In Phase 2 the RCIC system will continue to be used until it is necessary to transfer to a FLEX pump for RPV makeup. The remaining Phase 2 equipment is stored onsite and protected from all applicable hazards. The licensee's plan has provisions for primary and alternate connection points for the FLEX pump. This FLEX pump (one per unit) would be used to provide makeup for the RPV, torus (suppression chamber), and SFP.

The primary source of water for the FLEX pump is the ECT basin. From the ECT basin, the pump would be able to provide water to either 2B (3A) residual heat removal (RHR) line, 2A (3B) RHR line, or 2B (3A) high pressure service water (HPSW) line. The FLEX pump can also be located to take suction from the UHS at various points. From the UHS deployment location, the pumps' discharge would be routed to the HPSW system, which can be aligned to the RHR system for RPV injection. The FLEX pump is sized to provide sufficient flow for both RPV and SFP makeup. The injection strategy provides two completely independent flow paths to the RPV, as well as the flexibility to account for the availability of sources of water and injection points.

The licensee plans to open the hardened containment vent once the containment pressure reaches 2 psig. According to the timeline in the licensee's FIP, this could occur at approximately 1 hour into the event. To maintain suppression pool level after venting starts, the licensee's strategy provides for suppression pool makeup capability from the FLEX pump utilizing the suction sources discussed above.

Approximately 7 hours into the event, the FLEX DGs will be available to provide power to the battery chargers, as well as other loads, to support the overall FLEX strategy.

3.2.1.3 Phase 3

According to the licensee's FIP, the Phase 3 strategy would be to maintain and supplement/replace the Phase 2 strategy with Phase 3 equipment. The usage of the ECT or the UHS will provide adequate volume for the core cooling strategy into Phase 3. In Phase 3, makeup water could be provided to the ECT and purification would be available for the ECT or UHS makeup water. Other cleaner water tanks are located on site, and could be used if available, however they are not specifically credited since they are not fully protected from all hazards. The Phase 3 equipment starts to arrive from the NSRC within 24 hours of notification. The connection points used in Phase 2 are compatible with the equipment that will be arriving from the NSRC and thus can be used throughout Phase 3.

In the event that raw water is used to provide core cooling, the licensee will utilize the guidance contained in BWR Owners Group (BWROG) report BWROG-TP-14-006, "Fukushima Response Committee Raw Water Issue: Fuel Inlet Blockage from Debris." This guidance contains direction to maintain the water level at the level of the moisture separator drains to ensure that core cooling is maintained despite the possible clogging of fuel element orifices and filters.

3.2.2 Variations to Core Cooling Strategy for Flooding Event

For Peach Bottom, the limiting flooding event relates to a Susquehanna River flood that has an associated warning time. The predicted water level for the limiting flood would impact deployment from the FLEX Storage Building, and inundate the alternate FLEX pump deployment location at the UHS. In this scenario, the licensee would utilize the flood warning time to stage the FLEX equipment on higher ground, including locating the FLEX pump at the ECT basin suction location, which is also on higher ground. With this pre-deployment, the licensee would be able to use the RPV injection strategy as previously described, connecting to the RHR lines, to provide core cooling.

3.2.3 Staff Evaluations

3.2.3.1 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 assessments of the availability of SSCs for core cooling during an ELAP caused by a BDBEE.

3.2.3.1.1 Plant SSCs

Phase 1

In the licensee's FIP, Section 2.3.4.100 describes the RCIC system as a steam-driven turbine pump and associated valves and piping. The RCIC pump takes suction from the CST or the suppression pool and utilizes reactor steam to drive the turbine. The turbine steam supply is exhausted back into the suppression pool. The CST is not credited for FLEX strategies. The system operates independently of AC power, plant service air, and external cooling water system and requires only DC power from the station's batteries. The power source for the turbine-pump unit is the steam generated in the RPV by the decay heat in the core. The makeup water is delivered into the RPV through a connection to the "B" feedwater line and is distributed within the RPV through the feedwater spargers. The Reactor Building is the location of the RCIC system and suppression pool, and this structure is protected from all applicable external hazards. Thus, the NRC staff finds that the RCIC system and the suppression pool are robust and are expected to be available at the start of an ELAP event consistent with NEI 12-06, Section 3.2.1.3.

In the licensee's FIP, Section 2.3.1 describes the operation of the automatic depressurization system (ADS) SRVs as the mechanism for RPV pressure control and decay heat removal. The SRVs require DC control power from the station's batteries and pneumatic nitrogen to operate. The ADS SRVs and controls are located in the Reactor Building, which is protected from all applicable external hazards. Additionally, the SRVs are safety-related. Based on the FIP description, the NRC staff finds the ADS SRVs and support systems are robust, as defined in NEI 12-06, and would be expected to be available at the start of an ELAP event consistent with NEI 12-06, Section 3.2.1.3.

Phase 2

The licensee's RPV and suppression pool makeup strategy for each unit in Phase 2 transitions from the RCIC system to the FLEX pump. Operators are directed to align the suction of the FLEX pumps to the ECT, which is a Seismic Category I structure, protected from all applicable external hazards. The FLEX pumps' discharge is aligned to the safety-related RHR system through one of two designated loops. Each loop is capable of providing water makeup to the RPV or to the suppression pool. Based on the safety-related classification and associated external event protection of the ECT and RHR system, the staff concludes that the Phase 2 strategy uses SSCs that are robust, in accordance with the provisions of NEI 12-06.

Phase 3

The licensee's Phase 3 RPV makeup strategy for Peach Bottom does not rely on any additional installed plant SSCs in addition to those discussed for Phases 1 and 2.

3.2.3.1.2 Plant Instrumentation

The licensee's plan for Peach Bottom is to monitor instrumentation to support the FLEX cooling strategy. The instrumentation is powered by station batteries and will be maintained for indefinite coping via battery chargers powered by the FLEX DGs. A more detailed evaluation of the instrumentation power supply is contained in Section 3.2.3.6 of this safety evaluation.

As described in the FIP, the following instrumentation will be relied upon to support the core cooling and inventory control strategy:

- RPV Level (Wide Range)
- RPV Pressure
- Suppression Pool Level
- Suppression Pool Temperature
- Drywell Pressure
- Drywell Temperature

These instruments can be monitored from the Main Control Room (MCR), or locally at instrument racks.

The staff reviewed the instrumentation identified by the licensee to support its core cooling strategy and concludes that it is consistent with the recommendations specified in the endorsed guidance of NEI 12-06.

In accordance with NEI 12-06 Section 5.3.3.1, instructions for obtaining critical parameters locally should be provided in in plant procedures/guidance. According to the licensee's FIP, a Peach Bottom FLEX Support Guideline (FSG) provides alternate methods for obtaining critical parameters if key parameter instrumentation is unavailable.

3.2.3.2 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, the licensee has addressed both in a single, coupled calculation for Peach Bottom. This dependency notwithstanding, the NRC staff's discussion in this section of the safety evaluation focuses on the licensee's analysis of core cooling. The NRC staff's review of the licensee's analysis of containment thermal-hydraulic behavior is provided in Section 3.4.4.2 of this safety 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 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, the EPRI issued a technical report entitled "Use of Modular Accident Analysis Program (MAAP) in Support of Post-Fukushima Applications" [Reference 46]. 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 NRC 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 TRACE code, 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 [Reference 47], 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.

During the audit process, the NRC staff verified that the licensee's MAAP4 calculation, along with an associated addendum, addressed the limitations from the NRC staff's endorsement letter. The licensee 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. In particular, based upon review of the MAAP4 calculation documentation, the 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 Peach Bottom would maintain the collapsed liquid level in the reactor vessel 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, Peach Bottom'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 MAAP4 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, 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 NRC staff concludes that 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.

3.2.3.3 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 make-up 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 Peach Bottom assumed a seal leakage rate of 42 gallons per minute (gpm) at normal RPV operating pressure. This leakage rate includes 18 gpm per recirculation pump seal in accordance with NRC Generic Letter 91-07 [Reference 48]. In addition, the licensee's calculation assumed an additional primary system leakage rate of 5 gpm unidentified leakage and 1 gpm identified leakage. Thus, between the two recirculation pumps and the additional primary system leakage, the total primary leakage rate assumed for Peach Bottom during the ELAP event was 42 gpm at normal operating reactor pressure.

In the MAAP analysis, the licensee discussed system response to the variation of seal leakage rate as a function of RPV pressure in the thermal hydraulic simulation. The initial seal leakage rate was assumed to be 36 gpm (18 per seal) plus the identified and unidentified leakage. As the RPV was depressurized the seal leakage rate was reduced. The licensee concluded that the RPV water level continued to be above the top of the active fuel throughout the simulation period.

Since the unidentified seal leak rate assumed in the licensee's analysis matches the technical specification value, the staff concludes that it is an appropriate analysis assumption. The identified leak rate is below the technical specification value of 25 gpm, so the staff evaluated this area in more detail during the audit process. Specifically, the staff reviewed multi-year historical site values of primary system identified leakage and concluded that the licensee's assumption of 1 gpm was reasonable. This determination is consistent with NEI 12-06, Section 3.2.1.2, which states that at the time of the event the reactor and supporting systems are within normal operating ranges. Further, the NRC staff concludes that the recirculation pump seal leakage rate assumed by Peach Bottom is also reasonable based on the provisions of Generic Letter 91-07. The staff notes that gross seal failures are not anticipated to occur during the postulated ELAP event. As is typical of the majority of U.S. BWRs, Peach Bottom has an installed steam-driven pump (i.e., RCIC) capable of injecting into the primary system at a flow rate well in excess of the primary system leakage rate expected during an ELAP, and the other pumps used for core cooling in its FLEX strategy have a similar functional capability and margin well above the expected leakage rate.

Based upon the discussion above, the NRC staff concludes that the primary system and 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.

3.2.3.4 Shutdown Margin Analyses

As described in Peach Bottom's Updated Final Safety Analysis Report (UFSAR) [Reference 45], Section 3.6.4.1, the control rods provide adequate shutdown margin under all anticipated plant conditions, with the assumption that the highest-worth control rod remains fully withdrawn. According to the UFSAR this includes keeping the reactor subcritical for the most reactive condition of the nuclear system. Peach Bottom 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 licensee's FIP description of the reactor transient, supplemented by the audit review, the NRC staff concludes that the licensee's ELAP mitigating strategy maintains the reactor within the envelope of conditions analyzed by the licensee's existing shutdown margin design basis. Furthermore, the ELAP event analysis retains conservatism because the guidance in NEI 12-06 permits the assumption 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.

3.2.3.5 FLEX Pumps and Water Supplies

In Phase 2, when the RCIC is no longer available, the licensee utilizes a FLEX pump to provide RPV makeup. The FLEX pumps are Godwin Dri-Prime HL 130M, trailer-mounted, diesel engine-driven centrifugal pumps. The licensee has a total of three FLEX pumps, one for each unit plus an additional FLEX pump serving as the "N+1" component of the RPV makeup strategy. All three of these pumps are stored in the Robust FLEX Building, which is protected from all applicable external hazards. Section 3.10 of this safety evaluation provides a detailed discussion of the availability and robustness of each water source for the FLEX pumps.

Each FLEX pump is used to inject water from the ECT or UHS into the RPV and/or suppression pool using primary or alternate connection points. According to the licensee's FIP, the FLEX pump will be available for use approximately 12 hours after ELAP initiation. According to the licensee's FIP, the capability of the FLEX pump and associated hoses/connections have been evaluated to ensure that they are able to deliver the required amount of water makeup. To confirm this assertion in the licensee's FIP, the staff reviewed calculations PM-1173, "PBAPS FLEX Makeup Analysis in Response to NRC Order EA-12-049," Revision 5, and PM-1184, "Evaluation of FLEX Makeup to RPV and SFP via ECT," Revision 2, during the audit process.

From the review of the hydraulic analyses, the NRC staff confirmed that the FLEX pumps were capable of providing the required capacity for RPV and suppression pool makeup. During the onsite portion of the audit, the NRC staff conducted a walk down of the deployment locations of the FLEX pumps, the connection points, and the planned hose routing. The staff was able to confirm that the licensee's strategy for FLEX pump makeup was consistent with the descriptions in the hydraulic analysis and the FIP.

Based on the licensee's FIP description, supplemented by the staff's audit review of the hydraulic analyses, the NRC staff concludes that the portable FLEX pumps should perform as intended to support core cooling and RPV inventory control during an ELAP event, consistent with the provisions of NEI 12-06, Section 11.2.

3.2.3.6 Electrical Analyses

The licensee's electrical strategies provide power to the equipment and instrumentation used to mitigate the postulated event. The electrical strategies described in the FIP are integrated for maintaining or restoring the critical functions of core cooling, containment, and SFP cooling. Any function-specific considerations for containment and SFP cooling are noted in Sections 3.3.4.4 and 3.4.4.4 of this safety evaluation.

According to the licensee's FIP, operators would enter the FSGs following a loss of offsite power, emergency diesel generators (EDGs), and the station blackout (SBO) line with a confirmation of no imminent return of any of those power sources. The plant's indefinite coping capability is attained through the implementation of pre-determined FLEX strategies that are focused on maintaining or restoring key plant safety functions. A safety function-based approach provides consistency with, and allows coordination with, existing plant emergency operating procedures (EOPs).

During the first phase of an ELAP event, the licensee would rely on the safety-related Class 1E batteries to provide power to key instrumentation and applicable DC components. The Peach Bottom Class 1E station batteries and associated DC distribution systems are located within safety-related structures designed to meet applicable design-basis external hazards. The licensee's procedures direct operators to conserve DC power during the event by stripping non-essential loads. Operators will strip or shed unnecessary loads to extend battery life until backup power is available (Phase 2). The plant operators would commence load shedding of the station batteries within 15 minutes and complete load shedding within 1.5 hours from the onset of the event.

As part of the mitigating strategies, the licensee is crediting the Division I Class 1E 125/250 VDC batteries (2AD01/2CD01 and 3AD01/3CD01). These batteries were manufactured by Exide Technologies and are model GN-23 with a nominal capacity of 1800 ampere-hours (AH). In its FIP, the licensee stated the station batteries could cope for at least 7.25 hours.

During the audit process, the NRC staff reviewed the licensee's DC coping calculation PE-0140, "Class 1E 125/250V DC System What If Cases," Revision 13, which verified the capability of the DC system to supply power to the required loads during the first phase of the FLEX mitigation strategy. The licensee's calculation identified the required loads and their associated ratings (ampere (A) and minimum required voltage) and the non-essential loads that would be shed within 1.5 hours to ensure battery operation for at least 7.25 hours. Based on its review of the licensee's calculation, the NRC staff found that the Division I Class 1E batteries should have sufficient capacity to supply power for at least 7.25 hours. Further, based on its review of the licensee's analyses and procedures, and the battery vendor's capacity and discharge rates for the Class 1E station batteries, the NRC staff finds that the Peach Bottom DC systems have adequate capacity and capability to power the loads required to mitigate the consequences during Phase 1 of an ELAP, provided that necessary load shedding is completed within the times assumed in the licensee's analyses.

The licensee's Phase 2 strategy includes repowering the Class 1E battery chargers within 7 hours after initiation of an ELAP to maintain availability of instrumentation to monitor key parameters. The licensee's Phase 2 strategy relies on one portable 500 kW, 480 Vac, FLEX DG per unit. The licensee has a total of three 480 VAC 500 kW FLEX DGs to satisfy the "N+1" provision of NEI 12-06. The 480 VAC FLEX DGs, once deployed, would provide power to 125/250 VDC battery chargers, and other selected loads.

During the audit process, the NRC staff reviewed licensee calculation PE-0301, "FLEX Electrical Loading and Voltage Drop," Revision 0, conceptual single line diagrams, and the separation and isolation of the FLEX DGs from the EDGs. Based on the NRC staff's review of PE-0301, the expected loads in Phase 2 for the 500 kW FLEX DG are 182.6 kW and 108.8 kW, for Units 2 and Unit 3, respectively. In addition, the staff notes that the licensee took the FLEX cable lengths into consideration (i.e., ensured that the voltage drop did not result in violating the minimum required voltage required at the limiting component). Based on its review of the licensee's calculation, the NRC staff finds that a single 500 kW FLEX DG per unit is adequate to support the electrical loads required for the licensee's Phase 2 strategies. During the audit the staff confirmed that licensee guidelines FSG-010-2, "Aligning FLEX Generator to Panel 2AS1061 and for Fuel Oil Transfer," Revision 1, FSG-010-3, "Aligning FLEX Generator to Panel 3BS1061," Revision 1, FSG-011-2, "Aligning FLEX Generator to Panel 2BS1061 and for Fuel Oil Transfer," Revision 0, and FSG-011-3, "Aligning FLEX Generator to Panel 3BS1061," Revision 1, provide direction for staging and connecting a FLEX DG to energize the electrical buses to supply required loads within the required timeframes.

For Phase 3, the licensee plans to continue the Phase 2 coping strategy with additional assistance provided from offsite equipment/resources. The offsite electrical equipment that will be provided by the NSRC includes four (two per unit) 1-megawatt (MW) 4160 VAC CTGs, two (one per unit) 1100 kW 480 VAC CTGs, and distribution panels (including cables and connectors). The licensee plans to only connect the 480 VAC CTGs and not the 4160 VAC CTGs. Based on the margin available for the 480 VAC CTGs, the NRC staff finds that the 480 VAC CTGs being supplied from the NSRCs have sufficient capacity and capability to supply the required loads during Phase 3, if necessary. The staff confirmed that licensee procedure FSG-060, "Transitioning From FLEX Equipment to National SAFER Response Center (NSRC) Equipment," Revision 1, provides direction for connecting the NSRC supplied CTGs to the Peach Bottom electrical buses to supply required loads within the required timeframes, if necessary.

Based on its review, the NRC staff finds that the Class 1E station batteries should have sufficient capacity to support the licensee's strategy, and that the FLEX DGs and NSRC supplied CTGs should have sufficient capacity and capability to supply the necessary loads during an ELAP event.

3.2.4 Conclusions

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

3.3 Spent Fuel Pool Cooling Strategies

In 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 accounting for overspray). 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 2.1, strategies that have a time constraint to be successful should be identified and a basis provided that the time can be reasonably met. In 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.

In 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.

3.3.1 Phase 1

The licensee stated in its FIP that no actions are required during ELAP Phase 1 for SFP makeup because the time is sufficient to enable deployment of Phase 2 equipment. Initially, the licensee's analysis assumes a minimum water level in the SFP of 22 feet above top of the stored fuel. The licensee determined that with a full core offload boiling would begin in 2.46 hours. Once boiling starts, water level in the SFP would decrease, reaching 10 feet above the stored fuel in an additional 17 hours. Without makeup, the SFP level could reach the top of the fuel assemblies approximately 35 hours after the event initiates. Thus, the licensee's strategy is to begin providing makeup water to the SFPs within 12 hours of the event initiation. In Phase 1, the licensee will monitor SFP water level using reliable SFP level instrumentation installed per Order EA-12-051.

3.3.2 Phase 2

During Phase 2, the licensee's FIP states that the portable FLEX pump will be connected and available to supply SFP makeup within 12 hours of event initiation. Similar to the core cooling strategy, the FLEX pump will take suction from the ECT or the UHS. The SFP makeup equipment will be stored in the Robust FLEX Building and storage lockers in a stairwell outside the refuel floor of the Reactor Building. The operators will be directed by the applicable FSG to deploy hoses in the refuel floor area of the Reactor Building within 5.5 hours after ELAP event initiation, in advance of high dose rates or temperatures. The licensee's plan will provide the required flow by direct injection or by using spray. The mechanical connections for SFP makeup are described in Section 3.7.3.1 of this safety evaluation.

3.3.3 Phase 3

The FIP states that SFP cooling can be maintained indefinitely using the makeup strategies described in Phase 2 above. However, NSRC equipment would be available during Phase 3 for additional defense in depth.

3.3.4 Staff Evaluations

3.3.4.1 Availability of Structures, Systems, and Components

3.3.4.1.1 Plant SSCs

Condition 6 of NEI 12-06, Section 3.2.1.3, states that permanent plant equipment contained in structures with designs that are robust (as defined in NEI 12-06, Appendix A) with respect to seismic events, floods, and high winds, and associated missiles, are available. In addition, Section 3.2.1.6 states that the initial SFP conditions are: (1) all boundaries of the SFP are intact, including the liner, gates, transfer canals, etc., (2) although sloshing may occur during a seismic event, the initial loss of SFP inventory does not preclude access to the refueling deck around the pool, and (3) SFP cooling system is intact, including attached piping.

The licensee's FIP indicates that water level in the SFP would decrease to 10 feet above the stored within approximately 20 hours, assuming the maximum heat load conditions possible (full core offload). The licensee's sequence of events timeline in the FIP indicates that operators will deploy SFP cooling equipment in the Reactor Building within 5.5 hours after ELAP occurs to ensure the SFP area remains habitable for personnel entry. During the audit process, the staff confirmed that the licensee's makeup flow analysis, PM-1173, "PBAPS FLEX Makeup Analysis in Response to NRC Order EA-12-049," Revision 5, contained assumptions and results consistent with the description in the FIP. In addition, the staff reviewed the ELAP implementing procedure SE-11, "Extended Loss of AC Power (ELAP) – Sheet 6," Revision 18, and confirmed that the licensee would take actions to route hoses in the area of the SFP early in the event, consistent with the FIP description.

As described in the licensee's FIP, the Phase 1 SFP cooling strategy does not require any operator actions. However, as described in its FIP, the licensee does establish a ventilation path in the SFP area. The operators are directed to open designated doors and hatches in the Reactor Building(s) to establish natural convective cooling. During the audit process, the staff reviewed licensee procedure SE-11 to confirm that steps to establish secondary containment natural circulation are performed within 1 hour (high priority if a high decay heat load in the SFP is present).

The licensee's Phase 2 and Phase 3 SFP cooling strategy involves the use of the FLEX pump (or an NSRC-supplied pump for Phase 3), with suction from the ECT or UHS, to supply water to the SFP. The staff notes that the licensee has provisions for all of the methods of SFP makeup described in NEI 12-06 (direct makeup via hose, makeup via installed piping, and spray). The staff confirmed that the applicable FSGs direct operators to complete hose runs and staging of equipment needed for SFP makeup consistent with the FIP description. Thus, the staff concludes that the licensee has established provisions for SFP makeup in accordance with NEI 12-06, Revision 0, as endorsed. The staff's evaluation of the robustness and availability of the FLEX connection points and water sources (ECT and UHS) is discussed in Sections 3.7.3.1 and 3.10 of this safety evaluation, respectively.

3.3.4.1.2 Plant Instrumentation

In its FIP, the licensee stated that the instrumentation for SFP level will meet 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 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 safety evaluation.

3.3.4.2 Thermal-Hydraulic Analyses

As described in FIP Section 2.5.6, at the maximum design heat load, the SFP will boil in approximately 2.46 hours and water level will decrease to a level of 10 feet above the spent fuel racks in 17 hours from the start of boiling, assuming no operator action. Based on the anticipated boil-off rate, the licensee conservatively determined that a SFP makeup flow rate of 122 gpm (250 gpm would be provided for SFP spray) will maintain adequate SFP level. Since the licensee evaluates the worst case full core offload scenario in its FIP, the NRC staff finds the licensee has considered the maximum design-basis SFP heat load, consistent with the guidance in NEI 12-06, Section 3.2.1.6.

3.3.4.3 FLEX Pumps and Water Supplies

In Section 2.3.7.1 of its FIP, the licensee stated that calculations to verify that the capability of the FLEX pump(s) to deliver the required makeup flow for each configuration were performed. As described above, the FLEX pump is the same pump used for RPV and suppression pool makeup, and the staff confirmed during the audit process that the licensee's calculations reflected simultaneous makeup to the required delivery location(s). The NRC staff also confirmed that the performance criteria of the pump supplied by the NSRC for Phase 3 would provide a comparable capability to the licensee's FLEX pump, thus ensuring that the SFP makeup capability would be maintained if it was necessary to use the NSRC-supplied pump. Finally, the staff concludes that the licensee's capability for SFP spray, with a flow rate of 250 gpm for each unit, meets the spray provisions of NEI 12-06, Revision 0, and is therefore acceptable.

3.3.4.4 Electrical Analyses

The licensee's mitigating strategies for SFP cooling do not rely on electrical power, except for power to SFP level instrumentation. The capability of this instrumentation is described in Section 4 of this safety 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

Guidance document 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 such approach is for a licensee to perform an analysis demonstrating that containment pressure control is not challenged. Peach Bottom has a GE BWR with a Mark I containment for both units.

According to the licensee's FIP, computer code evaluations were performed to simulate ELAP conditions for Peach Bottom. During the audit process the NRC staff reviewed the licensee's containment evaluation, PB-MISC-010, "MAAP Analysis to Support FLEX Initial Strategy," Revision 0. According to the licensee, the analysis was based on the boundary conditions described in Section 2 of NEI 12-06. The calculation included modeling of the anticipatory containment venting element of the licensee's strategy. The calculation concluded that the containment parameters of pressure and temperature remain well below the respective UFSAR Section 5.2, Table 5.2.1 design limits (Drywell and Suppression Chamber) of 62 psig and 281°F for more than 72 hours. The NRC staff reviewed the licensee's evaluation and notes that actions to maintain containment capability and the required instrumentation functions have been developed, and are summarized below.

3.4.1 Phase 1

According to the licensee's FIP, during Phase 1, primary containment capability is maintained by normal design features of the containment, such as the containment isolation valves. Procedures are in place to maintain containment pressure within design limits. Monitoring of containment pressure and temperature will be available in the MCR via installed plant instrumentation powered by the safety-related batteries and safety-related uninterruptable power supplies (UPSs). The RCIC is used to inject water to the RPV following the ELAP event onset. The RCIC will remove decay heat energy from the RPV and pump water to the RPV with the turbine exhaust returning to the suppression pool. The energy deposited to the containment is from radiative heat transfer of the RPV and connected piping, leakage from the reactor recirculation pump seals, RPV SRV discharge to the suppression pool, RCIC turbine exhaust to the suppression pool, and other sources of leakage. The RCIC will continue to operate while the containment continues to heat up and pressurize. The torus is vented via the Hardened Containment Vent System (HCVS) to remove decay heat from the containment and to prevent suppression pool temperature from exceeding 250°F. The HCVS will be opened when containment pressure reaches 2 psig (approximately 1 hour into the event) and remain open to control containment pressure and temperature to support continued operation of RCIC for core cooling. Suppression pool water level will be maintained as directed by EOP's using the FLEX Pump(s). The FLEX Pump(s) will be ready for suppression pool makeup within 12 hours from event onset.

3.4.2 Phase 2

In Phase 2, containment capability is maintained by normal design features of the containment and by venting the torus using the HCVS. Suppression pool temperature will be limited by controlling torus pressure because the torus is in a saturated condition. Monitoring of containment pressure and temperature will be available in the MCR via installed plant instrumentation powered by the safety-related batteries and safety-related UPSs. These batteries, and subsequently the UPSs, are maintained in Phase 2 by deployment of FLEX DGs.

The strategy of venting of the torus maintains the suppression pool temperature within the limits assumed for the RCIC pump/turbine operation. Therefore, RCIC survivability is not threatened. The saturation pressure of the water temperature corresponding to the RCIC turbine/pump temperature limit is well below the maximum design pressure for containment assuring that the integrity of the containment is not challenged. In addition, FLEX pump(s) will be ready for injection to the RPV and/or for suppression pool makeup at 12 hours from event onset.

3.4.3 Phase 3

The Phase 3 philosophy is to maintain the Phase 2 strategy using offsite equipment to replace or supplement FLEX equipment. Actions to reduce containment temperature and pressure and to ensure continued functionality of the key parameters will utilize existing plant systems and those restored by off-site equipment and resources.

3.4.4 Staff Evaluations

3.4.4.1 Availability of Structures, Systems, and Components

The baseline assumptions of NEI 12-06 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

Containment

The primary containment design for Peach Bottom, Units 2 and 3 is a GE Mark 1 pressure suppression containment. The primary containment houses the RPV, the reactor coolant recirculation systems, and other primary system piping. The primary containment system consists of a drywell, a pressure suppression chamber which stores a large volume of water, a connecting vent system between the drywell and the suppression chamber, isolation valves, vacuum breakers, containment cooling systems, and other service equipment. According to the Peach Bottom UFSAR, the primary containment (drywell and suppression chamber) is designed for a maximum internal pressure of 62 psig coincident with a maximum temperature of 281°F.

Suppression Chamber Vent

According to the licensee's FIP, the HCVS has been installed to meet the requirements of NRC Order EA-13-109, "Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions." The Peach Bottom UFSAR, Section 5.2.3.6, states that the primary containment has been provided with a hardened (pipe) vent from the torus [suppression chamber] vapor space to the atmosphere. The vent is sized to exhaust sufficient steam to prevent the containment pressure from exceeding the primary containment pressure limit (PCPL) of 60 psig with a constant heat input equal to 1 percent of the rated thermal power. The direct hardened vent from the torus bypasses the standby gas treatment system. The hardened vent is a 16 inch line that is installed between the primary containment isolation valves. A 16 inch butterfly valve and a rupture disc are installed in the vent line. The valve serves as a primary containment outboard isolation barrier while the rupture disc precludes the occurrence of secondary containment bypass leakage. The rupture disc has a burst pressure of 30 psig, which is above the maximum calculated pressure that could result from leakage through the valve. If anticipatory venting is desired, the operational sequence includes breaching the rupture disc with an argon compressed gas source.

The provisions of Order EA-13-109 require that the HCVS be designed consistent with the design basis of the plant, up to and including the second containment isolation barrier, and that all other components be designed for reliable and rugged performance that is capable of ensuring functionality following a seismic event. The Peach Bottom HCVS components, other than the discharge pipes for each unit, are located within fully protected structures. The discharge vent pipes are routed up the outside of each unit's Reactor Building structure. Based on the compliance with Order EA-13-109 provisions, as described in the FIP, and location within the Reactor Building, the staff concludes that the HCVS components other than the discharge vent pipes external to the Reactor Building are robust as defined in NEI 12-06, Appendix A. Consistent with Order EA-13-109, the discharge vent pipes are installed to seismic standards applicable to the Peach Bottom site and are also designed to remain functional when subject to 300 mph tornado winds. However, the vent pipes external to the Reactor Buildings are not specifically designed to resist the site's design-basis tornado missile impact loading. During the audit process for Order EA-13-109, the NRC staff reviewed the licensee's analysis addressing this issue, ARA-002611, "Tornado Missile TORMIS Analysis," Revision 0. In addition, the licensee has established compensatory measures in the unlikely event that one or both of the vent pipes are crimped closed by a tornado missile impact. The staff's audit report for Peach Bottom Order EA-13-109 [Reference 55] documents this review. The results of the missile analysis and the availability of compensatory measures for potential vent pipe crimping are also documented in the licensee's fifth six-month update for Order EA-13-109 [Reference 56]. Based on the licensee's FIP description and the fifth six-month update for Order EA-13-109, supplemented by the Order EA-13-109 audit review, the staff concludes the licensee has demonstrated that the HCVS discharge piping has reasonable protection from external events, as specified in Order EA-12-049, and would therefore be available following an ELAP event.

3.4.4.1.2 Plant Instrumentation

In NEI 12-06, Table 3-1 specifies that containment pressure, suppression pool level, and suppression pool temperature are key containment parameters, which should be monitored by repowering the appropriate instruments. The licensee's FIP states that MCR instrumentation will be available due to the coping capability of the station batteries and associated inverters in Phase 1, or with the FLEX DGs deployed in Phase 2.

The following instrumentation providing key parameters is credited for all phases of the containment capability strategy:

Drywell Pressure
Drywell Temperature
Suppression Pool Temperature
Suppression Pool Level

If no AC or DC power was available, the FIP states that key credited plant parameters, including these containment parameters, would be available using alternate methods. Specifically, an FSG specifies these alternate methods for obtaining critical parameters if key instrumentation is unavailable.

Based on this information, the NRC staff concludes that 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

Calculation PB-MISC-010, "MAAP Analysis to Support Initial FLEX Strategy," Revision 6, uses the MAAP 4.0.6 computer code to evaluate the plant response to various scenarios. The analysis assumes the reactor has been operating for 100 days at 100 percent power, RCIC is started automatically and operates with suction from the suppression pool. The reactor coolant system leakage is assumed to be 42 gpm at onset of event. As discussed in Section 3.2.3.3 of this safety evaluation, 42 gpm is an acceptable assumed leakage rate for this analysis.

The analysis determined that with a 16-inch diameter vent, opened when the suppression pool reaches 200°F (approximately 1 hour into the event), the peak suppression pool temperature reaches 221°F, the peak suppression chamber air space temperature is 241°F and its pressure is 25 pounds per square inch absolute (psia), and the drywell reaches 256°F and has a peak pressure of 24.9 psia.

The NRC staff reviewed the evaluation and verified that the containment remains below the maximum drywell and wetwell pressure limit of 62 psig and the temperature limit of 281°F as shown in UFSAR Table 5.2.1 and thus concludes that the licensee's strategy will maintain the containment function under the postulated sequence of events.

3.4.4.3 FLEX Pumps and Water Supplies

FLEX pumps and water supplies are utilized to maintain water inventory in the RPV, and also support maintenance of the containment function. Section 3.2.3.5 of this safety evaluation provides an explanation of the FLEX pumps and water supplies.

3.4.4.4 Electrical Analyses

The licensee performed a containment evaluation based on the boundary conditions described in Section 2 of NEI 12-06. Based on the results of its evaluation, the licensee developed required actions to ensure the maintenance of containment capability and ensure that the required instrumentation continues to function.

The licensee's Phase 1 coping strategy is to monitor containment pressure and temperature using installed instrumentation, and maintain containment capability using normal design features of the containment, such as the containment isolation valves, as well as the HCVS. The licensee's strategy to repower instrumentation using the Class 1E station batteries is described in Section 3.2.3.6 of this safety evaluation and is adequate to ensure continued containment monitoring.

The installed HCVS has a dedicated 125 VDC battery for each unit. The dedicated 125 VDC HCVS batteries would supply power for a minimum of 24 hours to solenoid valves, instrumentation, and other HCVS loads. During the audit process, the NRC staff reviewed licensee calculation PE-0308, "HCVS Battery Sizing and Selection," Revision 1, which evaluated the battery/battery charger sizing and device terminal voltages for the 125 VDC HCVS system. The results of the calculation showed that the 125 VDC battery is adequately sized to supply power to the HCVS for 24 hours following an ELAP.

The licensee's Phase 2 coping strategy is to continue monitoring containment pressure and temperature using installed instrumentation and maintaining containment capability. The licensee's strategy to repower instrumentation using a 500 kW FLEX DG is identical to what was described in Section 3.2.3.6 of this safety evaluation and is adequate to ensure continued containment monitoring. The licensee also plans to recharge the HCVS battery utilizing the FLEX DG. During the audit process the staff reviewed licensee calculation PE-0301, "FLEX Electrical Loading and Voltage Drop," Revision 0C Minor, which showed that the addition of the HCVS battery charger is within the limit of the FLEX DG. The licensee would transition to Phase 2 prior to depleting the HCVS battery (i.e., within 24 hours). The staff confirmed that licensee guidelines FSG-010-2/3 and FSG-011-2/3 provide guidance to place the HCVS battery charger in service and power them from the FLEX DG.

The licensee's Phase 3 strategy is to continue its Phase 2 strategy throughout the event. Peach Bottom will receive offsite resources and equipment, including large CTGs, from an NSRC. Given the capacity of these CTGs, the NRC staff finds that it is reasonable to expect that the licensee could utilize these resources to supply power to the HCVS components to maintain the containment function indefinitely. The staff confirmed that licensee guideline FSG-060, "Transitioning from FLEX Equipment to National SAFER Response Center (NSRC) Equipment," Revision 1, provides direction for connecting the NSRC supplied CTGs to the Peach Bottom electrical buses to supply power to HCVS loads within the required timeframes, if necessary.

Based on its review, the NRC staff determined that the electrical equipment available onsite (e.g., Class 1E batteries, HCVS batteries, and 500 kW FLEX DGs) as supplemented with the equipment that will be supplied from an NSRC, has sufficient capacity and capability to supply the required loads to maintain containment.

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 should adequately address the requirements of the order.

3.5 Characterization of External Hazards

Sections 4 through 9 of NEI 12-06 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 applicable site-specific external hazards 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; snow, ice and extreme cold; and extreme high temperatures.

References to external hazards within the licensee's mitigating strategies and this safety evaluation are consistent with the guidance in NEI 12-06 and the related NRC endorsement of NEI 12-06 in JLD-ISG-2012-01. Guidance document 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 Order EA-12-049, on March 12, 2012, the NRC staff issued a Request for Information under Title 10 of the *Code of Federal Regulations* Part 50, Section 50.54(f) [Reference 26] (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 draft final rule, titled "Mitigation of Beyond-Design-Basis Events," hereafter called the MBDBE rule, which was provided to the Commission for approval on December 15, 2016 [Reference 52]. The 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 Reevaluat[i]on of Flooding Hazards" [Reference 49]). The Commission provided guidance in an SRM to COMSECY-14-0037 [Reference 27]. The Commission approved the staff's recommendations that licensees would 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 impact 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 40], the NRC staff informed the licensees that the implementation of mitigation strategies should continue as described in licensee's OIPs, and that the NRC safety evaluations and inspections related to Order EA-12-049 would 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 53]. The NRC staff endorsed Revision 2 of NEI 12-06 in JLD-ISG-2012-01, Revision 1 [Reference 54]. The licensee's MSAs would evaluate the mitigating strategies described in this safety evaluation 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 safety evaluation 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 described the seismic design of Peach Bottom Seismic Class I structures. The FIP states that the design earthquake corresponds to a maximum horizontal ground acceleration of 0.05g and the Maximum Credible Earthquake (MCE) considers a horizontal ground acceleration of 0.12g. This description is also presented in the Peach Bottom UFSAR, Section 2.5.3.1.1. Based on the FIP and UFSAR descriptions, the MCE corresponds to the Safe Shutdown Earthquake (SSE), using the current NRC terminology. According to the Peach Bottom UFSAR Section 2.5.3.6.1, Seismic Class I structures are designed in accordance with the response spectra associated with the design earthquake and the MCE. It should be noted that the actual seismic hazard can be depicted as a spectral graph of the acceleration versus the frequency of the motion. Peak acceleration in a certain frequency range, such as the numbers above, is often used as a shortened way to describe the hazard.

As the licensee's seismic reevaluation activities are completed, the licensee is expected to assess the mitigation strategies to ensure they can be implemented under the reevaluated hazard conditions as will potentially be required by the proposed MBDBE rulemaking. The licensee has appropriately screened in this external hazard and identified the hazard levels to be evaluated.

3.5.2 Flooding

In its FIP, the licensee described that the current design basis for the limiting site flooding event is a regional precipitation-based event corresponding to a combination of the probable maximum flood (PMF), failure of an upstream dam, and wind-generated waves on the Susquehanna River/Conowingo Pond. As described in the FIP, the critical equipment, systems, and structures essential to a safe shutdown of the reactor are flood protected to an elevation of 135 feet to protect against this postulated design-basis event. In the UFSAR, Section 2.4.3.5.3 provides similar information stating that the 135 foot protection level provides 1 foot of freeboard for the design flood. The site grade is 116 feet and the normal level of the river is between 104 feet and 109.25 feet. The licensee also stated in the six-month update letter dated August 28, 2015 [Reference 15], that the site structures are passively protected from ground water up to an elevation of 135 feet and thus there are no provisions for AC-powered ground water mitigation in the mitigating strategies plan.

As the licensee's flooding reevaluation activities are completed, the licensee is expected to assess the mitigation strategies to ensure they can be implemented under the reevaluated hazard conditions as will potentially be required by the draft final MBDBE rulemaking. The licensee has appropriately screened in this external hazard and identified the hazard levels to be evaluated.

3.5.3 High Winds

In 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 (Figure 3-1 of U.S. NRC, "Technical Basis for Regulatory Guidance on Design Basis Hurricane Wind Speeds for Nuclear Power Plants," NUREG/CR-7005, December, 2009); if the resulting frequency of recurrence of hurricanes with wind speeds in excess of 130 miles per hour (mph) exceeds 1E-6 per year, the site should address hazards due to extreme high winds associated with hurricanes using the current licensing basis for hurricanes. According to the licensee's FIP, based on a review of NEI 12-06 Figure 7-1, Peach Bottom is susceptible to hurricanes due to its location. The licensee's FIP also notes that winds in excess of 75 mph are rare on the site and that this is expected because the site is not affected by the full force of any hurricane.

The screening for high wind hazard associated with tornadoes should be accomplished by comparing the site location to NEI 12-06, Figure 7-2 (from U.S. NRC, "Tornado Climatology of the Contiguous United States," NUREG/CR-4461, Revision 2, February 2007); if the recommended tornado design wind speed for a 1E-6 per year probability exceeds 130 mph, the site should address hazards due to extreme high winds associated with tornadoes using the current licensing basis for tornados or Regulatory Guide 1.76, Revision 1.

In its FIP, regarding the determination of applicable extreme external hazards, the licensee stated that the site is located at 39° 45' 34" north latitude and 76° 16' 8" west longitude. In NEI 12-06 Figure 7-2, Recommended Tornado Design Wind Speeds for the 1E-6/year Probability Level indicates the site is in a region where the tornado design wind speed exceeds 130 mph. Therefore, the plant screens in for an assessment for high winds and tornados, including missiles produced by these events. According to the Peach Bottom UFSAR, Section C.2.4, the design tornado missile is equivalent to a 4 inch thick x 12 inch wide x 12 foot long wood plank traveling end-on at 300 mph; or a 4,000-pound passenger automobile, flying through the air at 50 mph, at not more than 25 feet above ground, with a contact area of 20 square feet.

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 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, regarding the determination of applicable extreme external hazards, the licensee stated that the site is located 39° 45' 34" north latitude and 76° 16' 8" west longitude. In addition, there is a high probability of severe ice storms in the area of the site. The staff notes that Peach Bottom is located within the region characterized by EPRI as ice severity level 4 (NEI 12-06, Figure 8-2, Maximum Ice Storm Severity Maps). Thus, there is the potential for severe damage to electrical transmission lines. The licensee concludes that the plant screens in for an assessment for snow, ice, and extreme cold hazard. In its FIP, the licensee stated that FLEX equipment is protected from severe temperatures.

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

3.5.5 Extreme Heat

In the section of its FIP regarding the determination of applicable extreme external hazards, the licensee stated that, as per NEI 12-06 Section 9.2 all sites are required to consider the impact of extreme high temperatures. According to the licensee's FIP, the Peach Bottom UFSAR states that there are occasional readings above 90°F in the summer. The licensee also states that the FLEX DG radiator design is based on a 104°F ambient temperature. Based on the provisions of NEI 12-06, the plant site screens in for an assessment for extreme high temperature hazard.

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 fifth six-month update dated August 28, 2015 [Reference 15], Exelon described the proposed Peach Bottom FLEX storage plan. Exelon described the storage configuration as an alternative to NEI 12-06, Revision 0. The proposal is as follows:

> Exelon proposes an alternate approach to NEI 12-06, Revision 0 for protection of FLEX equipment as stated in Section 5 (seismic), Section 7 (severe storms with high winds) and Section 8 (impact of snow, ice and extreme cold). This alternate approach will be to store "N" sets of equipment in a fully robust building and the +1 set of equipment in a commercial building. For all hazards scoped in for the site, the FLEX equipment will be stored in a configuration such that no one external event can reasonably fail the site FLEX capability (N). To ensure that no one external event will reasonably fail the site FLEX capability (N), Exelon will ensure that N equipment is protected in the robust building. To accomplish this, Exelon will develop procedures to address the unavailability allowance as stated in NEI 12-06, Revision 0, Section 11.5.3, ... This section allows for a 90-day period of unavailability. If a piece of FLEX equipment stored in the robust building were to become or found to be unavailable, Exelon will impose a shorter allowed outage time of 45 days. For portable equipment that is expected to be unavailable for more than 45 days, actions will be initiated within 24 hours of this determination to restore the site FLEX capability (N) in the robust storage location and implement compensatory measures (e.g., move the +1 piece of equipment into the robust building) within 72 hours where the total unavailability time is not to exceed 45 days. Once the site FLEX capability (N) is restored in the robust storage location, Exelon will enter the 90-day allowed out of service time for the unavailable piece of equipment with an entry date and time from discovery date and time.

Exelon's letter dated August 28, 2015, further described the maintenance and test features of the alternative storage plan.

The Peach Bottom FIP did not describe this alternative storage provision. Using the audit process, the staff reviewed the Peach Bottom program plan CC-PB-118, "Peach Bottom Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program," Revision 5, and recognized that the current storage arrangement at the site includes storing all of the site FLEX equipment, including the "N+1" equipment, in the robust storage building. Thus, the site is not currently using the "N+1" storage building in support of the mitigating strategies plan. The staff notes that storing all equipment in a fully robust storage building meets the storage provisions of NEI 12-06, Revision 0, and is therefore acceptable. In addition, should the site reactivate the "N+1" building for FLEX use, it would also be an acceptable as an alternative storage plan as long as it meets the provisions discussed in Section 3.14.2 of this safety evaluation, including the maintenance and test features.

In the licensee's FIP, the robust storage building is described as a single hardened structure of approximately 8,400 square feet that will meet the requirements for the external events identified in NEI 12-06, such as earthquakes, storms (high winds, and tornado missiles), extreme snow, ice, extreme heat, and cold temperature conditions. The robust storage building is located outside the Protected Area fence north of the Peach Bottom warehouse complex and east of the Low Level Radwaste Storage Building. According to the FIP there is some FLEX equipment stored in other robust plant buildings such as the Reactor Buildings and the Radwaste Building.

Since the robust storage building is located at the plant grade and is below the postulated flood elevation, the Peach Bottom FLEX plan allows for deployment of FLEX equipment to a higher elevation before water levels affect the FLEX Building. The licensee would use the projected flood warning time to accomplish this pre-deployment.

In summary, according to the licensee's FIP, all equipment credited for implementation of the FLEX strategies at Peach Bottom is either stored in the Robust FLEX Building or in a plant structure that is considered to be robust.

3.6.1.1 Seismic

The Robust FLEX Building is designated as a Seismic Category I structure. According to the licensee's FIP, large FLEX portable equipment such as pumps, generators, fuel trailers, hose trailers, tractors, and trucks are secured with tie-down straps to floor anchors inside the Robust FLEX Building to protect them during a seismic event. The Robust FLEX Building anchors are integrated into the floor slab.

3.6.1.2 Flooding

The top of the slab (floor elevation) of the robust storage building is at an elevation of 118.5 feet, which is below the evaluated flood hazard maximum probable flood elevation of 127.49 feet in that area of the site. According to NEI 12-06, Section 6.2.3.1.c equipment can be stored below the flood level if time is available and plant procedures/guidance address the needed action to relocate the equipment.

During the audit process, the staff reviewed procedure SE-4, "Flood," Revision 42, and FSG-003, "Pre-staging FLEX Equipment," Revision 0, to confirm that the FLEX equipment is pre-deployed in advance of a flood impacting the Robust FLEX Storage Building. Thus, the staff concludes that the licensee meets the provisions of NEI 12-06, Section 6.2.3.1.c, and the protection and deployment plan for the flooding event is acceptable.

3.6.1.3 High Winds

According to the licensee's FIP, the robust storage building is protected against high wind (hurricane and tornado) loading and associated missiles. Thus, the staff concludes that the licensee meets the provision of Section 7.3.1.1.a of NEI 12-06. The debris removal and deployment vehicles are stored in the robust storage building and thus should be protected from high winds and available to support FLEX strategy deployment.

3.6.1.4 Snow, Ice, Extreme Cold and Extreme Heat

According to the licensee's fifth six-month update, storage of FLEX equipment should account for the fact that the equipment will need to function in a timely manner. The equipment should be maintained at a temperature within a range to ensure its likely function when called upon by means such as storage in a heated enclosure or by direct heating (e.g., jacket water, battery, engine block heater, etc.). According to the licensee's FIP, the Robust FLEX Building is temperature controlled.

3.6.1.5 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 should adequately address the requirements of the order.

3.6.2 Availability of FLEX Equipment

Section 3.2.2.16 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 additional 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 (e.g., a single pump capable of all water supply functions for a dual unit site). In this case, the "N+1" could simply involve a second pump of equivalent capability. 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.

Table 2 of the FIP lists the FLEX portable equipment stored onsite as well as the quantities (except for hoses and cables), and functional uses. This includes the major pumps and generators referred to in the descriptive portions of the FIP. It also includes tow and debris removal vehicles, and other miscellaneous support equipment. In its FIP, the licensee stated that for hoses and cables required for FLEX strategies, an alternate approach to meet the "N+1" capability stated in Section 3.2.2 of NEI 12-06, Revision 0, has been selected. This alternative approach is discussed in Section 3.14.1 of this safety evaluation.

In its FIP, the licensee indicated that to ensure readiness of FLEX equipment and support equipment, periodic maintenance and testing will be performed. In addition, the unavailability of FLEX equipment will be administratively controlled such that risk to the mitigating strategy capability is minimized.

Based on the number of portable FLEX pumps, FLEX DGs, and support equipment identified in the FIP and during the audit review, the NRC staff finds that, if implemented appropriately, the licensee's FLEX strategies include a sufficient number of portable FLEX pumps, FLEX DGs, and equipment for RPV makeup, SFP makeup, and maintaining containment consistent with the "N+1" recommendation in Section 3.2.2.16 of NEI 12-06, with the exception of hoses and cables. For hoses and cables, the licensee is proposing an alternative approach that is discussed in Section 3.14.1 of this safety evaluation.

3.7 Planned Deployment of FLEX Equipment

According to the licensee's FIP, pre-determined haul paths have been identified and documented in an FSG. In addition, the FSG shows the haul paths from the FLEX Storage Building to the various deployment locations. The licensee's FIP also indicates that these haul paths are checked for possible obstructions in another FSG.

3.7.1 Means of Deployment

According to the licensee's FIP, debris removal equipment such as the FLEX tractors are stored inside the Robust FLEX Building in order to be reasonably protected from external events such that the equipment will remain functional and deployable to clear obstructions from the pathway between the Robust FLEX Building and its deployment location(s). The primary deployment vehicles are the FLEX tractors and the F-750 truck. In addition, supplemental FLEX debris removal hand tools such as tow chains, chainsaws, demolition saw, axes, sledgehammer, and bolt cutters are also available. The license's fifth six-month update also indicates that a BROCO torch will be available for quick metal cutting. According to the license's FIP, deployment of the FLEX debris removal equipment from the Robust FLEX Building is not dependent on off-site power. All actions required to access and deploy debris removal equipment and FLEX equipment can be accomplished manually.

3.7.2 Deployment Strategies

According to the licensee's FIP, the Robust FLEX Building incorporates multiple access doors for equipment deployment. The equipment is stored in a manner to facilitate the deployment sequence. Deployment paths and staging areas are contained in the snow removal plan.

For a flooding event, deployment is accomplished ahead of the flood waters impacting the robust storage building, located at the site grade elevation. Licensee procedures are established to deploy equipment from the robust storage building during the flood warning time. According to the license's FIP, the flood warning time would be at 49.5 hours, based on the reevaluated flood hazard performed under the 50.54(f) letter [Reference 26]. During the audit process, the staff reviewed features of the licensee's design-basis flood as described in a report titled "Hydraulic Studies for Determination of Flood Level of Susquehanna River at Peach Bottom Atomic Power Station Under Probable Maximum Flood Conditions," dated February 1971, performed by Tippets, Abbett, McCarthy, and Stratton, Engineers and Architects (called the "TAMS Report" by the licensee in their fifth six-month update). The staff's review of this report finds that the warning time of 49.5 hours described in the licensee's FIP is a reasonable estimate for the design-basis flood, as well as the reevaluated hazard. The staff also concludes that this is sufficient warning time for the necessary pre-deployment of the FLEX equipment.

According to the license's fifth six-month update a liquefaction study has been performed which supports the deployment path and storage structure. During the audit process the staff reviewed a report from Geosystems Consultants Incorporated, titled "Geotechnical Investigation Liquefaction Potential Analysis Peach Bottom Atomic Power Station," Project No. 2013G368, dated July 2014, to confirm this assessment. The licensee has pre-determined staging locations and deployment routes for the major pieces of FLEX equipment such as the diesel-driven FLEX pump and electrical generator. The locations may vary depending on the event conditions. For a flooding event, locations have been established that are above the projected maximum flood height, with access to the necessary connections.

For deployment of the FLEX makeup pumps, the license's fifth six-month update states that the suction availability from the intake bay is protected from the weather and will not freeze immediately after shutdown following an ELAP. In addition, according to the licensee's FIP, the ECT suction is taken below the level at which surface freezing could occur. Thus, access to a liquid suction source for makeup is expected to be available.

3.7.3 Connection Points

3.7.3.1 Mechanical Connection Points

RPV and Suppression Pool Makeup

The licensee's FIP describes the RPV and suppression pool makeup connection points for the FLEX pumps. The FLEX pumps' suction is drawn from either the ECT or the UHS.

If the ECT is the selected source of makeup water, the FLEX pumps would be located near the ECT. The licensee has installed a new Seismic Class I, tornado missile protected, six-inch, tie-in line that is connected to the 24-inch ECT reservoir letdown line. This connection provides a suction source for a hose that connects to the two FLEX pumps (one per unit). The discharge of the FLEX pumps can be connected via hose to the Unit 2 "B" (2B)/Unit 3 "A" (3A) RHR loop through a new 4-inch pipe connection. These are the preferred connection points for each unit. From the RHR system, flow can be directed to the RPV, the torus, and/or the SFP. An alternate discharge routing can be made into the Unit 2 "A" (2A)/Unit 3 "B" (3B) RHR loop through a 3-inch pipe connection. Similar to the preferred flow path, makeup can be directed from the RHR system to the RPV, torus, and/or the SFP. The RHR piping and associated fittings are designed per Seismic Class I criteria and are fully protected from all external events. The licensee can also route the FLEX pump discharge to the HPSW system, connecting into the 2B(3A) loop. From HPSW, a valve lineup allows a flow path into the RHR system, which can then supply the RPV, torus, and/or SFP.

The licensee also has provisions to locate the FLEX pumps near the UHS. From this location the licensee can access the UHS water from several points with a hardened suction hose/strainer assembly. The licensee would then connect the pump discharge in the same manner as the ECT/HPSW system configuration described above.

SFP Cooling

Generally, the connections for SFP makeup using the FLEX pump are the same as described above. In addition, when the FLEX pumps are staged at the ECT location, the licensee's plan calls for a set of hoses to be run from the pumps' discharge to the SFP with the capability for direct pool makeup or spray. This hose routing would be available when utilizing both the preferred and alternate connections to the RHR system. If the licensee is using the ECT as the pump suction, but discharging into the HPSW system, the SFP makeup hose would be run from a connection on the RHR system. In this configuration, the licensee could also use the hard pipe SFP makeup lines that tie into the RHR system as described above for RPV and suppression pool makeup. If the licensee is using the UHS for the FLEX pumps' suction, SFP makeup would occur in the same manner as for the ECT/HPSW configuration. Most of the FLEX connections for the licensee's SFP makeup plan are located inside the Reactor Buildings, which are protected from all applicable external hazards. If the licensee is using the HPSW option, the connections to the HPSW system are located in the HPSW room, which is protected from all hazards except flooding.

3.7.3.2 Electrical Connection Points

During Phase 2, the licensee's FLEX strategy to re-power the station's battery chargers requires the use of a single 500 kW, 480 VAC DG per unit. The preferred FLEX DG location for each unit is at the 135' elevation just outside the unit's Reactor Building outer railroad door. If using this location, the licensee would utilize panels 2(3) AS1061 which are located inside the Reactor Buildings for each unit. The alternate FLEX DG location for each unit is at the 135' elevation west of the unit's Reactor Building. For these locations, the licensee would utilize panels 2(3) AS1062 which are mounted on the exterior west wall of each unit's Reactor Building. Each of the four connection locations and the associated cabling are equipped with quick connect fittings and are color-coded to facilitate installation. According to the FIP, the licensee has FSGs to provide direction for staging and connecting the FLEX DGs and energizing the applicable electrical buses. During the audit process, the staff confirmed that the licensee had performed checks during post modification testing to ensure that proper phase rotation will exist between the FLEX DGs and the electrical buses, as assisted by the color coding scheme.

For Phase 3, the licensee will receive four (two per unit) 1 MW 4160 VAC CTGs and two (one per unit) 1100 kW 480 VAC CTGs from an NSRC. The licensee plans to only connect the 480 VAC CTGs and not the 4160 VAC CTGs. The 480 VAC CTGs would be deployed in the vicinity of the 480 VAC FLEX DGs. During the audit process, the staff reviewed licensee guideline FSG-60, "Transitioning from FLEX Equipment to National SAFER Response Center (NSRC) Equipment," Revision 1, and confirmed that steps for performing phase rotation checks are included in the deployment instructions.

3.7.4 Accessibility and Lighting

According to the licensee's FIP, there are areas at Peach Bottom that must be accessed to implement FLEX strategies if a beyond-design-basis event occurs. Some AC power is restored when the Unit 2 and Unit 3 FLEX DGs are in operation to provide lighting in areas of the MCR, cable spread room, Radwaste Building, Turbine Building, and Unit 3 Circulating Water Pump Structure. All FSG series procedures have guidance for use of flashlights or head lamps if needed. Additional lighting is provided by use of smaller portable generators and lighting towers. In the FIP, Tables 1 and 2 show provisions for lighting associated with offsite and onsite FLEX equipment, respectively.

3.7.5 Access to Protected and Vital Areas

According to the licensee's FIP, the ability to open doors for ingress and egress, ventilation, or temporary cables/hoses routing is necessary to implement the FLEX coping strategies. With the declaration of an ELAP, security keys are issued by procedure to Operations personnel to enable access to appropriate areas and Security is contacted to support Protected Area access.

3.7.6 Fueling of FLEX Equipment

In Section 2.9.4 of its FIP, the licensee described that there are four underground EDG fuel oil storage tanks at Peach Bottom that each have about 33,000 gallons of usable fuel for a total of 132,000 gallons. The licensee described in the FIP how diesel fuel oil will be delivered to the FLEX equipment throughout the ELAP event. One option is to use a portable diesel oil transfer pump that can transfer diesel fuel oil from any of the four underground EDG fuel oil storage tanks to the F-750 truck. The F-750 truck has two diesel fuel oil tanks that hold a total of approximately 200 gallons. A second option, if available, is to use an installed fuel oil transfer pump that can transfer fuel oil from two of the four underground storage tanks. This second option would be able to supply the FLEX strategy for a minimum of 22 days.

The licensee indicated in the fifth six-month update that the fuel oil stored in the EDG storage tanks is maintained by accepted programs to meet required standards. In addition, fuel oil of diesel engine driven FLEX equipment will be periodically replaced as part of the Preventative Maintenance (PM) program. In addition, during the audit process, the NRC staff conducted an onsite walk down of the four EDG tank locations to confirm the accessibility of fuel oil during the ELAP event. Based on the FIP description and the information provided in the fifth six-month update, the NRC staff finds that the overall FLEX refueling strategy is acceptable for the Peach Bottom site.

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 should adequately address the requirements of the order.

3.8 Considerations in Using Offsite Resources

3.8.1 Peach Bottom SAFER Plan

The industry has collectively established the needed off-site capabilities to support FLEX Phase 3 equipment needs via the SAFER Team. The SAFER team consists of the Pooled Equipment Inventory Company (PEICo) and AREVA Inc. and provides FLEX Phase 3 management and deployment plans through contractual agreements with every commercial nuclear operating company in the United States.

There are two NSRCs established to support nuclear power plants in the event of a BDBEE. Each NSRC holds five sets of equipment, four of which will be able to be fully deployed to the plant when requested. The fifth set allows removal of equipment from availability to conduct maintenance cycles. In addition, the plant's FLEX equipment hose and cable end fittings are standardized with the equipment supplied from the NSRC.

By letter dated September 26, 2014 [Reference 28], the NRC staff issued its assessment of the NSRCs established in response to Order EA-12-049. In its assessment, the 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.

During the audit process, the NRC staff reviewed the Peach Bottom SAFER plan and noted that it contains: (1) SAFER control center procedures, (2) NSRC procedures, (3) logistics and transportation procedures, (4) staging area procedures, which include travel routes between staging areas to the site, (5) guidance for site interface procedure development, and (6) a listing of site-specific equipment (generic and non-generic) to be deployed for FLEX Phase 3.

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 available, which are offsite areas (within about 25 miles of the plant) utilized for receipt of ground transported or airlifted equipment from the NSRCs. From Staging Areas "C" and/or "D", the SAFER team will transport the Phase 3 equipment to the on-site Staging Area "B" for interim staging prior to it being transported to the final location in the plant (Staging Area "A") for use in Phase 3. Though not mentioned in the FIP, the Peach Bottom SAFER plan specifies the Martin State Airport as the primary Staging Area "D". This airport is approximately 44 miles from the site. Staging Area "C" is the Coatesville EOF Parking lot, approximately 46 miles from the site. Staging Area "B" is the onsite blast area east of the warehouse at the Peach Bottom site. For a flood event, Staging Area "B" would be near the "N+1" storage building. Staging Area "A" corresponds to the various deployment locations for the FLEX equipment, in the vicinity of the applicable plant buildings.

Use of helicopters to transport equipment from Staging Area "C" to Staging Area "B" is recognized as a potential need within the SAFER Plan and is provided for.

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 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 Peach Bottom, ventilation that provides cooling to occupied areas and areas containing required equipment will be lost. Per the guidance given in NEI 12-06, FLEX strategies must be capable of execution under the adverse conditions (unavailability of installed plant lighting, ventilation, etc.) expected following a BDBEE resulting in an ELAP. In addition, NEI 12-06 states that a basis should be provided for the capability of the [FLEX] equipment to continue to function regarding the extreme environments that may be posed.

The primary concern with regard to ventilation is the heat buildup, which occurs with the loss of forced ventilation in areas that continue to have heat loads. The licensee performed a loss of ventilation analysis to quantify the maximum steady-state temperatures expected in specific areas related to FLEX implementation to ensure that the environmental conditions remain acceptable and within equipment qualification and design limits.

The key areas identified by the licensee for all phases of execution of the FLEX strategy activities are the MCR, battery rooms, emergency switchgear rooms (ESRs), RCIC pump rooms, and containment. The licensee evaluated these areas to determine the temperature profiles following the postulated event. The results of the licensee's room heat-up evaluations have concluded that temperatures remain within acceptable limits for all rooms/areas using passive and active means of ventilation.

Main Control Room

The licensee's FIP describes the actions that the operational staff will take to establish ventilation during an ELAP event. During the audit process the staff reviewed licensee calculation PM-1031, "Peach Bottom Control Room Temperature Analysis – Fire Safe Shutdown," Revision 1, which modeled the transient temperature response in the MCR following a fire safe shutdown event. The staff also reviewed the licensee's program plan, CC-PB-118, "Peach Bottom Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program," Revision 5, which assesses environmental conditions in the applicable FLEX operational areas. According to the licensee's program plan, the conditions of calculation PM-1031 bound the conditions that would be present in a loss of power event. In particular, the heat load assumed in the analysis bounds the expected heat load that would be present in the MCR with a loss of AC power. The calculation determined that the maximum MCR temperature would be 112.7°F. The temperature cycled between 103°F and 112°F during the transient, varying with the daily diurnal temperature fluctuations. The calculation modeled a 72 hour timeframe, and assumes that selected Turbine Building doors are opened approximately 5 hours into the event along with ventilating the MCR with a portable fan. The calculation also assumes that the MCR emergency ventilation supply fan is powered by 10 hours into the event, using the FLEX DG. The staff reviewed guideline FSG-030, "Establishing Control Room Ventilation and Lighting," Revision 1, to confirm that it provides guidance to establish portable ventilation and open doors as well as steps to run the emergency ventilation supply fan after the FLEX DG is in service. In its FIP, the licensee stated that MCR ventilation would begin at 5.5 hours into the event, reasonably consistent with the analysis, and the FLEX DG will be in service within 7 hours, potentially allowing the installed emergency supply fan to be in operation in advance of the assumptions of the analysis.

The staff concludes that the licensee's plan should maintain the MCR temperatures consistent with the analysis. Based on MCR temperature remaining below 120°F (the temperature limit for electronic equipment to be able to survive indefinitely, identified in NUMARC-87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," Revision 1, as endorsed by NRC Regulatory Guide 1.155), the NRC staff expects that the electrical equipment in the MCR should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Class 1E Battery Rooms

According to the licensee's FIP, establishing battery room ventilation is commenced at 6 hours into the event. The FIP also states that the licensee's plan has provisions for opening doors and operating a small portable fan powered by a small portable generator to ventilate the room. In addition, the emergency battery room ventilation supply fan can be operated once the FLEX DG is placed in service. During the audit process the staff reviewed calculation PM-1186, "Division 1 Battery Room Transient Temperature Profile During ELAP," Revision 1, which modeled the transient temperature response for 72 hours and determined what actions are needed to maintain operability of the equipment in the rooms. The licensee's calculation determined that during extreme heat conditions the battery room would reach a peak temperature of 108°F at 6 hours and would drop to 94°F when battery room ventilation is restored via the FLEX DG. Battery room temperature would then oscillate between 108°F and 94°F as a result of the diurnal cycle. The staff notes that the licensee's analysis assumes the portable fans are placed in service at 6 hours; however, the FLEX DG capable of powering the battery room fans is not projected to be placed in service until 7 hours. Based on the battery room temperature trends evident in the calculation, the staff concludes that the room temperatures would remain within limits even if the fans are not running until the 7 hour point. The staff also reviewed guideline FSG-031, "Establishing Battery Room and Switchgear Room Ventilation," Revision 0, and confirmed that it provides guidance for restoring battery room ventilation after the FLEX DG is placed in service or, if normal battery room ventilation cannot be restored, applicable doors and portable ventilation are established.

Based on the above, the NRC staff finds that the licensee's ventilation strategy (restoring normal ventilation or, alternatively, establishing portable ventilation and opening doors) should maintain battery room temperature below the maximum temperature limit (120°F) of the batteries, as specified by the battery manufacturer (Exide Technologies). Therefore, the NRC staff finds that the electrical equipment located in the battery rooms will not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Emergency Switchgear Rooms (ESRs)

Similar to the battery room evaluation, the licensee's calculation PM-1186, "Division 1 Battery Room Transient Temperature Profile During ELAP," Revision 1, models the transient temperature response for 72 hours in the ESRs and determined what actions are needed to maintain operability of the equipment in the rooms. The licensee calculation determined that during extreme heat conditions, the ESRs would reach a peak temperature of 108°F at 6 hours. At 6 hours, operators would open the ESR doors and flow would be established as a result of battery room ventilation being restored. At 8 hours additional ventilation would be provided by a portable 7500 cubic feet per minute fan. The ESR temperature would then oscillate between 108°F and 114°F as a result of the diurnal cycle. Similar to the battery rooms, the NRC staff concludes that the possibility that the FLEX DG would not be available until 7 hours does not appear to result in unacceptable temperatures in the ESRs, based on the temperature trend plots. The staff confirmed that guideline FSG-031, "Establishing Battery Room and Switchgear Room Ventilation," Revision 0, provides guidance for establishing portable ventilation and opening the ESR doors.

Based on the above, the NRC staff finds that the licensee's ventilation strategy should maintain ESR temperature 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," Revision 1). Therefore, the NRC staff finds that the electrical equipment located in the ESRs will not be adversely impacted by the loss of ventilation as a result of an ELAP event.

RCIC Pump Rooms

According to the licensee's FIP, a procedure directs opening of the RCIC and high pressure coolant injection (HPCI) pump room doors. A separate guideline establishes portable ventilation to keep the room temperature below 150°F. The sequence of events included in the licensee's FIP also indicates that RCIC fan deployment will be completed by 7 hours into the event. During the audit process the staff reviewed PM-1159, "RCIC Heat Up Analysis for Extended Loss of AC Power (ELAP) / Extended SBO," Revision 1, which modeled the transient temperature response in the RCIC pump rooms for 72 hours. The calculation determined that the temperature in the RCIC rooms would stabilize and remain below 130°F for the 72 hour evaluation period, assuming that doors were opened and a fan deployed at 4 hours into the event. The calculation also indicates that temperatures will remain below 150°F if the compensatory actions are delayed until 55 hours into the event. The calculation also provides justification for the 150°F room temperature limit. The staff also confirmed that licensee guidelines FSG-032-2(3), "Establishing HPCI/RCIC/Sump Pump Room Ventilation, Lighting and Water Removal," Revision 0, would provide guidance to open additional doors and establish portable ventilation. Licensee procedure SE-11, directs the RCIC room ventilation actions at 4 hours, consistent with the licensee's analysis.

Based on the above, the NRC staff finds that the licensee ventilation strategy (opening doors and establishing ventilation) should maintain the temperature of the RCIC pump rooms below 150°F, the limit for operation of the pumps. Therefore, the NRC staff finds that the RCIC function will not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Containment

The Peach Bottom FLEX strategy credits the use of the SRV pilot solenoid valves. The licensee's FIP did not discuss the FLEX functionality of components in the primary containment, primarily the SRV solenoids. During the audit process, the NRC staff questioned the capability of the credited equipment in containment. The licensee responded in the sixth six-month update letter [Reference 16], that the evaluation for survivability of drywell electrical equipment had been completed. In order to confirm the information described in the sixth six-month update letter, the staff reviewed licensee technical evaluation 2530982-02, "Evaluation of Certain Drywell Electrical Equipment for Survivability During an ELAP Event at Peach Bottom Atomic Power Station, Units 2 & 3," dated October 2, 2015. This document evaluated the performance of the SRV pilot solenoid valves and supporting equipment during ELAP conditions to assure proper operation throughout the event. The licensee also performed analysis PB-MISC-010, "MAAP Analysis to Support FLEX Initial Strategy," Revision 6, which modeled the transient temperature response in the containment for the first 72 hours. The results of analysis PB-MISC-010 showed that the peak temperature and pressure would be 277°F and 11.4 psig, respectively. The results of technical evaluation 2530982-02 showed SRV pilot solenoid valves survivability for at least 7.7 days at 276°F. The licensee concluded that the peak environmental qualification temperature and pressure (340°F and 48.7 psig) applicable to these components bounds the ELAP conditions with significant margin.

In order to assess the long term performance of the SRVs, the NRC staff also notes that the licensee will receive offsite resources and equipment from an NSRC within 24 - 72 hours after the onset of an ELAP event. The NRC staff finds that it is reasonable to expect that the licensee would utilize these resources to reduce or maintain temperatures within containment to ensure that required electrical equipment survives indefinitely, if necessary. The staff also notes that plant operators will continue to monitor containment parameters and perform additional actions that may be required to reduce containment temperature and pressure as described in Section 2.4.3 of the licensee's FIP.

Based on temperatures remaining below the design limits of equipment and the availability of offsite resources after 72 hours, the NRC staff finds that the electrical equipment in the containment should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Based on its review of the essential station equipment required to support the FLEX mitigation strategy, which are primarily located in the MCR, Class 1E battery rooms, ESRs, RCIC pump rooms, and containments, the NRC staff finds that the electrical equipment should perform their required functions at the expected temperatures as a result of a loss of ventilation during the postulated event.

3.9.1.2 Loss of Heating

According to the licensee's fifth six-month update, the Robust FLEX Storage Building contains a heating system that is designed to survive the design basis for snow ice and cold. This letter also describes the "N+1" storage building which if used has heat and electricity capable of energizing engine block heaters. Thus, prior to a loss of power event in cold temperatures, the facilities housing equipment necessary for the success of the FLEX strategy should be at an appropriate temperature.

At the onset of the event, the Class 1E Battery Rooms would be at their normal operating temperature. In order to evaluate the impact of a loss of heating on the station batteries, the licensee reviewed this potential in calculation PM-1186 as a "winter case." The results of this calculation showed that over the initial 9 hour period when the batteries are being discharged, the room temperature would drop less than one half of a degree from the room starting temperature (assumed to be 65°F). The calculation assumes that no ventilation is provided during this period. Further, the licensee's sixth six-month update discusses the low temperature case and states that the minimum temperature assumed in the DC coping analysis for the batteries is 60°F and thus bounds the calculated room temperature. The NRC staff reviewed licensee calculation PM-1186 during the audit process and confirmed that the temperature in the battery rooms should remain above 64.5°F, validating the assumption of the DC coping analysis. Thus, the staff concludes that Peach Bottom Class 1E station batteries should perform their required functions as a result of loss of normal heating during an ELAP event.

In its FIP, the licensee described the freeze protection for FLEX pumps and suction hoses being obtained by maintaining flow in the pump/suction hose through the use of a recirculation flow line. Diesel fuel for FLEX equipment is treated with a fuel additive during cold weather conditions to prevent gelling. According to the licensee's FIP, the water in the ECT would be available during freezing conditions due to the suction hose connections being made well below the water level where only a layer of ice would be expected. In addition, the licensee's fifth six-month update describes the UHS suction supply from the inlet bay as being protected from the weather and not susceptible to freezing immediately upon unit shutdown after a postulated ELAP. In the fifth six-month update, the licensee described the underground EDG fuel oil storage tanks as being at a constant temperature and thus protected from extreme cold temperatures. Based on the licensee's descriptions, the NRC staff finds that the plant equipment and diesel fuel supply for FLEX should perform their required functions as a result of loss of normal heating during an ELAP event.

3.9.1.3 Hydrogen Gas Control in Vital Battery Rooms

An additional ventilation concern that is applicable to Phases 2 and 3, is the potential buildup of hydrogen in the battery rooms as a result of loss of ventilation during an ELAP event. Off-gassing of hydrogen from batteries is only a concern when the batteries are charging. According to the licensee's fifth six-month update a calculation was performed to estimate the hydrogen generation and it concluded that battery room's hydrogen concentration would be 0.52 percent at 72 hours after initiation of an ELAP event, assuming no ventilation is provided. The licensee further extrapolated this value to 1 percent hydrogen at 156 hours. Based on the information provided by the licensee regarding projected hydrogen generation and the staff's audit review of the licensee's guideline FSG-031 previously described in Section 3.9.1.1 of this safety evaluation, the NRC staff concludes that the licensee's hydrogen control strategy is reasonable.

Based on its review of the licensee's battery room ventilation strategy, the NRC staff finds that hydrogen accumulation in the Peach Bottom Class 1E battery rooms should not reach the combustibility limit for hydrogen (4 percent) during an ELAP event.

3.9.2 Personnel Habitability

The licensee's FIP describes methods that could be employed in the event that high temperatures (greater than 120°F) are encountered during the performance of the FLEX strategy. These methods includes existing procedures that allow the licensee to cope with temporary entry into high temperature areas with compensatory actions such as cooling garments, stay time controls, and personnel rotation. In addition, the staff notes that procedure SE-11, Sheet 6, "Extended Loss of AC Power (ELAP)," provides guidance on the priority and timing for implementing ventilation strategies to control heat-up in various critical buildings/rooms applicable to the ELAP strategy.

3.9.2.1 Main Control Room

Section 3.9.1.1 of this safety evaluation describes the staff's review of the analysis and supporting procedural guidance that form the basis for the licensee's strategy to control temperatures in the MCR. The supporting calculation predicts that under the analyzed high temperature conditions, the MCR temperature will fluctuate between 112°F and 103°F following the daily diurnal temperature changes. This analysis assumes that the operational staff takes the actions specified in the licensee's procedures and FSGs to ventilate the MCR.

Based on these results, the NRC staff concludes that the guidance provides sufficient mitigating actions such that the environmental conditions in the MCR will not prevent operators from taking necessary actions to address an ELAP.

3.9.2.2 Spent Fuel Pool Area

According to the licensee's FIP, the strategy for maintaining the SFP key safety function is to monitor level and provide sufficient makeup to maintain a safe level. The monitoring takes place via instrumentation installed in response to Order EA-12-051 and the monitoring location is in the Radwaste Building, away from the immediate area of the SFP. Makeup is accomplished via hoses or installed piping systems and the hose set up is completed by 5.5 hours into the event in the vicinity of the SFP. During this time, the licensee will also take actions to vent the Reactor Building to allow natural convective cooling of the area. Therefore, in order to execute the licensee's strategy, the environment must accommodate actions in the first 5.5 hours of an event.

During the audit process, the NRC staff reviewed calculation PM-1174, "SFP Air Space Transient Temperature Profile Following ELAP," Revision 1. The calculation used the Generation of Thermal-Hydraulic Information in Containment (GOTHIC) Version 8.0 computer program. The calculation shows that by opening selected doors and roof hatches the temperature on the refueling floor area of the SFP will remain below 120°F for at least 5 hours. During the audit process the staff also reviewed guideline FSG-033 and procedure SE-11 to confirm that the necessary natural convective cooling and hose runs are established in a timeframe that reflects the assumptions of supporting analysis.

Based on the FIP description, and supported by the audit review of calculations and procedural guidance, the NRC staff concludes that the actions needed to monitor and maintain SFP water level are feasible, given the projected environmental conditions.

3.9.2.3 Other Plant Areas

The licensee's FIP describes several actions that will be performed to support RCIC pump operation. First, the FIP states procedure SE-11 directs the opening of select RCIC and HPCI room doors in order to limit heat up of the RCIC Room. In addition, actions to establish lighting, water removal, and portable ventilation are also described in the licensee's FSGs. According to the licensee's FIP, equipment necessary to provide ventilation is stored in the RCIC Room FLEX cabinet or in the Robust FLEX Building.

As described in Section 3.9.1.1 of this safety evaluation, the NRC staff reviewed the licensee's RCIC room temperature evaluation, calculation PM-1159 during the audit process. This shows that the RCIC room temperature will approach 130°F. The staff notes that the RCIC room is not normally occupied and that any necessary room entries to support the FLEX strategy are likely to be of short duration. Based on the compensatory actions described, the limited potential exposure time, and the licensee's established procedures controlling work in high temperature environments, the NRC staff concludes that the elevated temperatures in the RCIC room will not prevent operators from taking the necessary actions to operate the RCIC pump during an ELAP.

3.9.3 Conclusions

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 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.10 Water Sources

Condition 3 of NEI 12-06, Section 3.2.2.5 states that cooling and makeup water inventories are considered available if they are contained in systems or structures with designs that are robust with respect to seismic events, floods, and high winds, and associated missiles. The NRC staff reviewed the licensee's planned water sources to verify that each water source was robust as defined in NEI 12-06.

3.10.1 RPV Make-Up

Phase 1

The FIP indicates that for Phase 1, the suppression pool provides makeup water to the RPV through the RCIC pump for about 12 hours after ELAP initiation. The suppression pool is a large volume of reactor grade water (122,900 cubic feet or approximately 919,356 gallons per UFSAR Table 1.7.4) and is located inside primary containment, a fully protected location. The suppression pool also receives SRV discharge and is vented to atmosphere during the event response. Thus, while RCIC is running, it will gradually lose level.

Phase 2

As the event progresses, the suppression pool will begin to lose level, in which case the FLEX pump will be configured to draw from the ECT or UHS. With these suction sources the FLEX pump can provide makeup to the suppression pool when the RCIC pump is running. The ECT provides about 3.55 million gallons of makeup water for the two Peach Bottom units and is protected from all applicable external hazards. As an alternative water source, the UHS can provide essentially unlimited amount of makeup water, though it would not be the preferred source during a flooding event based on the logistics for FLEX pump staging.

Phase 3

For Phase 3, the makeup sources are the same as the Phase 2 strategy. According to the licensee's FIP, arrangements can be made for replenishing the ECT via the Emergency Response Organization or the Nuclear Duty Officer. Makeup water can also be obtained through contact with the NSRC.

3.10.2 Suppression Pool Make-Up

The licensee's FIP describes the capability to provide makeup water to the suppression pool using the FLEX pump. The water source is from the ECT or UHS, and either can be used to maintain suppression pool level as needed throughout the ELAP event. Once the RCIC pump has been secured, and the FLEX pump is supplying RPV makeup, the licensee's calculation (PM-1173) shows that suppression pool makeup will no longer be needed.

3.10.3 Spent Fuel Pool Make-Up

No SFP makeup is required in Phase 1. Phase 2 and Phase 3 makeup to the SFP is from the ECT or UHS, as described in Section 3.7.3.1 of this safety evaluation. The licensee indicated in the FIP that water quality is not a concern for water makeup to the SFP.

3.10.4 Containment Cooling

Containment temperature and pressure are controlled by providing makeup to the RPV and/or the suppression pool along with operation of the HCVS. Thus the water sources associated with containment cooling are the same as those described above (ECT and UHS).

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 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 an ELAP occurring during power operations. This is appropriate, as plants typically operate at power for 90 percent or more of the year. When the ELAP occurs with the plant at power, the mitigation strategy initially focuses on the use of the steam-driven RCIC pump 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 makeup 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 makeup to the SFP. The licensee's analysis shows that following a full core offload to the SFP, about 35 hours are available to implement makeup before boil-off results in the water level in the SFP dropping far enough to uncover fuel assemblies, and the licensee has stated that they have the ability to implement makeup to the SFP within that time.

When a plant is in a shutdown mode in which steam is not available to operate a steam-powered pump such as RCIC (which typically occurs when the RPV 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 43], which described methods to ensure plant safety in those shutdown modes. By letter dated September 30, 2013 [Reference 44], 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 concludes 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. The licensee's FIP states that the guidance in this position paper will be followed at Peach Bottom.

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 should adequately address the requirements of the order.

3.12 Procedures and Training

3.12.1 Procedures

In its FIP, the licensee indicated that the inability to predict actual plant conditions that require the use of beyond-design-basis (BDB) equipment makes it impossible to provide specific procedural guidance. As such, the Peach Bottom FSGs 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 accomplish FLEX strategies or supplement EOPs, procedural guidance will direct the entry into and exit from the appropriate FSG procedure. The licensee also stated that FLEX strategy guidelines have been developed in accordance with BWROG guidelines. The FSGs provide available, pre-planned FLEX strategies for accomplishing specific tasks. The FSGs are used to supplement (not replace) the existing procedure structure that establishes command and control for the event. In addition, the licensee indicated in its FIP that procedural interfaces have been incorporated into the loss of power flowchart to the extent necessary to include appropriate reference to FSGs and provide command and control for the ELAP.

3.12.2 Training

In its FIP, the licensee stated that Peach Bottom's Nuclear Training Program has been revised to assure personnel proficiency in the mitigation of BDBEEs is adequate and maintained. According to the licensee, these programs and controls were developed and have been implemented in accordance with the Systematic [NRC term - Systems] Approach to Training (SAT) process. Training for both operations personnel and site emergency response leaders has been developed.

In its FIP, the licensee stated that 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. Upon SAFER equipment deployment and connection in an event, turnover and familiarization training on each piece of SAFER equipment will be provided to station operators by the SAFER deployment/operating staff.

3.12.3 Conclusions

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 item, NEI submitted a letter to the NRC 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.

In its FIP, the licensee stated that periodic testing and preventative maintenance of the BDB/FLEX equipment conforms to the guidance provided in INPO [Institute of Nuclear Power Operations] AP-913. A fleet procedure has been developed to address PM activities using EPRI templates or manufacturer provided information/recommendations, equipment testing, and the unavailability of equipment. The EPRI has completed and has issued "Preventive Maintenance Basis for FLEX Equipment - Project Overview Report." Preventative Maintenance Templates for the major FLEX equipment including the portable diesel pumps and generators have also been issued.

According to the licensee, the EPRI PM Templates for FLEX equipment conform to the guidance of NEI 12-06, providing assurance that stored or pre-staged FLEX equipment are being properly maintained and tested. The EPRI Templates are used for equipment where applicable. However, in those cases where EPRI templates were not available, PM actions were developed based on manufacturer provided information/recommendations and an Exelon fleet procedure

The licensee's FIP states that the unavailability of FLEX equipment and applicable connections that perform a FLEX mitigation strategy for core, containment, and SFP is controlled and managed per a Peach Bottom procedure such that risk to mitigating strategy capability is minimized. According to the licensee, the guidance in this procedure conforms to the guidance of NEI 12-06 for FLEX equipment as follows:

- Portable FLEX equipment may be unavailable for 90 days provided that the site FLEX capability (N) is available
- If portable equipment becomes unavailable such that the site FLEX capability (N) is not maintained, initiate actions within 24 hours to restore the site FLEX capability (N) and implement compensatory measures (e.g., use of alternate suitable equipment or supplemental personnel) within 72 hours

The NRC staff notes that should the licensee revert to the storage alternative described in Section 3.14.2 of this safety evaluation, additional out-of-service controls may apply to the FLEX equipment.

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

3.14.1 Reduced Set of Hoses and Cables as Backup Equipment

In its FIP, the licensee took an alternative approach to the NEI 12-06 guidance for hoses and cables. In NEI 12-06, Section 3.2.2 states that in order to assure reliability and availability of the FLEX equipment required to meet these capabilities, the site should have sufficient equipment to address all functions at all units on-site, plus one additional spare, i.e., an "N+1" capability, where "N" is the number of units on-site. Thus, a two-unit site would nominally have at least three portable pumps, three sets of portable AC/DC power supplies, three sets of hoses & cables, etc. On behalf of the industry, NEI submitted a letter to the NRC [Reference 50] proposing an alternative regarding the quantity of spare hoses and cables to be stored on site. The alternative proposed was that that either: (a) 10 percent additional lengths of each type and size of hoses and cabling necessary for the "N" capability plus at least one spare of the longest single section/length of hose and cable be provided or, (b) that spare cabling and hose of sufficient length and sizing to replace the single longest run needed to support any FLEX strategy. The licensee has committed to following the NEI proposal. By letter dated May 18, 2015 [Reference 51], the NRC agreed that the alternative approach is reasonable, but that the licensees may need to provide additional justification regarding the acceptability of various cable and hose lengths with respect to voltage drops, and fluid flow resistance. Based on the licensee's FIP discussion, the NRC staff approves this alternative as being an acceptable method of compliance with the order.

3.14.2 FLEX Storage Building Alternative Approach

As described in the licensees fifth six-month update dated August 28, 2015, the Peach Bottom FLEX storage configuration could utilize two storage locations: one robust building and one commercial building. The robust and commercial buildings are located in two different locations outside the protected area, on owner controlled property. The site FLEX robust storage structure is designed to withstand design-basis wind, tornado, and seismic events as outlined in NEI 12-06. If the storage configuration utilizing the robust and commercial buildings is used, in general, the robust building would contain the site's "N" FLEX equipment and the commercial building would contain the "N+1" FLEX equipment. In NEI 12-06, Revision 0, Section 10.1, stipulates that "N+1" sets of FLEX equipment be protected from all applicable BDBEEs. However, if the alternative storage configuration described by the licensee is used, it would not protect "N+1" sets of FLEX equipment from all applicable BDBEEs as stipulated in NEI 12-06, Revision 0, Section 10.1. As a result, the licensee proposed an alternate approach to NEI 12-06, Revision 0, for protection of FLEX equipment.

In its fifth six-month update dated August 28, 2015, the licensee acknowledged that this storage configuration would be an alternative to the guidance in NEI 12-06, Revision 0. The fifth six-month update also describes a reduced allowed out of service time for FLEX equipment maintenance to address the alternative FLEX storage configuration. The NRC staff notes that by letter dated December 10, 2015, NEI submitted guidance document NEI 12-06, Revision 2 [Reference 53] to the NRC for review. By letter dated January 22, 2016 [Reference 54], the NRC staff endorsed NEI 12-06, Revision 2. Guidance document NEI 12-06, Revision 2, contains modifications which resulted in NRC acceptance of the storage of backup ("N+1") equipment such that it is not protected from the applicable BDBEE hazards. Section 11.5.4.b of NEI 12-06, Revision 2, contains the condition that if the site FLEX capability (N) is met, but not protected for all of the site's applicable hazards, then the allowed unavailability is reduced to 45 days (compared to the 90 day unavailability with any FLEX equipment unavailable, but with the FLEX capability (N) available and in a protected or diverse storage configuration). Although Peach Bottom is evaluated to NEI 12-06, Revision 0, in this safety evaluation, the licensee's proposed alternative (if used) would follow the 45 day unavailability limit consistent with NEI 12-06, Revision 2 [Reference 53]. Therefore, the NRC staff finds the storage alternative described in the fifth six-month update to be acceptable.

In conclusion, the NRC staff finds that although the guidance of NEI 12-06 has not been met, if these alternatives are implemented as described by the licensee, they will meet the requirements of the order.

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 29], the licensee submitted its OIP for Peach Bottom in response to Order EA-12-051. By letter dated June 24, 2013 [Reference 30], the NRC staff sent a request for additional information (RAI) to the licensee. The licensee provided a response by letter dated July 19, 2013 [Reference 31]. By letter dated October 30, 2013 [Reference 32], the NRC staff issued an ISE and RAI to the licensee.

By letters dated August 28, 2013 [Reference 33], February 28, 2014 [Reference 34], August 28, 2014 [Reference 35], February 27, 2015 [Reference 36], and August 28, 2015 [Reference 37], the licensee submitted status reports for the Integrated Plan and the RAI in the ISE. 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 December 15, 2015 [Reference 38], the licensee reported that full compliance with the requirements of Order EA-12-051 was achieved at both units.

The licensee has installed a SFP level instrumentation system designed by Westinghouse, 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 an audit report on August 18, 2014 [Reference 39].

The staff performed an onsite audit to review the implementation of SFP level instrumentation related to Order EA-12-051 at Peach Bottom. The scope of the audit included verification of: (a) whether the site's seismic and environmental conditions are enveloped by the equipment qualifications, (b) whether the equipment installation met the requirements and vendor's recommendations, and (c) whether program features met the order requirements. By letter dated September 23, 2015 [Reference 23], the NRC issued an audit report on the licensee's progress. The following evaluation applies to both Peach Bottom, Units 2 and 3, unless otherwise noted.

4.1 Levels of Required Monitoring

In its RAI response letter dated July 19, 2013 [Reference 31], the licensee provided a sketch illustrating the SFP levels of monitoring as follows:

- Level 1 corresponds to a plant elevation of 232 feet - 8.5 inches
- Level 2 corresponds to a plant elevation of 220 feet - 0 inches
- Level 3 corresponds to a plant elevation of 210 feet - 0 inches

In its third six-month update letter dated August 28, 2014 [Reference 35], the licensee clarified Level 1 as 232 feet - 10 inches.

The NRC staff's assessment of the licensee's selection of the SFP levels of monitoring is as follows.

- <u>Level 1</u>: According to the provisions of NEI 12-02, Level 1 should be the HIGHER of two points. The first point is the water level at which suction loss occurs due to uncovering of the coolant inlet pipe, weir or vacuum breaker. The second point is the water level at which loss of spent fuel coolant pump net positive suction head (NPSH) occurs under saturated conditions. Peach Bottom Level 1 (232 feet - 10 inches) is designated at an elevation above the top of SFP weir (232 feet - 8.5 inches). The water in the SFP flows over the weir and into the skimmer surge tanks from which the SFP Cooling Pumps draw suction. According to the licensee's OIP, this level also corresponds to the normal operating level in the SFP. This elevation is also well above the level in the skimmer surge tank where the SFP cooling pumps would receive a protective trip. The staff concludes that the designated Level 1 setting is slightly above the HIGHER of the two points described in NEI 12-02 for Level 1, and is therefore acceptable.

- Level 2: According to NEI 12-02, Level 2 corresponds to an elevation that is 10 feet (plus or minus one foot) above the top of the storage racks seated in the SFP. Alternatively this level can correspond to a level that provides adequate radiation shielding to maintain personnel radiological dose levels acceptable while performing local operations in the vicinity of the pool. The licensee's Level 2 (220 feet - 0 inches) is consistent with the first of these two options since is 10 feet above the highest point of any fuel rack seated in the SFP (210 feet - 0 inches), and is therefore acceptable.

- Level 3: According to NEI 12-02, Level 3 corresponds to an elevation that equals the highest point of any fuel rack seated in the SFP (plus or minus one foot). The licensee's designated Level 3 equals the top of the storage racks seated in the Peach Bottom SFP (210 feet - 0 inches). This is consistent with the NEI 12-02 guidance for Level 3, and is therefore acceptable.

Based on the evaluation above, the NRC staff finds that the licensee's selection of Levels 1, 2, and 3 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 Evaluation of Design Features

Order EA-12-051 required that the SFP level instrumentation include specific design features, including specifications on the instruments, arrangement, mounting, qualification, independence, power supplies, accuracy, testing, and display. Below is the NRC staff's assessment of the design features of the SFP level instrumentation.

4.2.1 Design Features: Instruments

In its OIP, the licensee stated that the SFP level instrumentation design will install fixed primary and backup level sensors. Related to the SFP level instrumentation's measurement range, in its OIP, the licensee stated that the primary and backup SFP instrument channels will provide continuous level indication over a minimum range of 22 feet - 10 inch, from the top of the spent fuel racks at elevation 210 feet - 0 inch to the SFP normal water level elevation 232 feet – 10 inch. The NRC staff notes that the instrument's measurement range fully covers the licensee's designated Levels 1, 2, and 3.

The NRC staff finds that the licensee's design, with respect to the number of SFP instrument channels and measurement range, 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

Regarding the SFP level instrumentation arrangement, in its OIP, the licensee stated that the sensors will be mounted, to the extent practical, near the pool walls and below the pool curb to minimize their exposure to damaging debris and not interfere with SFP activities. SFP level instrumentation channel electronics and power supplies will be located in seismic and missile protected areas either below the Reactor Building refuel floor or in buildings other than the Reactor Building. The areas will be selected to provide suitable radiation shielding and environmental conditions for the equipment consistent with instrument manufacturer's recommendations. Power supplies and indication equipment and cabling for each SFP level instrumentation channel will be separated, equivalent to redundant safety related components.

In its fifth six-month update letter dated August 28, 2015 [Reference 37], the licensee provided a description of the final location of the level probes and the electronics equipment. The level probes are located diagonally opposed (north and south) on opposite sides of the pool, which is a distance that is greater than the shortest dimension of the pool, consistent with the provisions of NEI 12-02. The electronics equipment is located in the Radwaste Building Fan Room.

Based on the licensee's arrangement description, confirmed by a walk down conducted during the onsite audit, the staff concludes that there is sufficient channel separation between the primary and back-up level instrument channels, 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. Thus, the NRC staff finds that the licensee's 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

With regard to the mounting design of the level probe, in its letter dated August 28, 2015, the licensee stated, in part, that the model used by Westinghouse to calculate the stresses in the bracket assembly, considers load combinations for the dead load, [dynamic] load and seismic load on the bracket. The reactionary forces calculated from these loads become the design inputs to design the mounting bracket anchorage to the refuel floor to withstand a SSE. The seismic loads are obtained from Peach Bottom's UFSAR Appendix C Section 2.6, including dead, dynamic, and earthquake loads. According to the licensee, the following methodology will be used in determining the stresses on the bracket assembly:

- Frequency analysis, taking into account the dead weight and the hydrodynamic mass of the structure, is performed to obtain the natural frequencies of the structure in all three directions.

- SSE response spectra analysis is performed to obtain member stresses and support reactions.

- Modal responses are combined using the Ten Percent Method per Regulatory Guide 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis," Revision 1.

- The seismic loads for each of the three directions are combined by the Square Root of the Sum of Squares Method.

- Sloshing analysis is performed to obtain liquid pressure and its impact on bracket design.

- The seismic results are combined with the dead load results and the hydrodynamic pressure results in absolute sum. These combined results are compared with the allowable stress values.

The licensee further stated that sloshing forces will be obtained by analysis. The TID-7024, "Nuclear Reactors and Earthquakes," dated 1963, by the US Atomic Energy Commission, approach will be used to estimate the wave height and natural frequency. Horizontal and vertical impact force on the bracket components were calculated using the wave height and natural frequency obtained using the TID-7024 approach. Using this methodology, sloshing forces were calculated and added to the total reactionary forces that are applicable for bracket anchorage design. According to the licensee, the analysis also confirmed that the level probe can withstand a credible design-basis seismic event.

Related to the mounting of the SFP level instrumentation electronics equipment in the Radwaste Building Fan Room, in its letter dated August 28, 2015, the licensee stated, in part, that the display enclosure and its bracket were subjected to seismic testing, including shock and vibration test requirements. The level sensor electronics are enclosed in a [National Electrical Manufacturers Association] NEMA-4X housing. The display electronics panel utilizes a NEMA-4X rated stainless steel housing as well. These housings are mounted to a seismically qualified wall and contain the active electronics, and aid in protecting the internal components from vibration induced damage.

The NRC staff notes that the total load for the mounting bracket appropriately includes the dead load, dynamic load, design-basis maximum seismic loads, and the hydrodynamic loads that could result from pool sloshing. Further, the assumptions, analytical, and model used in the sloshing analysis for the sensor mounting bracket appear to be adequate. The staff also reviewed the site-specific seismic analyses for the SFP level instrumentation's mounting design during the site audit and concludes that demonstrates that the instruments will function per design following the maximum seismic ground motion.

Based on the licensee's description, confirmed by the audit review, the NRC staff finds that the licensee's mounting design 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.

4.2.4 Design Features: Qualification

4.2.4.1 Augmented Quality Process

Appendix A-1 of the guidance in NEI 12-02 describes a quality assurance process for non-safety systems and equipment that are not already covered by existing quality assurance requirements. In 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 reliability of the instrumentation would be assured through compliance with the guidance (NEI 12-02, as endorsed). Further the licensee also stated that reliability would be established through the use of an augmented quality assurance process.

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

Section 3.4 of NEI 12-02 states, in part:

> 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 components used 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.

During the vendor audit [Reference 39], the NRC staff reviewed the Westinghouse SFP level instrumentation's qualifications and testing for temperature, humidity, radiation, shock and vibration, seismic, and electromagnetic compatibility (EMC). The staff further reviewed the projected seismic, radiation, and environmental to confirm that the Peach Bottom conditions are bounded by the testing program. Below is the staff's assessment of the equipment reliability of the Peach Bottom SFP level instrumentation.

4.2.4.2.1 Radiation, Temperature, and Humidity

4.2.4.2.1.1 Radiation

In its fifth six-month update letter dated August 28, 2015, the licensee stated that environmental conditions applicable to the SFP instrumentation system components installed in the SFP area are bounded by the qualification test conditions, except for the BDB Total Integrated Dose (TID) 12" above the top of the fuel rack. According to the licensee, the BDB TID 12" above the top of the fuel rack for Peach Bottom is 3E07 R γ [Rad gamma], per calculation PM-1176, "NEI 12-02 Spent Fuel Pool Doses." The radiation value to which the Westinghouse equipment is qualified to is 1E07 R γ. The site-specific BDB radiation value at this level is thus higher than the value to which Westinghouse qualified the instrument. However, the value of 3E07 R γ is applicable only when the water is at Level 3, and the only components of the indicating system that are exposed to this high of a radiation dose are the stainless steel probe and the stainless steel anchor. These materials are inherently resistant to radiation effects. With the SFP at level 3, components located above the pool would be exposed to a lower dose of approximately 7E06 R γ, and would therefore be bounded by the instrument qualification testing level. Thus, the licensee concluded that the higher site-specific dose applicable to the probe and anchor would not adversely impact the overall instrument qualification.

The anticipated BDB radiological conditions in the Radwaste Building, where the electronics equipment is located, were summarized in the licensee's letter dated August 28, 2015. In this letter, the licensee stated that the level sensor transmitter and bracket, electronics display enclosure and bracket are designed and qualified to operate reliably at radiation levels ≤ 1E03 R γ. During the audit process the staff confirmed that the Radwaste Building would be a mild environment under the postulated conditions and that the Westinghouse equipment's design limits envelop the anticipated Peach Bottom BDB radiological conditions for this area.

4.2.4.2.1.2 Temperature and Humidity

The licensee's OIP states that the SFP level instrumentation will consider the environmental conditions of temperature and humidity during normal operation, the event, and for up to 7 days post-event. In its letter dated August 25, 2015, the licensee stated that the level sensor probe, coax coupler and connector assembly, launch plate and pool side bracket assembly, and coax cable are designed and qualified to operate reliably in the below specified (SFP area) environmental conditions.

Parameter	Normal	BDB
Temperature	65 – 109.7°F	212°F
Pressure	-0.25" water column	Atmospheric
Humidity	10-90% Relative Humidity (RH)	100% (saturated steam)

In addition, in its letter dated August 25, 2015, the licensee also provided the anticipated environmental conditions in the Radwaste Building, where the electronics equipment is located. These conditions apply to the level sensor transmitter and bracket, electronics display enclosure, and bracket.

Parameter	Normal	BDB
Temperature	65-107.1°F	65-107.1°F
Pressure	Atmospheric	Atmospheric
Humidity	0-95% RH	0-95% (non-condensing)

During the audit process, the NRC staff compared the design conditions to the projected Peach Bottom-specific conditions in these two areas and concluded that the Westinghouse equipment's design limits envelop the anticipated Peach Bottom's temperature and humidity conditions.

Based on the licensee's OIP statements, as confirmed during the audit process, the staff finds that the equipment qualifications envelop the anticipated site radiation, temperature, and humidity conditions before, during, and after a postulated BDBEE. The staff also concludes that the equipment environmental testing has demonstrated that the SFP level instrumentation should maintain its functionality under the expected BDB conditions.

4.2.4.2.2 Shock and Vibration

Guidance document NEI 12-02, as endorsed, specifies that instrument channel reliability shall be demonstrated regarding the effects of shock and vibration. Guidance document NEI 12-02 further provides methods for the manufacturer to establish shock and vibration ratings. In its letter dated August 28, 2015, the licensee stated that the probe, cable, and mounting brackets are inherently resistant to shock and vibration loadings. The remaining instrumentation components were subjected to testing that included shock and vibration requirements.

Based on the licensee's description, supplemented by the Westinghouse vendor audit, the NRC staff concludes that the licensee's SFP level instrumentation should be able to withstand the effects of shock and vibration that could occur as the result of a BDBEE.

4.2.4.2.3 Seismic

In its letter dated August 28, 2015, the licensee stated, in part, that the seismic adequacy of the SFP level instrumentation components was demonstrated by vendor testing and analysis in accordance with the following:

- IEEE [Institute of Electrical and Electronics Engineers] 344-2004, "IEEE Recommended Practice for Seismic Qualification of Class 1E Electrical Equipment for Nuclear Power Generating Stations"
- IEEE-323-1974, "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations"
- Regulatory Guide 1.100, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants," Revision 3
- Regulatory Guide 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis," Revision 1
- Peach Bottom Calculation PS-1123, "Seismic Qualification of the Spent Fuel Pool Level Instrumentation System Equipment"

During the audit process, the staff reviewed the licensee's calculation, PS-1123, which demonstrated that the readout display in the Radwaste Building was acceptable for the projected seismic loadings. Based on the licensee's letter, use of appropriate standards, with confirmation by the vendor and onsite audit reviews, and also considering the evaluation of the SFP level instrumentation mounting that is addressed in Section 4.2.3 of this safety evaluation, the NRC staff concludes that the SFP level instrumentation was evaluated and/or tested to seismic conditions that envelop anticipated SSE at Peach Bottom.

4.2.4.2.4 Electromagnetic Compatibility (EMC)

As a result of the NRC staff's evaluation of the EMC testing results during the vendor audit, the staff identified a generic item applicable to all licensees utilizing the Westinghouse SFP level instrumentation equipment that would be assessed during the onsite audit process. This generic item is to identify any additional measures, site-specific installation instructions or compensatory measures to address the potential effect of an EMC event on the SFP level instrumentation equipment. Specifically, in selecting the location for the SFP level instrumentation electronics equipment, the potential for Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) should be considered. The risk of EMI/RFI is inversely proportional to the distance between electronics equipment and any sources of EMI/RFI such as large induction motors, variable frequency drives, UPSs and other sources of power switching.

During the onsite audit, the NRC staff reviewed the licensee's assessment of potential susceptibilities of EMI/RFI in the areas where the SFP instrument located. As part of the modification process, the licensee performed radio interference testing on the SFP level instrumentation via work orders (WOs) 04175242-50 and 04175242-51 to determine whether additional measures needed to address EMI/RFI. The results from these WOs indicated that there was no noticeable interference from radio operations near the SFP level instrumentation electronics equipment. The NRC staff did not identify any concerns with respect to the licensee's evaluation of the potential susceptibilities of the equipment to EMI/RFI.

Based on the licensee's description, confirmed by the audit reviews, the NRC staff finds that the reliability aspects of the SFP level instrumentation design appear to be consistent with the 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 fifth six-month update dated August 28, 2015, the licensee stated, in part, that the two channels of the level measurement system will be installed such that:

- The level probes will be mounted diagonally opposed on opposite sides (north and south) of the SFP and are separated by a distance greater than the span of the shortest side of the pool. This meets the NEI 12-02, Revision 1 guidance for channel separation.
- The signal cables from the level probes maintain physical separation for the routing on the refuel floor....also, the signal cables are in separate conduits for the entire route.

Further, the licensee stated that the Unit 2 level transmitters and electronics enclosures are located in the south end of the Radwaste Building Fan Room, while the Unit 3 level transmitters and electronics enclosures are locating in the north end of the Radwaste Building Fan Room.

Guidance document NEI 12-02 states that independence of permanently installed instrumentation, and primary and backup channels, is obtained by physical and power separation. The NRC staff notes that the licensee's design description, as confirmed by the onsite audit activities, maintains appropriate physical separation of the two channels, consistent with NEI 12-02. In addition, the staff notes with the licensee's design, as detailed in the power supply discussion contained in Section 4.2.6 of this safety evaluation, the loss of one level instrument channel would not affect the operation of other channel under BDBEE conditions. Therefore, the staff finds the licensee's 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

In its OIP, the licensee stated that the each channel will be powered from a different 120 VAC bus. In its fifth six-month update dated August 28, 2015, the licensee stated that the primary channels of both Unit 2 and Unit 3 receive power from 120 VAC power distribution panel 20Y035. The backup channels of both Unit 2 and Unit 3 receive power from 120 VAC power distribution panel 30Y035. Both power sources, 20Y035 and 30Y035, are fed from safety-related Division 1 motor control centers (MCCs). Furthermore, both of the MCC's that feed the power sources are backed up by a power supply which is part of the station FLEX strategy. Each of the four power feeds is routed in its own conduit.

The NRC staff notes that with the licensee's design, the loss of one level instrument channel power would not affect the operation of other channel under BDBEE conditions. The NRC staff finds the licensee's 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

In its third six-month update letter dated August 28, 2014, the licensee described the channel accuracy under both normal SFP level conditions and conditions that would be present if SFP level were at Level 2 and Level 3 datum points during the postulated BDB event. Each instrument channel will be accurate to within ±3 inches during normal SFP level conditions. The licensee also stated that the instrument channels will retain this accuracy under BDB conditions. According to the licensee, the site calibration and channel verification procedures will follow the vendor's recommended routine testing/calibration verification and calibration methodology to ensure that accuracy is maintained.

Order EA-12-051 states that the instruments should be maintained within the designed accuracy following a power supply interruption or change in power source without recalibration. Further, NEI 12-02 states that accuracy should be sufficient to allow trained personnel to determine level without conflicting or ambiguous indication and that Levels 2 and 3 should correspond to their respective levels +/- 1 foot. Based on the licensee's submittals dated August 28, 2014, and August 28, 2015, the NRC staff finds that, if implemented properly, the instrument channels should maintain the designed accuracy following a power source change or interruption without the need of recalibration and provide the necessary information regarding SFP level. The staff concludes that the licensee's 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 letter dated August 28, 2015, the licensee stated that a Westinghouse calibration procedure and functional test procedure describe the capabilities and provisions of SFP level instrumentation periodic testing and calibration, including in-situ testing.

In addition, the licensee stated that if level is not within the required accuracy during operational checks, a channel calibration will be performed.

Order EA-12-051 states that processes shall be established and maintained for scheduling and implementing necessary testing and calibration of the SFP level instrumentation to maintain the channels within their design accuracy. Guidance document NEI 12-02 states that testing and calibration shall be consistent with vendor recommendations or other documented basis. The NRC staff notes by comparing the levels in the instrument channels and the maximum level allowed deviation for the instrument channel design accuracy, the operators could determine if recalibration or troubleshooting is needed. Based on the licensee's letter dated August 28, 2015, the staff finds the licensee's SFP level instrumentation design allows for testing and appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately addresses the requirements of the order.

4.2.9 Design Features: Display

In its third six-month update letter dated August 28, 2014, the licensee stated that the primary and backup instrument channels will be located in the Fan Room on the 165 foot elevation of the Radwaste Building, which is directly behind the MCR. The Unit 2 channels will be in the southern half of the room and the Unit 3 channels will be in the northern half. This location was selected due to the display location proximity to the MCR.

According to the licensee, radiological habitability at this location and the associated access routes have been evaluated against Peach Bottom UFSAR Section 12.3, Radiation Shielding, as well as estimated dose rates from SFP drain-down conditions to Level 3. The licensee states that exposure to personnel monitoring SFP levels would remain less than emergency exposure limits allowable for emergency responders to perform this action. The location is at an elevation below the SFP operating floor and is located in a different building, physically separated by concrete walls and closed air lock/fire doors from the SFP, such that heat and humidity from a boiling SFP would not comprise habitability and accessing these displays. The SFP level monitoring will be the responsibility of operations personnel.

According to the licensee, diverse communication methods are available for operators to contact the MCR to provide the SFP level from the display location, for both the primary and backup channels displays. It takes up to 5 minutes to reach the display location, for both the primary and backup channels, when an operator is dispatched from the MCR. The actual time for accessing the display locations is based on walk downs. The access route is through a short distance of the 165 foot elevation of the Turbine Building and then into the robust Seismic Category I structures to the display locations. The operator can access the fan room from either the Unit 2 or Unit 3 side. The licensee assesses that being able to provide the indicated SFP level within approximately 10 minutes is not considered an unreasonable delay.

Guidance document NEI 12-02 states that display locations should be: (1) promptly accessible to the appropriate plant staff giving appropriate consideration to various drain down scenarios, (2) outside of the area surrounding the SFP floor, (3) inside a structure providing protection against adverse weather, and (4) outside of any very high radiation areas or locked high radiation areas during normal operation. Based on the licensee's description, the NRC staff review concludes that each of these characteristics of the display location are met at Peach Bottom.

Based on the evaluation above, the NRC staff finds that the licensee's 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 addresses the requirements of the order.

4.3 Evaluation of Programmatic Controls

4.3.1 Programmatic Controls: Training

In its OIP, the licensee stated that personnel who perform operation and maintenance functions associated with the SFP level instrumentation channels will be trained to perform the job specific functions necessary for their assigned tasks. Applicable training materials will be developed consistent with equipment vendor guidelines, instructions, and recommendations. The SAT process will be used to identify the population to be trained and to identify the initial and continuing training requirements. Initial training will be completed prior to placing the SFP level instruments in service.

Guidance document NEI 12-02 specifies that the SAT process can be used to identify the population to be trained, and also to determine both the initial and continuing elements of the required training. Based on the licensee's OIP, 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

In its letter dated August 28, 2015, the licensee stated that site procedures will be developed for system inspection, calibration and test, maintenance, operation and normal and abnormal responses, in accordance with Exelon's procedure control process. Technical objectives to be achieved in each of the respective procedures are described below:

- System Inspection: To verify that visible portions of system components are in place, complete, and in the correct configuration.
- Calibration and Test: To verify that the system is within the specified accuracy is functioning as designed, and is appropriately indicating SFP water level.
- Maintenance: To establish and define scheduled and preventive maintenance requirements and activities necessary to minimize the possibility of system interruption.
- Operation: To provide sufficient instructions for operation and use of the system by plant operation staff.
- Responses: To define the actions to be taken upon observation of system level indications, including actions to be taken at the levels defined in NEI 12-02.

Guidance document NEI 12-02 states that procedures will be developed using guidelines and vendor instructions to address the maintenance, operation, and abnormal response issues associated with the instrumentation. It also states that licensees will have a strategy to ensure SFP water level addition is initiated at an appropriate time based on the mitigating strategies developed in response to Order EA-12-049. Based on the licensee's description, the staff finds that the licensee's procedure development appears to be consistent with NEI 12-02, as endorsed by JLD-ISG-2012-03. Thus, if implemented as described, the licensee's procedure development should adequately address the requirements of Order EA-12-051.

4.3.3 Programmatic Controls: Testing and Calibration

In its third six-month update dated August 28, 2014, the licensee stated that instrument channel calibration will be performed if the level indication reflects a value that is outside the acceptance band established in the Peach Bottom calibration and channel verification procedures. Calibration will be performed once per refueling cycle and would be completed within 60 days of a planned refueling outage considering normal testing scheduling allowances (e.g. 25 percent).

In its fourth six-month update letter dated February 27, 2015, the licensee further stated that the level displayed by the channels will be verified per the station operating procedures. If the level is not within the required accuracy, channel calibration will be performed. Functional checks will be performed at the vendor's recommended frequency. Calibration tests will be performed in accordance with the vendor's calibration procedure and at the vendor's recommended frequency. The licensee also stated that the SFPI channel/equipment maintenance/preventative maintenance and testing program requirements will be established to ensure design and system readiness. These program requirements will be established in accordance with Exelon's processes and procedures with consideration for vendor recommendations to ensure that appropriate regular testing, channel checks, functional tests, periodic calibration, and maintenance is performed.

In its fourth six-month update letter dated February 27, 2015, the licensee provided the planned compensatory actions for extended out-of-service events which are summarized as follows:

Number of Channel(s) Out-of-Service	Required Restoration Action	Compensatory Action if Required Restoration Action not Completed Within Specified Time
1	Restore channel to functional status within 90 days (or if channel restoration not expected within 90 days, then proceed to Compensatory Action)	Immediately initiate action in accordance with note below
2	Initiate action within 24 hours to restore one channel to functional status and restore one channel to functional status within 72 hours	Immediately initiate action in accordance with note below

Note: Initiate an Issue Report to enter the condition into the Corrective Action Program. Identify the equipment out of service time is greater than the specified allowed out of service time, develop and implement an alternate method of monitoring, determine the cause of the non-functionality, and the plans and schedule for restoring the instrumentation channel(s) to functional status.

Guidance document NEI 12-02 states that the testing and calibration of the instrumentation shall be consistent with the vendor recommendations or other documented basis. Based on the licensee's submittals, the NRC staff concludes that the licensee's testing and calibration plan appears to be consistent with the vendor recommendations. Further, the staff concludes that the licensee's maintenance program also appears to be consistent with the vendor recommendations. Additionally, compensatory actions for instrument channel(s) out-of-service appear to be consistent with guidance in NEI 12-02.

Based on the evaluation above, the staff finds that the licensee's testing and calibration program appears to be consistent with NEI 12-02, 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 December 15, 2015 [Reference 38], the licensee stated that they would meet the requirements of Order EA-12-051 for each unit by following the guidelines of NEI 12-02, which has been endorsed, with clarifications and exceptions, by JLD-ISG-2012-03. In the evaluation above, the NRC staff finds that, if implemented appropriately, the licensee has conformed to the guidance in 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 Peach Bottom according to the licensee's design, it should 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 at Peach Bottom in June 2015 [Reference 23]. The licensee reached its final compliance date on November 6, 2017, for Order EA-12-049, and October 21, 2015 for Order EA-12-051, and has declared that both of the reactors are 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 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, "Order Modifying 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, "Order Modifying 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, 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. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, 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)," February 28, 2013 (ADAMS Accession No. ML13059A305)

11. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, First Six-Month Status Report 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)," August 28, 2013 (ADAMS Accession No. ML13246A412)

12. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, Second Six-Month Status Report 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)," February 28, 2014 (ADAMS Accession No. ML14059A222)

13. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, Third Six-Month Status Report 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)," August 28, 2014 (ADAMS Accession No. ML14241A252)

14. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, Fourth Six-Month Status Report 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)," February 27, 2015 (ADAMS Accession No. ML15058A263)

15. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, Fifth Six-Month Status Report 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)," August 28, 2015 (ADAMS Accession No. ML15245A364)

16. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, Sixth Six-Month Status Report 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)," February 26, 2016 (ADAMS Accession No. ML16057A009)

17. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, Seventh Six-Month Status Report 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)," August 26, 2016 (ADAMS Accession No. ML16239A293)

18. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, Eighth Six-Month Status Report 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)," February 28, 2017 (ADAMS Accession No. ML17059D132)

19. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, Ninth Six-Month Status Report 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)," August 28, 2017 (ADAMS Accession No. ML17240A029)

20. 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)

21. NRC Office of Nuclear Reactor Regulation Office Instruction LIC-111, "Regulatory Audits," December 16, 2008 (ADAMS Accession No. ML082900195)

22. Letter from Jeremy S. Bowen (NRC) to Michael J. Pacilio (Exelon), "Peach Bottom Atomic Power Station, Units 2 and 3 – Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049 (Mitigation Strategies)," November 22, 2013 (ADAMS Accession No. ML13220A105)

23. Letter from Peter Bamford (NRC) to Bryan Hanson (Exelon), "Peach Bottom Atomic Power Station, Units 2 and 3 – Report for the Onsite Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Pool Instrumentation Related to Orders EA-12-049 and EA-12-051," September 23, 2015 (ADAMS Accession No. ML15254A135)

24. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Unit 2, "Report of Full Compliance with 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)," January 6, 2017 (ADAMS Accession No. ML17006A167)

25. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Unit 3, "Report of Full Compliance with 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)," January 5, 2018 (ADAMS Accession No. ML18005A701)

26. 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)

27. 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)

28. 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)

29. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, Overall Integrated Plan in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," February 28, 2013 (ADAMS Accession No. ML13059A390)

30. Letter from Richard Ennis (NRC) to Michael J. Pacilio (Exelon), "Peach Bottom Atomic Power Station, Units 2 and 3 – Request for Additional Information RE: Overall Integrated Plan in Response to Order EA-12-051, 'Reliable Spent Fuel Pool Instrumentation,' June 24, 2013 (ADAMS Accession No. ML13171A354)

31. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, Response to Request for Additional Information – Overall Integrated Plan in Response to Commission Order Modifying License Requirements for Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," July 19, 2013 (ADAMS Accession No. ML13200A343)

32. Letter from Richard Ennis (NRC) to Michael J. Pacilio (Exelon), "Peach Bottom Atomic Power Station, Units 2 and 3 – Interim Staff Evaluation and Request for Additional Information Regarding the Overall Integrated Plan For Implementation of Order EA-12-051, Reliable Spent Fuel Pool Instrumentation," October 30, 2013 (ADAMS Accession No. ML13295A303)

33. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, 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. ML13241A039)

34. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, 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 28, 2014 (ADAMS Accession No. ML14059A227)

35. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, 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. ML14241A303)

36. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, 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 27, 2015 (ADAMS Accession No. ML15058A254)

37. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, Fifth 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, 2015 (ADAMS Accession No. ML15243A099)

38. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, Report of Full Compliance with March 12, 2012 Commission Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051)," December 15, 2015 (ADAMS Accession No. ML15352A135)

39. Letter from Jason Paige (NRC) to Joseph W. Shea (TVA), "Watts Bar Nuclear Plant, Units 1 and 2, Report for the Westinghouse Audit in Support of Reliable Spent Fuel Instrumentation Related to Order EA-12-051," August 18, 2014 (ADAMS Accession No. ML14211A346)

40. 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).

41. Letter from Nicholas Pappas (NEI) to Jack R. Davis (NRC) regarding FLEX Equipment Maintenance and Testing, 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, October 7, 2013 (ADAMS Accession No. ML13276A224)

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

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

45. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, Submittal of the Updated Final Safety Analysis Report (Revision 26), Fire Protection Program (Revision 21), and Reference Drawings," dated April 6, 2017 (ADAMS Accession No. ML17108A393)

46. EPRI Report 3002001785, "Use of Modular Accident Analysis Program (MAAP) in Support of Post-Fukushima Applications," June 30, 2013 (ADAMS Accession No. ML13190A201)

47. Letter from Jack R. Davis (NRC) to Joseph E. Pollock (NEI), regarding MAAP use in support of post-Fukushima applications, dated October 3, 2013 (ADAMS Accession No. ML13275A318)

48. Generic Letter 91-07, "GI-23, 'Reactor Coolant Pump Seal Failures' and its Possible Effect on Station Blackout," May 2, 1991 (ADAMS Accession No. ML031140509)

49. COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluat[i]on of Flooding Hazards," November 21, 2014 (ADAMS Accession No. ML14309A256)

50. Letter from Nicholas Pappas (NEI) to Jack R. Davis (NRC) regarding alternate approach to NEI 12-06 guidance for hoses and cables, May 1, 2015 (ADAMS Accession No. ML15126A135)

51. Letter from Jack R. Davis (NRC) to Joseph E. Pollock (NEI), regarding NRC endorsement of NEI's alternative approach to NEI 12-06 guidance for hoses and cables, May 18, 2015 (ADAMS Accession No. ML15125A442)

52. SECY-16-0142, "Draft Final Rule – Mitigation of Beyond-Design-Basis Events," December 15, 2016 (ADAMS Accession No. ML16301A005)

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

54. 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, January 22, 2012 (ADAMS Accession No. ML15357A163)

55. Letter from Rajender Auluck (NRC) to Bryan Hanson (Exelon), "Peach Bottom Atomic Power Station, Units 2 and 3 – Report for the Audit of Licensee Responses to Interim Staff Evaluations Open Items Related to NRC Order EA-13-109 to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions," November 30, 2017 (ADAMS Accession No. ML17328A163)

56. Exelon letter to NRC, "Peach Bottom Atomic Power Station, Units 2 and 3, Fifth Six Month Status Report in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," December 15, 2016 (ADAMS Accession No. ML16350A265)

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Date: May 9, 2018

SUBJECT: PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3 – SAFETY EVALUATION REGARDING IMPLEMENTATION OF MITIGATING STRATEGIES AND RELIABLE SPENT FUEL POOL INSTRUMENTATION RELATED TO ORDERS EA-12-049 AND EA-12-051 (CAC NOS. MF0845, MF0846, MF0849, AND MF0850; EPID NOS. L-2013-JLD-0017 AND L-2013-JLD-0018) DATED May 9, 2018

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