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

April 24, 2017

Mr. James J. Hutto
Regulatory Affairs Director
Southern Nuclear Operating Co., Inc.
P.O. Box 1295, Bin 038
Birmingham, AL 35201-1295

SUBJECT: JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2 – 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. MF0716, MF0717, MF1429, AND MF1430)

Dear Mr. Hutto:

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 27, 2013 (ADAMS Accession No. ML13059A387), Southern Nuclear Operating Company, Inc. (SNC, the licensee) submitted its OIP for the Joseph M. Farley Nuclear Plant, Units 1 and 2 (FNP) 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 January 17, 2014 (ADAMS Accession No. ML13337A584), and February 8, 2016 (ADAMS Accession No. ML16014A734), the NRC issued an Interim Staff Evaluation (ISE) and audit report, respectively, on the licensee's progress. By letter dated December 13, 2016 (ADAMS Accession No. ML16348A559), SNC submitted a compliance letter and Final Integrated Plan (FIP) in response to Order EA-12-049. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-049.

By letter dated February 27, 2013 (ADAMS Accession No. ML13059A387), SNC submitted its OIP for FNP 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 letter dated October 21, 2013 (ADAMS Accession No. ML13294A496), the NRC staff issued an ISE on the licensee's progress. By letters dated June 26, 2015 (ADAMS Accession No. ML15182A175), and January 14, 2015 (ADAMS Accession No. ML15014A422), SNC stated to have achieved full compliance with Order EA-12-051.

The enclosed safety evaluation provides the results of the NRC staff's review of SNC's strategies for FNP. The intent of the safety evaluation is to inform SNC 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 191, "Implementation of Mitigation Strategies and Spent Fuel Pool Instrumentation Orders and Emergency Preparedness Communications/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 Milton Valentin-Olmeda, Orders Management Branch Project Manager for Farley, at 301-415-2864 or at Milton.Valentin-Olmeda@nrc.gov.

Sincerely,

John P. Boska

John P. Boska, Acting Chief
Orders Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket Nos.: 50-348 and 50-364

Enclosure:
Safety Evaluation

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

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

SOUTHERN NUCLEAR OPERATING COMPANY, INC.

JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2

DOCKET NOS. 50-348 AND 50-364

1.0 INTRODUCTION

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

On March 12, 2012, the NRC issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12054A736). This order directed licensees to develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities in the event of a BDBEE. Order EA-12-049 applies to all power reactor licensees and all holders of construction permits for power reactors.

On March 12, 2012, the NRC also issued Order EA-12-051, "Order Modifying Licenses With Regard to Reliable Spent Fuel Pool Instrumentation" (ADAMS Accession No. ML12054A679). This order directed licensees to install reliable SFP level instrumentation (SFPLI) with a primary channel and a backup channel, and with independent power supplies that are independent of the plant alternating current (ac) and direct current (dc) power distribution systems. Order EA-12-051 applies to all power reactor licensees and all holders of construction permits for power reactors.

2.0 REGULATORY EVALUATION

Following the events at the Fukushima Dai-ichi nuclear power plant on March 11, 2011, the NRC established a senior-level agency task force referred to as the Near-Term Task Force (NTTF). The NTTF was tasked with conducting a systematic and methodical review of the NRC regulations and processes and determining if the agency should make additional improvements to these programs in light of the events at Fukushima Dai-ichi. As a result of this review, the NTTF developed a comprehensive set of recommendations, documented in SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," dated July 12, 2011 (ADAMS Accession No. ML11186A950). 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," (ADAMS Accession No. ML12039A103) 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 (ADAMS Accession No. ML120690347), the NRC staff issued Orders EA-12-049 and EA-12-051.

2.1 Order EA-12-049

Order EA-12-049, Attachment 2, (ADAMS Accession No. ML12054A736) 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 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 December 10, 2015, following submittals and discussions in public meetings with NRC staff, the Nuclear Energy Institute (NEI) submitted document NEI 12-06, Revision 2, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," (ADAMS Accession No.

ML16005A625) to the NRC to provide revised specifications for an industry-developed methodology for the development, implementation, and maintenance of guidance and strategies in response to the Mitigation Strategies order. The NRC staff reviewed NEI 12-06, Revision 2, and on January 22, 2016, issued Japan Lessons-Learned Division (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-01, Revision 1, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," (ADAMS Accession No. ML15357A163), endorsing NEI 12-06, Revision 2, with exceptions, additions, and clarifications, as an acceptable means of meeting the requirements of Order EA-12-049, and published a notice of its availability in the *Federal Register* (81 FR 10283).

2.2 Order EA-12-051

Order EA-12-051, Attachment 2, (ADAMS Accession No. ML12054A679) 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.
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> 1. The spent fuel pool level instrumentation shall include the following design features:
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> 1.1 Instruments: The instrumentation shall consist of a permanent, fixed primary instrument channel and a backup instrument channel. The backup instrument channel may be fixed or portable. Portable instruments shall have capabilities that enhance the ability of trained personnel to monitor spent fuel pool water level under conditions that restrict direct personnel access to the pool, such as partial structural damage, high radiation levels, or heat and humidity from a boiling pool.
>
> 1.2 Arrangement: The spent fuel pool level instrument channels shall be arranged in a manner that provides reasonable protection of the level indication function against missiles that may result from damage to the structure over the spent fuel pool. This protection may be provided by locating the primary instrument channel and fixed portions of the backup instrument channel, if applicable, to maintain instrument channel separation within the spent fuel pool area, and to utilize inherent shielding from missiles provided by existing recesses and corners in the spent fuel pool structure.
>
> 1.3 Mounting: Installed instrument channel equipment within the spent fuel pool shall be mounted to retain its design configuration during and following the maximum seismic ground motion considered in the design of the spent fuel pool structure.

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

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

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

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

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

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

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

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

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

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

On August 24, 2012, following several NEI submittals and discussions in public meetings with NRC staff, the NEI submitted document NEI 12-02, "Industry Guidance for Compliance With

NRC Order EA-12-051, To Modify Licenses With Regard to Reliable Spent Fuel Pool Instrumentation," Revision 1 (ADAMS Accession No. ML12240A307) 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" (ADAMS Accession No. ML12221A339), 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 27, 2013 (ADAMS Accession No. ML13059A387), Southern Nuclear Operating Company, Inc. (SNC, the licensee) submitted its OIP for the Joseph M. Farley Nuclear Plant, Units 1 and 2 (FNP, Farley) in response to Order EA-12-049. By letters dated August 27, 2013 (ADAMS Accession No. ML13240A240), February 26, 2014 (ADAMS Accession No. ML14058B028), August 26, 2014 (ADAMS Accession No. ML14239A291), February 26, 2015 (ADAMS Accession No. ML15057A245), August 27, 2015 (ADAMS Accession No. ML15239B294), February 25, 2016 (ADAMS Accession No. ML16057A158), and August 8, 2016 (ADAMS Accession No. ML16221A398) the licensee submitted six-month updates to the OIP. 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 January 17, 2014 (ADAMS Accession No. ML13337A584), and February 8, 2016 (ADAMS Accession No. ML16014A734), the NRC issued an Interim Staff Evaluation (ISE) and an audit report on the licensee's progress. By letter dated December 13, 2016 (ADAMS Accession No. ML16348A559) the licensee reported that full compliance with the requirements of Order EA-12-049 was achieved, and submitted a Final Integrated Plan (FIP).

3.1 Overall Mitigation Strategy

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

While the initiating event is undefined, it is assumed to result in an extended loss of ac power (ELAP) with 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.

The FNP are Westinghouse pressurized-water reactors (PWRs) with large dry ambient pressure containments. Each unit has three reactor coolant system (RCS) loops. 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. Core decay heat is removed by steaming to atmosphere from the steam generators (SGs) initially through the SG main steam safety valves (MSSVs). Makeup to the SGs is initially provided by the turbine-driven auxiliary feedwater (TDAFW) pump taking suction from the condensate storage tank (CST). The operators would begin a controlled cooldown and depressurization of the RCS by manually operating the SG atmospheric relief valves (ARVs). The SGs would be depressurized in a controlled manner over a period of several hours to about 230 pounds per square inch gage (psig) and then maintained at this pressure while the operators borate the RCS. Depressurizing the SGs reduces temperature and pressure of the RCS.

The water supply for the TDAFW pump is initially from the CST. The CST will provide a minimum of 12 hours of RCS decay heat removal, in addition to absorbing the latent heat associated with the planned RCS cooldown. Prior to emptying the CST, the operators will place the SG FLEX pump in service to refill the CST from the reactor makeup water storage tank (RMWST) or to feed the SG directly should the TDAFW pump become unavailable. Inventory in the refueling water storage tank (RWST) will be available as an additional source for refilling the CST or the RMWST. Operators will transition the SG water supply from the TDAFW pump to portable FLEX pumps using water from the onsite clean water inventory and ultimately from the UHS, the service water (SW) pond, using off site supplied water purification equipment to limit the raw water impact on the SGs.

The electrical strategy for Phase 1 relies on the installed station batteries and the loads powered from it, including alternate current (AC) loads powered by the inverters. The licensee sheds unnecessary loads to prolong battery life. The operators will complete the dc bus load stripping within the initial hour following event initiation to ensure safety-related battery life is extended up to 8 hours. Following dc load stripping and prior to battery depletion, one 600 volt alternating current (Vac) diesel generator (DG), sized to supply both units, will be deployed from the FLEX Storage Building (FSB). The portable generator will be used to repower the essential battery chargers, the safety injection (SI) accumulator isolation valves (which must be closed before the licensee initiates the final RCS cooldown), main control room (MCR) lighting, fuel oil transfer pumps, and the portable FLEX ventilation fans.

As is typical of Westinghouse plants, there is no Phase 1 capability to make up to the RCS. The RCS cooldown will result in inventory contraction in the RCS, with the result that the pressurizer would drain and a steam void would form in the reactor vessel upper head. The RCS leakage, particularly from the RCP seals, would also contribute to the decrease in RCS liquid volume. However, during the cooldown RCS pressure should drop below the safety injection accumulator pressure and the injection of some quantity of borated water into the RCS from the accumulators would then occur. With low leakage RCP seals and the injection of accumulator inventory, licensee's analyses demonstrate that single phase natural circulation in the RCS can be maintained for approximately 29 hours without reliance upon FLEX RCS injection. The licensee will start RCS injection/boration 14 hours into the ELAP to ensure that reactivity control and boron mixing is maintained in the RCS. A 480 Volt (V) FLEX DG will be deployed to power the boron injection (BI) FLEX pump skids for both units. The boric acid tanks (BATs), two in each unit, are the primary suction source for the FLEX BI pumps. The RWST is also available as a source of borated water for boron injection and makeup if needed. There is one RWST per unit. Borated water from the BAT or RWST will be injected into the RCS through FLEX connections located downstream of the charging pumps in the charging and cold leg injection headers.

For Phase 3, a National Strategic Alliance of FLEX Emergency Response (SAFER) Response Center (NSRC) will provide high capacity pumps and large turbine-driven DGs. This equipment provides redundancy to the on-site FLEX equipment along with additional capabilities such as water treatment and RCS boration. The onsite emergency response organization will determine how to use these additional capabilities. There are two NSRCs in the United States.

The mitigation strategies for SFP makeup include adding water using a single diesel-driven SFP FLEX pump taking suction from the SW pond and discharging through hoses either directly into the SFPs,to connections in the existing SFP cooling lines, or to portable spray monitors positioned around the SFPs. Makeup will maintain a sufficient amount of water above the top of the fuel assemblies for cooling and shielding. When supplemented by portable equipment delivered from off-site (NSRC), water from the Chattahoochee River can be used to replace depleted water inventories. Ventilation of the generated steam is accomplished by opening the SFP room door, the new fuel area roll up door and the new fuel area missile door thus establishing a natural draft vent path. Airflow through these doors provides adequate vent pathways through which the steam generated by SFP boiling can exit the auxiliary building (AB).

The FNP has large dry containment buildings and utilizes RCP low leakage seals. The low leakage seals will limit the leakage inside the containment. The licensee's calculations demonstrate that no actions are required to maintain containment pressure below design limits for over 72 hours, so no actions are needed in Phases 1 and 2. There are also no time sensitive actions in Phase 3. Connection and utilization of NSRC equipment for long-term coping or recovery will be provided by technical support center (TSC) personnel, who will assess the condition of the plant and infrastructure following the BDBEE. If needed to reduce containment temperature and pressure, a low pressure high flow pump provided by the NSRC can be used to supply water from the UHS, the SW pond, to the containment coolers.

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 2, 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 due 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.

To adequately cool the reactor core under ELAP conditions, two fundamental physical requirements exist: (1) a heat sink is necessary to accept the heat transferred from the reactor core to coolant in the RCS and (2) sufficient RCS inventory is necessary to transport heat from the reactor core to the heat sink via natural circulation. Furthermore, inasmuch as heat removal requirements for the ELAP event consider only residual heat, the RCS inventory should be replenished with borated coolant in order to maintain the reactor in a subcritical condition as the RCS is cooled and depressurized.

As reviewed in this section, the licensee's core cooling analysis presumes that, per endorsed guidance from NEI 12-06, both units would have been operating at full power prior to the event. Therefore, the SGs may be credited as the heat sink for core cooling. Maintenance of sufficient RCS inventory, despite ongoing system leakage expected under ELAP conditions, is accomplished through a combination of installed systems and FLEX equipment. The specific means used by the licensee to accomplish adequate core cooling during the ELAP with loss of normal access to the UHS event are discussed in further detail below. The licensee's strategy for ensuring compliance with Order EA-12-049 for conditions where one or more units are shut down or being refueled is reviewed separately in Section 3.11 of this safety evaluation (SE).

3.2.1 Core Cooling Strategy and RCS Makeup

3.2.1.1 Core Cooling Strategy

3.2.1.1.1 Phase 1

As stated in FNP's FIP, the heat sink for core cooling in Phase 1 would be provided by the three SGs, which would be fed simultaneously by the unit's TDAFW pump with inventory initially supplied from the CST, which is seismically robust. The CST has a capacity of 500,000 gallons; however, due to vulnerabilities to tornado driven missile hazards only the capacity of the lower portion of the CST is credited. The licensee calculates that this portion of the CST contains 164,000 gallons, which is sufficient to remove residual heat from the reactor for approximately 12 hours. This includes the removal of sensible heat required for the plant cooldown to 350 degrees Farenheit (°F). Prior to the depletion of the CST, an operator will initiate makeup to the CST using water from the RMWST (preferred) or the RWST (alternate).

Following closure of the main steam isolation valves (MSIVs), as would be expected in an ELAP event, steam release from the SGs to the atmosphere would initially be accomplished via the MSSVs. The SG ARVs would typically be operated by the instrument air system, which is assumed to be lost in the ELAP event. At or prior to 10 hours after the initiation of the ELAP event, operators will take local control of the SG ARVs and initiate a plant cooldown. The licensee has confirmed that both the MSSVs and the ARVs are robust with respect to all applicable external hazards.

The FNP Phase 1 strategy directs operators to initiate a cooldown and depressurization of the RCS at approximately 10 hours after the initiation of the ELAP. Over a period of approximately 3.2 hours, the licensee will cool down the RCS from post-trip conditions until a procedurally specified minimum SG pressure is met. The minimum SG pressure is set to avoid the injection of nitrogen gas from the SI accumulators into the RCS and is specified in the appropriate emergency operating procedure. Cooldown and depressurization of the RCS significantly extends the expected coping time because it (1) reduces the potential for damage to RCP seals (as discussed in Section 3.2.3.3) and, (2) allows coolant stored in the nitrogen-pressurized accumulators to inject into the RCS to offset system leakage and maintain shutdown margin.

3.2.1.1.2 Phase 2

The FNP FIP states that the strategy for core cooling in Phase 2 would be to continue using the SGs as a heat sink, with SG secondary inventory being supplied by the TDAFW pump. After the depletion of the CST, water will be transferred to the CST from the RMWST using a diesel driven FLEX pump and hoses. The RMWST has a minimum capacity of 160,000 gallons of demineralized water and is robust to all applicable hazards. The licensee calculates that the RMWST water volume is sufficient to remove residual heat from the reactor for an additional 19 hours. Following the depletion of the RMWST, the RCS makeup FLEX pump will be aligned to transfer water from the RWST to the CST or RMWST. The RWST contains 471,000 gallons of borated water.

When the TDAFW pump is unable to deliver water to the SG's, a diesel driven FLEX pump will be staged near the CST. This pump will take suction on either the CST or the RMWST and deliver water to the SG's through a connection on the discharge piping of the AFW pumps (primary connection) or through a B.5.b connection on the main feedwater system (alternate connection). Both the primary and alternate connections provide the capability to deliver feed flow to all three SG's.

The licensee's FIP states that the SG FLEX pump is rated for 300 gallons per minute (gpm) at 949.8 feet (ft) of head. Use of the FLEX pump will require that the SGs have been depressurized to 230 psig or less. The sizing of the SG FLEX pump is based on the decay heat requirements one hour after reactor shutdown.

3.2.1.1.3 Phase 3

Per the FNP FIP, the licensee's core cooling strategy for Phase 3 is a continuation of the Phase 2 strategy with additional offsite equipment provided from the NSRC. Core cooling will continue to be provided by the SGs with feedwater supplied by either the TDAFW pump, the SG FLEX pump, or by Phase 3 equipment provided by the NSRC. Phase 3 pumps from the NSRC can connected to the Phase 2 connection points and inject into the SGs to provide cooling. In addition, water purification from the NSRC can be used to treat feedwater drawn from the SW pond providing cleaner water to reduce the amount of degradation of heat transfer in the SGs.

3.2.1.2 RCS Makeup Strategy

3.2.1.2.1 Phase 1

Following the reactor trip at the start of the ELAP, operators will isolate RCS letdown pathways and confirm the existence of natural circulation flow in the RCS. A small amount of RCS leakage will occur through the low-leakage RCP seals, but because the expected inventory loss would not be sufficient to drain the pressurizer prior to the RCS cooldown, its overall impact on the RCS behavior will be minor. Although the RCS cooldown planned for implementation at approximately 10 hours into the event would be expected to drain the pressurizer and create a vapor void in the upper head of the reactor vessel, ample RCS volume should remain to support natural circulation flow throughout Phase 1. Likewise, there is no need to initiate boration during this period, since the reactor operating history assumed in the endorsed NEI 12-06 guidance implies that a substantial concentration of xenon-135 would be present in the reactor core. As operators depressurize the RCS, injection of the borated inventory from the nitrogen-pressurized accumulators will occur. Following depressurization of the SGs, the licensee's procedures direct accumulator isolation once electrical power is restored to the corresponding isolation valves via FLEX equipment. Per its FIP, the licensee estimated that actions to effect accumulator isolation should be completed within the first 24 hours into the event. Furthermore, the licensee terminates cooldown at a temperature such that nitrogen injection from the accumulator is precluded, even considering the potential long-term heat up of containment and the accumulator gas space during an ELAP.

3.2.1.2.2 Phase 2

The licensee's FIP states that, in Phase 2, RCS inventory control and boration are accomplished by means of a portable FLEX BI pump powered by a FLEX DG. In the course of cooling and depressurizing the SGs, a significant fraction of the accumulator liquid inventory may inject into the RCS, filling volume vacated by the thermally induced contraction of RCS coolant and system leakage. However, crediting boration from the accumulators is challenging because actual RCS leakage may be quite small, and furthermore, dependent upon the rate of heat loss from the RCS (i.e., particularly from the reactor vessel upper head), RCS pressure may remain several hundred pounds per square inch (psi) above the SG target pressure for multiple hours into the event. Thus, in order to ensure long-term subcriticality as positive reactivity is added from the RCS cooldown and xenon decay, RCS boration will be initiated using a portable FLEX pump no later than 14 hours into the event. With low-leakage Westinghouse Generation 3 SHIELD RCP seals installed on all RCPs, SNC concluded that FLEX RCS makeup is not necessary to prevent the loss of single-phase natural circulation cooling for at least 29 hours into the event. Therefore, the injection of borated RCS makeup water for reactivity control will be in progress long before entry into reflux cooling becomes a concern.

The method of boration and inventory control in Phase 2 is through the use of a portable FLEX BI pump with a capacity of 20 gpm at 1,193.2 ft of head. The pump is electrically powered by a portable 480 Vac DG. One generator is common to both units and will power both of the FLEX BI pumps. The pump will be aligned to take suction primarily from the BAT. The BAT contains a minimum capacity of 11,336 gallons of borated water at a concentration of 7,000 to 7,700 particles per million (ppm). When the contents of the BAT are depleted the pump will be aligned to take suction from the RWST. Both of these sources are robust for all applicable hazards. The FLEX BI pump can be aligned to discharge to either a primary or alternate FLEX connection. The primary and alternate connections are located downstream of the charging pumps on the charging and cold leg injection headers.

3.2.1.2.3 Phase 3

The Phase 3 strategy for indefinite RCS inventory control and subcriticality is simply a continuation of the Phase 2 strategy, with backup pumps, a boration skid and water treatment equipment supplied by the NSRC. To facilitate the use of higher quality water for RCS makeup, as necessary, the FIP states that the licensee will use water purification equipment from the NSRC to treat water that will be used for core cooling.

3.2.2 Variations to Core Cooling Strategy for Flooding Event

In its FIP, the licensee stated that FNP is above the design-basis flood level. The grade elevation of all safety-related structures, including the AB, the containment building, and the diesel generator buildings, are at 155 ft above mean sea level (MSL) which is higher than the maximum probable flood level of 144.2 ft MSL (without wave run-up) and 153.3 ft MSL (with wave run-up). Additionally, the FIP states that there is no large, enclosed, or partially enclosed body of water adjacent to the site. Therefore, the deployment paths located within the owner control area would not be adversely affected by the external flooding events. The licensee core cooling and makeup strategy implementation remain the same for a flooding event. Refer to Section 3.5.2 of this SE for further discussion on flooding.

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 baseline assumptions for the availability of SSCs for core cooling during an ELAP caused by a BDBEE.

3.2.3.1.1 Plant SSCs

Phase 1

According to the licensee's FIP, the TDAFW pump automatically starts and delivers AFW flow from the CST to the SGs. In Section 2.4.4.1 of its FIP, the licensee stated that the TDAFW pump is located in a structure that is protected from all applicable design-basis external events. The licensee states in its FIP, that the TDAFW pump is seismically robust and safety-related. The steam admission valves supply steam to the TDAFW pump and remain remotely operable for 2 hours. After 2 hours, operators must manually control TDAFW pump speed. In the FIP, Section 2.3.4.1 states that in the event the TDAFW pump fails to start, procedures direct the operators to manually reset and start the pump. The operators will manually adjust feed control valves to maintain SG level because the compressed air system is not seismically robust. Based on the licensee's FIP, the NRC staff finds that the TDAFW pump is robust and is expected to be available at the start of an ELAP event.

Initially, steam vents from the SGs via the MSSVs. The MSSVs are spring loaded relief valves that do not require additional control. Subsequently, the licensee plans to use local, manual operation of the ARVs to cooldown and depressurize the SGs. As described in FIP Sections 2.4.4.3 and 2.4.4.4, both the MSSVs and ARVs are seismically robust and protected from all applicable hazards. Based on the licensee's FIP, the NRC staff finds that the MSSVs and ARVs are robust and are expected to be available at the start of an ELAP event. The NRC staff's evaluation of the robustness and availability of water sources for an ELAP event is discussed in Section 3.10 of this SE.

Phase 2

The licensee's Phase 2 core cooling strategy continues to use the SGs as the heat sink. The site will continue to use the TDAFW pump as long as possible, using portable equipment to refill the CST. At some point during the evolution, the licensee will transition to using a portable SG FLEX pump discharging through a primary or alternate connection point to the SGs. The licensee does not plan to rely on any installed plant SSCs other than installed systems with FLEX connection points and water sources discussed in SE Sections 3.7 and 3.10, respectively.

Phase 3

The licensee's Phase 3 core cooling strategy is similar to the Phase 2 strategies, but uses the NSRC equipment backup equipment and extended capability, as needed.

RCS Makeup

Phase 1

As is typical of Westinghouse plants, the licensee does not have the ability to makeup to the RCS in Phase 1. The licensee's Phase 1 RCS inventory control strategy relies on Westinghouse SHIELD Passive Shutdown Seals, and the licensee's analysis demonstrated that no RCS make up is needed within 29 hours.

Phase 2

The licensee's Phase 2 RCS inventory strategy will use a BI pump. This strategy does not rely on any installed plant SSCs other than the piping systems with FLEX connection points and the borated water sources discussed in SE Sections 3.7 and 3.10, respectively.

Phase 3

The licensee's Phase 3 RCS inventory strategy does not rely on any additional installed plant SSCs other than those discussed in Phase 2. However, the licensee can establish shutdown cooling as described in Section 3.2.1.1.3 above.

3.2.3.1.2 Plant Instrumentation

According to FNP's FIP, the following instrumentation would be relied upon to support the licensee's core cooling and RCS inventory control strategy:

- RCS temperature (T-hot and T-cold, wide range)
- RCS pressure (wide range)
- Reactor vessel level indication
- SG level
- SG pressure
- AFW flow
- Pressurizer level
- Neutron flux (source range)
- CST level
- Containment pressure
- Core exit thermocouples

All of these instruments are powered by the installed safety-related Station Batteries. To prevent a loss of vital instrumentation, operators will extend battery life to a minimum of 8.5 hours by shedding unnecessary loads. The load shedding will be completed within 60 minutes from the start of the ELAP event. A FLEX DG (600 Vac) powering both units will be deployed within 8 hours from ELAP event initiation. This leaves a margin of at least a half hour prior to the depletion of the batteries. The licensee stated that based on validation and verification the time margin is greater than 1 hour. For the least limiting train of batteries, a margin in excess of 2 hours exists.

The licensee's FIP states that, as recommended by Section 5.3.3 of NEI 12-06, procedures have been developed to read the above instrumentation locally using a portable instrument, where applicable. FLEX Support Guideline Number 7 (FSG-007), "Loss of Instrumentation or Control Power," provides guidance for obtaining alternate readings for the following parameters:

- RCS temperature
- RCS pressure (wide range)
- RCS level
- SG level
- SG pressure
- Containment temperature
- Containment pressure
- Pressurizer level
- CST level
- Source range NIS

Furthermore, as described in its FIP, the portable FLEX equipment credited in the licensee's mitigating strategies is supplied with the instrumentation necessary to support local equipment operation.

The instrumentation available to support the licensee's strategies for core cooling and RCS inventory during the ELAP event is consistent with the recommendations specified in the endorsed guidance of NEI 12-06. Based on the information provided by the licensee, the NRC staff understands that indication for the above instruments would be available and accessible continuously throughout the ELAP event.

3.2.3.2 Thermal-Hydraulic Analyses

The licensee based its mitigating strategy for reactor core cooling, in part, on a generic thermal-hydraulic analysis performed for a reference Westinghouse four-loop reactor using the NOTRUMP computer code. The NOTRUMP code and corresponding evaluation model were originally submitted in the early 1980s as a method for performing licensing-basis safety analyses of small-break loss-of-coolant accidents (LOCAs) for Westinghouse PWRs. Although NOTRUMP has been approved for performing small-break LOCA analysis under the conservative Appendix K paradigm and constitutes the current evaluation model of record for many operating PWRs, the NRC staff had not previously examined its technical adequacy for performing best-estimate simulations of the ELAP event. Therefore, in support of mitigating strategy reviews to assess compliance with Order EA-12-049, the NRC staff evaluated licensees' thermal-hydraulic analyses, including a limited review of the significant assumptions and modeling capabilities of NOTRUMP and other thermal-hydraulic codes used for these analyses. The NRC staff's review included performing confirmatory analyses with the TRACE code to obtain an independent assessment of the duration that reference reactor designs could cope with an ELAP event prior to providing makeup to the RCS.

Based on its review, the NRC staff questioned whether NOTRUMP and other codes used to analyze ELAP scenarios for PWRs would provide reliable coping time predictions in the reflux or boiler-condenser cooling phase of the event because of challenges associated with modeling complex phenomena that could occur in this phase, including boric acid dilution in the intermediate leg loop seals, two-phase leakage through RCP seals, and primary-to-secondary heat transfer with two-phase flow in the RCS. Due to the challenge of resolving these issues within the compliance schedule specified in Order EA-12-049, the NRC staff requested that industry provide makeup to the RCS prior to entering the reflux or boiler-condenser cooling phase of an ELAP, such that reliance on thermal-hydraulic code predictions during this phase of the event would not be necessary.

Accordingly, the ELAP coping time prior to providing makeup to the RCS is limited to the duration over which the flow in the RCS remains in natural circulation, prior to the point where continued inventory loss results in a transition to the reflux or boiler-condenser cooling mode. In particular, for PWRs with inverted U-tube SGs, the reflux cooling mode is said to exist when vapor boiled off from the reactor core flows out the saturated, stratified hot leg and condenses on SG tubes, with the majority of the condensate subsequently draining back into the reactor vessel in countercurrent fashion. Quantitatively, as reflected in documents such as the PWR Owners Group (PWROG) report PWROG-14064-P, Revision 0, "Application of NOTRUMP Code Results for Westinghouse Designed PWRs in Extended Loss of AC Power Circumstances," industry has proposed defining this coping time as the point at which the one-hour centered time-average of the flow quality passing over the SG tubes' U-bend exceeds one-tenth (0.1). As discussed further in Section 3.2.3.4 of this SE, a second metric for ensuring adequate coping time is associated with maintaining sufficient natural circulation flow in the RCS to support adequate mixing of boric acid.

With specific regard to NOTRUMP, preliminary results from the NRC staff's independent confirmatory analysis performed with the TRACE code indicated that the coping time for Westinghouse PWRs under ELAP conditions could be shorter than predicted in WCAP 17601-P, "Reactor Coolant System Response to the Extended Loss of AC Power Event for Westinghouse, Combustion Engineering and Babcock & Wilcox NSSS Designs." Subsequently, a series of additional simulations performed by the staff and Westinghouse identified that the discrepancy in predicted coping time could be attributed largely to differences in the modeling of RCP seal leakage. (The topic of RCP seal leakage will be discussed in greater detail in Section 3.2.3.3 of this SE.) These comparative simulations showed that when similar RCP seal leakage boundary conditions were applied, the coping time predictions of TRACE and NOTRUMP were in adequate agreement. From these simulations, as supplemented by review of key code models, the NRC staff obtained sufficient confidence that the NOTRUMP code may be used in conjunction with the WCAP-17601-P evaluation model for performing best-estimate simulations of ELAP coping time prior to reaching the reflux cooling mode.

Although the NRC staff obtained confidence that the NOTRUMP code is capable of performing best-estimate ELAP simulations prior to the initiation of reflux cooling using the one-tenth flow-quality criterion discussed above, the staff was unable to conclude that the generic analysis performed in WCAP-17601-P could be directly applied to all Westinghouse PWRs, as the vendor originally intended. In PWROG-14064-P, Revision 0, the industry subsequently recognized that the generic analysis would need to be scaled to account for plant-specific variation in RCP seal leakage. However, the staff's review, supported by sensitivity analysis performed with the TRACE code, further identified that plant-to-plant variation in additional parameters, such as RCS cooldown terminus, accumulator pressure and liquid fraction, and initial RCS mass, could also result in substantial differences between the generically predicted reference coping time and the actual coping time that would exist for specific plants.

During the audit, the NRC staff evaluated a comparison of the generic analysis values from WCAP-17601-P and PWROG-14064-P to the FNP plant-specific values. The NRC staff concurred that the plant parameters were conservative. Farley has installed low-leakage SHIELD shutdown seals; therefore, the seal leakage expected for FNP is significantly less than assumed in the generic NOTRUMP analysis case. The NRC staff concluded based on licensee evaluation, that the licensee could maintain natural circulation flow in the RCS for approximately 29 hours for single phase and greater than 72 hours for two-phase during the ELAP event prior to requiring RCS makeup. The RCS makeup would be available per the licensee's mitigating strategy for shutdown margin at approximately 14 hours, thus, the licensee's strategy for RCS makeup provides sufficient margin to the onset of reflux cooling.

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 Reactor Coolant Pump (RCP) Seals

Leakage from the RCP seals is among the most significant factors in determining the duration that a PWR can cope with an ELAP event prior to initiating RCS makeup. An ELAP event would interrupt cooling to the RCP seals, resulting in increased leakage and the potential for failure of elastomeric o-rings and other components, which could further increase the leakage rate. As discussed above, as long as adequate inventory is maintained in the RCS, natural circulation can effectively transfer residual heat from the reactor core to the SGs and limit local variations in boric acid concentration. Along with cooldown-induced contraction of the RCS inventory, cumulative leakage from RCP seals governs the duration over which natural circulation can be maintained in the RCS. Furthermore, the seal leakage rate at the depressurized condition can be a controlling factor in determining the flow capacity requirement for FLEX pumps to offset ongoing RCS leakage and recover adequate system inventory.

Per FNP's FIP, the licensee credits Generation 3 SHIELD low leakage seals for FLEX strategies including RCS inventory control and boration. The low leakage seals limit the total RCS leak rate to no more than 5 gpm (1 gpm per RCP seal and 1 gpm of unidentified RCS leakage in accordance with Technical Specification).

The SHIELD low leakage seals are credited in the FLEX strategies in accordance with the four conditions identified in the NRC's endorsement letter of TR-FSE-14-1-P, "Use of Westinghouse SHIELD Passive Shutdown Seal for FLEX Strategies," dated May 28, 2014 (ADAMS Accession No. ML14132A128). In its FIP, SNC describes compliance with each condition of SHIELD seal use as follows:

(1) Credit for the SHIELD seals is only endorsed for Westinghouse RCP Models 93, 93A, and 93A-1.

    This condition is satisfied because, as stated in the FIP, the RCPs for FNP are Westinghouse Model 93A.

(2) The maximum steady-state reactor coolant system (RCS) cold-leg temperature is limited to 571 °F during the ELAP (i.e., the applicable main steam safety valve set points result in an RCS cold-leg temperature of 571 °F or less after a brief post-trip transient).

As stated in the FIP, the maximum steady-state RCP seal temperature during an ELAP response is expected to be the RCS cold leg temperature corresponding to the lowest SG safety relief valve setting of 1,075 psig. This results in a RCS cold leg temperature of approximately 553 °F to 557 °F.

(3) The maximum RCS pressure during the ELAP (notwithstanding the brief pressure transient directly following the reactor trip comparable to that predicted in the applicable analysis case from WCAP-17601-P) is as follows: for Westinghouse Models 93 and 93A-1 RCPs, RCS pressure is limited to 2,250 pounds per square inch atmospheric (psia); for Westinghouse Model 93A RCPs, RCS pressure is to remain bounded by Figure 7.1-2 of TR-FSE-14-1-P, Revision 1.

As stated in FIP, normal operating pressure for Unit 1 and Unit 2 is 2,250 psia. Allowing for the possibility of a brief pressure transient directly following the reactor trip, the NRC staff concludes that the licensee's mitigating strategy of cooling the reactor core via the MSSVs and SG ARVs will maintain reactor pressure within limiting value for Model 93A.

(4) Nuclear power plants that credit the SHIELD seal in an ELAP analysis shall assume the normal seal leakage rate before SHIELD seal actuation, and a constant seal leakage rate of 1.0 gpm for the leakage after SHIELD seal actuation.

The FNP FIP and supporting calculations assume a constant Westinghouse SHIELD RCP seal package leakage rate of 1 gpm per RCP, plus 1 gpm of unidentified RCS leakage, for a total RCS leakage of 4 gpm. As stated in the FIP, the actual seal leakage rate expected during an ELAP event would exceed this value for a brief period (in the order of 10 minutes based on LTR-FSE-14-29) prior to actuation of the SHIELD seal. As noted previously, the FNP calculation indicates that reflux cooling would not be entered for a minimum of 29 hours (single-phase) and 72 hours (two-phase) into the event, even if FLEX RCS makeup flow were not provided as planned. In that the FNP mitigating strategy directs RCS makeup to begin at approximately 14 hours after the event initiation; ample margin exists to accommodate the small additional volume of leakage that is expected to occur before actuation of the SHIELD seal.

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

3.2.3.4 Shutdown Margin Analyses

In the analyzed ELAP event, the loss of electrical power to control rod drive mechanisms is assumed to result in an immediate reactor trip with the full insertion of all control rods into the core. The insertion of the control rods provides sufficient negative reactivity to achieve subcriticality at post-trip conditions. However, as the ELAP event progresses, the shutdown margin for PWRs is typically affected by several primary factors:

- the cooldown of the RCS and fuel rods adds positive reactivity

- the concentration of xenon-135, which (according to the core operating history assumed in NEI 12-06) would
    - initially increase above its equilibrium value following reactor trip, thereby adding negative reactivity
    - peak at roughly 12 hours post-trip and subsequently decay away gradually, thereby adding positive reactivity
- the passive injection of borated makeup from nitrogen-pressurized accumulators due to the depressurization of the RCS, which adds negative reactivity

At some point following the cooldown of the RCS, PWR licensees' mitigating strategies generally require active injection of borated coolant via FLEX equipment. In many cases, boration would become necessary to offset the gradual positive reactivity addition associated with the decay of xenon-135; but, in any event, borated makeup would eventually be required to offset ongoing RCS leakage. The necessary timing and volume of borated makeup depend on the particular magnitudes of the above factors for individual reactors.

The specific values for these and other factors that could influence the core reactivity balance that are assumed in the licensee's current calculations could be affected by future changes to the core design. However, NEI 12-06, Section 11.8 states that "[e]xisting plant configuration control procedures will be modified to ensure that changes to the plant design ... will not adversely impact the approved FLEX strategies." Inasmuch as changes to the core design are changes to the plant design, the NRC staff expects that any core design changes, such as those considered in a core reload analysis, will be evaluated to determine that they do not adversely impact the approved FLEX strategies, especially the analyses which demonstrate that recriticality will not occur during a FLEX RCS cooldown.

In the FNP FIP, Section 2.4.9 and shutdown margin calculation LTR-FSE-12-25 describe the strategy necessary to maintain shutdown margin following the initiation of the ELAP event. In both documents the licensee stated that the initial plant cooldown and depressurization would supply negative reactivity by injecting borated water into the RCS from the SI accumulators, followed by employing the BI FLEX pump. The licensee does not credit the boron addition from the SI accumulators, which adds conservatism. The licensee's strategy is designed to provide a shutdown margin of 1 percent following cooldown to a core inlet temperature of 425 °F and xenon decay. In order to ensure that an acceptable amount of boric acid concentration is supplied to the RCS, and completed in sufficient time to ensure proper mixing, the licensee initiates the injection of borated water into the RCS at approximately 14 hours following the initiation of the ELAP event.

The primary means of providing borated water in Phase 2 is the BI FLEX Pump taking suction from the BAT. The RWST will be used as an alternate borated water source. The licensee's analysis demonstrated that adequate shutdown margin would be provided with the use of either water source. A reactor head vent letdown path can be established if needed to allow sufficient boration. Power (dc) for the head vent solenoids to operate is maintained throughout the event by the safety-related station batteries initially, and then by the battery chargers once the 600 Vac FLEX DG is operating. The applicable valves can be operated from the MCR. Letter LTR-FSE-12-25 shows that the injection of approximately 5,000 gallons from the BAT or 9,241 gallons from the RWST, with a boric acid minimum concentration of 7,000 and 2,400 ppm, respectively, would meet the shutdown margin requirement of 1 percent at limiting conditions.

By Technical Specification minimum requirement, the BAT and the RWST have a usable capacity of 11,336 and 471,000 gallons, respectively. This ensures adequate borated water is available for further cooldown. No credit is given to boron injection from the SI accumulators in the shutdown margin calculation.

Toward the end of an operating cycle, when RCS boron concentration reaches its minimum value, some PWR licensees may need to vent the RCS to ensure that their FLEX strategies can inject a volume of borated coolant that is sufficient to satisfy shutdown margin requirements. The licensee's FIP concluded that, although the RCS volume shrinks as it cools down, the available volume for the required boric acid solution injection is limited by the letdown through the head vent flow path. The volume of borated coolant required to provide adequate shutdown margin is larger when taking suction upon the RWST, which, for an equivalent pumping capacity, extends the overall time required for boration. The larger injection volume may further necessitate additional letdown from the RCS, as described above.

The NRC staff's audit review considered whether the licensee had followed recommendations from the PWROG's position paper and the associated conditions imposed in the NRC staff's endorsement letter. Regarding the first condition, the audit review found that the licensee's shutdown margin calculation had considered an appropriate range of RCS leakage rates in determining the limiting condition for the shutdown margin analysis. Furthermore, the NRC staff concluded that the licensee's plan to initiate RCS makeup within 14 hours satisfies the second two conditions. Therefore, the NRC staff concludes that the licensee's calculation conforms to the intent of the PWROG position paper, including the intent of the additional conditions imposed in the NRC staff's endorsement letter.

The NRC staff's audit review of the licensee's shutdown margin calculation determined that credit was taken for uniform mixing of boric acid during the ELAP event. The NRC staff had previously requested that the industry provide additional information to justify that borated makeup would adequately mix with the RCS volume under natural circulation conditions potentially involving two-phase flow. In response, the PWROG submitted a position paper, dated August 15, 2013 (withheld from public disclosure due to proprietary content), which provided test data regarding boric acid mixing under single-phase natural circulation conditions and outlined applicability limits intended to ensure that boric acid addition and mixing during an ELAP would occur under conditions similar to those for which boric acid mixing data is available. By letter dated January 8, 2014 (ADAMS Accession No. ML13276A183), the NRC staff endorsed the above position paper with three conditions:

> Condition 1: The required timing and quantity of borated makeup should consider conditions with no RCS leakage and with the highest applicable leakage rate.
>
> This condition is satisfied because the licensee's planned timing for establishing borated makeup acceptably considered both the maximum and minimum RCS leakage conditions expected for the analyzed ELAP event.
>
> Condition 2: Adequate borated makeup should be provided either (1) prior to the RCS natural circulation flow decreasing below the flow rate corresponding to single-phase natural circulation, or (2) if provided later, then the negative reactivity from the injected boric acid should not be credited until one hour after the flow rate in the RCS has been restored and maintained above the flow rate corresponding to single-phase natural circulation.

This condition is satisfied because the licensee's planned timing for establishing borated makeup would be prior to RCS flow decreasing below the expected flow rate corresponding to single-phase natural circulation for the analyzed ELAP event.

Condition 3: A delay period adequate to allow the injected boric acid solution to mix with the RCS inventory should be accounted for when determining the required timing for borated makeup. Provided that the flow in all loops is greater than or equal to the corresponding single-phase natural circulation flow rate, a mixing delay period of 1 hour is considered appropriate.

This condition is satisfied because the licensee's planned timing for establishing borated makeup allows a 1 hour period to account for boric acid mixing; furthermore, during this 1 hour period, the RCS flow rate would exceed the single-phase natural circulation flow rate expected during the analyzed ELAP event.

During the audit review, the licensee confirmed that FNP will comply with the August 15, 2013, position paper on boric acid mixing, including the above conditions imposed in the staff's corresponding endorsement letter. The NRC staff's audit review indicated that the licensee's shutdown margin calculations are generally consistent with the PWROG's position paper, including the three additional conditions imposed in the NRC staff's endorsement letter.

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

The licensee relies on three different portable pumps for core cooling during Phase 2. The licensee plans to use a SG FLEX pump to feed the SGs from the CST or the RMWST. Also, the licensee plans to use an RCS Makeup FLEX pump to provide CST makeup from the RWST. The licensee also relies on a BI FLEX pump to provide supplemental high pressure, low flow boron injection. In Section 2.4.10 of the FIP, the licensee identified the performance criteria (e.g., flow rate, discharge pressure) for the Phase 2 portable pumps. A detailed discussion of the availability and robustness of each water source is provided in Section 3.10 of this SE.

During Phase 2, core cooling will be transferred to a portable diesel-driven centrifugal SG FLEX pump when the TDAFW pump is no longer available. The SG FLEX pump will take suction from the CST, or RMWST. A single pump provides full capability to feed all SGs for one unit so the licensee has three onsite. Also, the licensee plans to makeup to the CST with this pump while using the TDAFW pump to ensure the CST is not exhausted. In the FIP, Section 2.4.10.1 states that the SG FLEX pump can provide 300 gpm at 409 psi with an available net positive suction head of 13 ft, which is greater than the 6 ft required. The licensee performed calculation A181154, "FLEX Portable System Steam Generator Injection FLEX Pump Sizing Criteria," Version 2.0, to determine the fluid system hydraulic performance using the fluid analysis equations and the Microsoft Excel software package. The NRC staff noted that this calculation assessed different possible lineups based on such variables as suction sources, connection points and hose paths to determine the flow to ensure that the SG FLEX pump procured by the licensee would be adequate for providing injection into the SGs at the required flow rate and discharge pressure.

Furthermore, the licensee relies on the 480 Vac motor-driven centrifugal RCS Makeup FLEX pumps to makeup to the depleted CST or RMWST. As described in Section 2.4.10.2, the RCS makeup can provide 100 gpm at 43 psi discharge pressure to one unit, so the licensee has procured three pumps. Although this capacity is much less than the SG FLEX pump, decay heat requirements at the time during which this pump will be used will be less than 100 gpm. As stated above, prior to that time the SG FLEX pump can be used to refill the CST as necessary. The licensee performed calculation A181146, "FLEX Phase 2 Core Cooling Subsystem Sizing Criteria for the RWST to the CST or RMWST pump," Version 1.0, to determine the fluid system hydraulic performance using the fluid analysis equations and the Microsoft Excel software package. The NRC staff noted that this calculation assessed different possible lineups based on such variables as suction sources, connection points and hose paths to determine the flow to ensure that the RCS Makeup FLEX pump procured by the licensee would be adequate for providing CST makeup at the required flow rate and discharge pressure.

Additionally, SNC relies on a BI FLEX pump to provide high pressure low flow RCS makeup. The FLEX boron pumps are a portable, 480 Vac motor-driven centrifugal pumps. One pump is required for each unit and the licensee has an additional spare for a total of three. The licensee calculation A181129, "Sizing Criteria for the Boron Injection Pump," Version 2, described above determined the BI FLEX pump fluid system hydraulic performance. This calculation assessed different possible lineups based on such variables as suction sources, connection points and hose paths to determine the flow to ensure that the FLEX boron pump would be adequate for providing injection into the RCS at the required flow rate and discharge pressure. The calculation determined the minimum requirements to 20 gpm at a discharge pressure of 1,193 psi. The calculation A181105, "FLEX Portable System, Boron Injection Subsystem," Version 2.0, provided the vendor information (pump curves) to show the procured pumps could deliver as needed.

The staff confirmed that flow rates and pressures evaluated in the hydraulic analyses were reflected in the FIP for the respective SG and RCS makeup strategies based upon the above FLEX pumps being diesel and motor driven and the respective FLEX connections being made as directed by the FLEX Support Guidelines (FSGs). During the onsite audit, the staff conducted a walk down of the hose deployment routes for the above FLEX pumps to confirm the reasonableness of the pump staging locations, hose distance runs, and connection points used in the above hydraulic analyses and the FIP. Also, the NRC staff noted that the performance criteria for the FLEX Phase 3 NSRC pumps are consistent with the FLEX Phase 2 portable pumps capacities.

Based on the staff's review of the FLEX pumping capabilities at FNP, as described in the above hydraulic analyses and the FIP, the licensee has demonstrated that its FLEX pumps should perform as intended to support core cooling and RCS makeup during an ELAP caused by an external event, consistent with 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 ELAP with loss of normal access to the UHS event. The electrical strategies described in the FIP are practically identical for maintaining or restoring core cooling, containment, and SFP cooling, except as noted in Sections 3.3.4.4 and 3.4.4.4 of this SE.

The NRC staff reviewed the licensee's FIP, conceptual electrical single-line diagrams, and the summary of calculations for sizing the FLEX generators and station batteries. The NRC staff also reviewed the licensee's evaluations that addressed the effects of temperature on the electrical equipment credited in the FIP as a result of the loss of heating, ventilation, and air conditioning (HVAC) caused by the event.

According to the licensee's FIP, operators would declare an ELAP following a loss of offsite power, emergency diesel generators (EDGs), and any ac source. The plants 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 AOPs. The FLEX strategies are implemented in support of AOPs using FSGs.

During the first phase of the ELAP event, FNP would rely on the Class 1E station batteries to provide power to key instrumentation for monitoring parameters and power to controls for SSCs used to maintain the key safety functions (reactor core cooling, RCS inventory control, and containment integrity). The FNP Class 1E station batteries and associated dc distribution systems are located in a safety-related structure designed to meet all applicable design-basis external hazards. The licensee's procedure NMP-OS-019-104(124), "FSG-4, ELAP DC Load Shed/Management," would 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 (Phase 2) is available. The plant operators would commence load shedding after approximately 30 minutes and complete load shedding within 60 minutes from the onset of an ELAP.

The 125 Vdc system for each unit consists of two 125 Vdc switchgear assemblies, three 125 Vdc battery chargers (one charger can supply either train), two 125 Vdc batteries, and six dc distribution cabinets. The Class 1E station batteries were manufactured by C&D Technologies. The Class 1E station batteries (1A, 1B, 2A, and 2B) are model LCUN-27 rated at 1884 ampere-hours at an 8-hour discharge rate to 1.75 V per cell. The NRC staff reviewed the licensee's dc sizing calculation (SE-SNC458207-001, "Auxiliary Building Battery LOSP Extended Coping Time Study," Revision 2) which verified the capability of the dc system to supply power to the required loads during the first phase of the FNP mitigation strategy. The licensee's evaluation identified the required loads, associated ratings (ampere (A) and minimum required voltage) and the non-essential loads that would be shed within 60 minutes to ensure battery operation until power is restored to the battery chargers (approximately 8 hours). Based on its review, the NRC staff confirmed that Battery 1A could be extended up to 8.5 hours, Battery 1B could be extended up to 9.6 hours, Battery 2A could be extended up to 9.4 hours, and Battery 2B could be extended up to 10 hours by shedding non-essential loads.

The NEI White Paper, "EA-12-049 Mitigating Strategies Resolution of Extended Battery Duty Cycles Generic Concern," (ADAMS Accession No. ML13241A186) provides guidance for calculating extended duty cycles of batteries (i.e., beyond 8 hours) and was endorsed by the NRC (ADAMS Accession No. ML13241A188). In addition to the White Paper, the NRC sponsored testing at Brookhaven National Laboratory that resulted in the issuance of NUREG/CR-7188, "Testing to Evaluate Extended battery Operation in Nuclear Power Plants," in May 2015. The testing provided additional validation that the NEI White Paper method was technically acceptable. The NRC staff reviewed the licensee's battery calculations and confirmed that they had followed the guidance in the NEI White Paper.

Based on the NRC staff's review of the licensee's analysis and procedures and the battery vendor's capacity and discharge rates for the Class 1E station batteries, the NRC staff finds that the FNP dc systems should have adequate capacity and capability to power the loads required to mitigate the consequences during Phase 1 of an ELAP event provided that necessary load shedding is completed within the times assumed in the licensee's analysis.

The licensee's Phase 2 strategy includes repowering 600 Vac load centers (Train A or Train B) approximately 8 hours after initiation of an ELAP event (8.5 hours maximum). The licensee's strategy relies on a portable 545 kilowatt (kW) 600 Vac FLEX DG for both units. The licensee has a total of two portable 600 Vac FLEX DGs. A 600 Vac FLEX DG would provide power to the battery chargers, critical instrumentation, fuel oil transfer pumps, accumulator discharge motor operated valves (MOVs), FLEX ventilation fans, MCR lighting, and the SFP level indication system for both units.

Additionally, the licensee's Phase 2 strategy includes deploying a 114 kW 480 Vac FLEX DG approximately 14 hours after initiation of an ELAP event (19 hours maximum), to power the RCS makeup or boron injection FLEX pump skids for both units. The licensee has a total of two portable 480 Vac FLEX DGs.

The NRC staff reviewed the licensee's calculation A181126, "FLEX Portable System Phase 2 480 V and 600 V Alternate Power Diesel Generator Sizing," Revision 2, conceptual single line diagrams, and the separation and isolation of the FLEX DGs from the EDGs. Based on the NRC staff's review, the required loads for the Phase 2 545 kW FLEX DG is approximately 503 kW running the primary strategy and 484 kW running for the alternate strategy. The required loads for the 114 kW FLEX DG is approximately 80 kW running. To reduce voltage and frequency dips, the licensee's procedures provide directions to sequence loads when loading the FLEX DGs. Therefore, one 545 kW and one 114 kW FLEX DG is adequate to support the electrical loads required for the licensee's Phase 2 strategy.

If the "N" FLEX 600 or 480 Vac DGs become unavailable or otherwise out of service for maintenance, the other ("N+1") FLEX 600 or 480 Vac DGs would be deployed to continue to support the required loads. The "N+1" FLEX 600 and 480 Vac DGs are identical to the "N" FLEX 600 and 480 Vac DGs, respectively, thus ensuring electrical compatibility and sufficient electrical capacity in an instance where substitution is required. Since the "N+1" FLEX 600 and 480 Vac DGs are identical and interchangeable with the "N" FLEX 600 and 480 Vac DGs, respectively, the NRC staff finds that the licensee has met the provisions of NEI 12-06, for spare equipment capability regarding the Phase 2 FLEX generators.

For Phase 3, the licensee plans to continue the Phase 2 coping strategy with additional assistance provided from offsite equipment/resources. The offsite resources, provided by an NSRC for the site, include four 1-megawatt (MW) 4160 Vac Combustion Turbine Generators (CTGs), two 1,100 kW 480 Vac CTGs, two 480 Vac to 600 Vac step-up transformers, and distribution panels (including cables and connectors). Since the licensee plans to continue its Phase 2 coping strategy, one 480 Vac CTG and a 480 Vac to 600 Vac step-up transformer could be used to replace a Phase 2 600 Vac FLEX DG while the other 480 Vac CTG could replace a Phase 2 480 Vac FLEX DG, if necessary.

Each portable 4160 Vac CTG is capable of supplying approximately 1 MW, but two CTGs could be operated in parallel to provide a total of approximately 2 MW per unit. While the licensee does not anticipate needing to use the 4160 Vac CTGS supplied by an NSRC, in calculation A-181127, "FLEX Portable System Phase 3 4160V Alternate Power Turbine Driven Generator Sizing," Revision 2, they determined the minimum loads that could be powered by the NSRC supplied 4160 Vac CTGs during Phase 3 (Unit 1 Train A 200 kW, Unit 2 Train A 98 kW, Unit 1 Train B 122 kW, and Unit 2 Train B 16 kW). The train to be powered during Phase 3 would be the opposite train as was powered during Phase 2. Based on its review of this calculation and the licensee's FIP, the NRC staff finds that the NSRC supplied 4160 Vac CTGs should have adequate capacity to supply the Phase 3 loads, if necessary.

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 RCS 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 3-2 and Appendix D summarize an approach consisting of two 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; and 2) makeup via connection to SFP cooling piping or other alternate location capable of exceeding the boil-off rate for the design-basis heat load. However, in JLD-ISG-2012-01, Revision 1 (ADAMS Accession No. ML15357A163), the NRC staff did not fully accept this approach, and added another requirement to either have the capability to provide spray flow to the SFP, or complete an SFP integrity evaluation which demonstrates that a seismic event would have a very low probability of inducing a crack in the SFP or its piping systems so that spray would not be needed to cool the spent fuel. The evaluation must use the reevaluated seismic hazard described in Section 3.5.1 below if it is higher than the site's current Safe Shutdown Earthquake (SSE). During the event, the licensee selects the SFP makeup method to use based on plant conditions. This approach also requires a strategy to mitigate the effects of steam from the SFP, such as venting.

As described in NEI 12-06, Section 3.2.1.7, and JLD-ISG-2012-01, Section 1.1, strategies that must be completed within a certain period of time should be identified and a basis that the time can be reasonably met should be provided. 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. In 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 loss of cooling in the SFP. As a result, the pool water will heat up and eventually boil off, if no mitigating actions are taken. The licensee's response is to provide makeup water. The timing of operator actions and the required makeup rates depend on the decay heat level of the fuel assemblies in the SFP. The sections below address the response during operating, pre-fuel transfer or post-fuel transfer operations. The effects of an ELAP with full core offload to the SFP is addressed in Section 3.11 of this SE. The licensee has decided to provide the spray flow described in JLD-ISG-2012-01.

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 to boil is sufficient to enable deployment of Phase 2 equipment. During Phase 1, operators will establish ventilation pathways in the AB and monitor level using the SFPLI installed per Order EA-12-051.

3.3.2 Phase 2

During Phase 2, FIP Section 2.5.2 states that operators will deploy a portable SFP FLEX pump to supply water from the SW pond to the SFPs. The SFP FLEX pump discharge can be routed to a connection to the SFP cooling system (not requiring refueling floor access), or routed to the refuel floor to provide direct makeup to the pool and provide spray flow via portable nozzles.

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 is available during Phase 3 for SFP cooling and provide additional defense-in-depth. The NSRC will also provide additional water purification equipment to provide an indefinite clean water source.

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 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 staff reviewed the licensee's calculation on habitability on the SFP refuel floor. This calculation and the FIP indicate that boiling begins at approximately 18 hours during a normal, non-outage situation. The staff noted that the licensee's sequence of events timeline in the FIP indicates that operators will deploy hoses and spray nozzles as a contingency for SFP makeup within 6 hours from event initiation to ensure the SFP area remains habitable for personnel entry.

As described in the licensee's FIP, the licensee's Phase 1 SFP cooling strategy does not require any operator actions. However, the licensee does state in FIP Section 2.5.4.3 that operators will establish a ventilation path to cope with temperature, humidity and condensation from evaporation and/or boiling of the SFP prior to the SFP boiling. The operators are directed to open the SFP room door, an exterior roll-up door to the new fuel room, and an exterior missile door to the new fuel room.

The licensee's Phase 2 and Phase 3 SFP cooling strategy involves the use of the SFP FLEX pump or NSRC supplied pump for Phase 3, with suction from the SW pond, to supply water to the SFP. The staff's evaluation of the robustness and availability of FLEX connections points for the FLEX pump is discussed in SE Section 3.7.3.1 below. Furthermore, the staff's evaluation of the robustness and availability of the SW pond for an ELAP event is discussed in SE Section 3.10.3.

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 SE.

3.3.4.2 Thermal-Hydraulic Analyses

As described in Section 2.5.6 of the FIP, at the maximum design heat load which includes a full core offload the SFP will boil in approximately 5.6 hours and boil off to a level 15 ft above the top of fuel in 23.9 hours from initiation of the event with no operator action. Therefore, the licensee conservatively determined that a SFP makeup flow rate of at least 125 gpm per pool will maintain adequate SFP level at 15 ft above the fuel for an ELAP occurring during normal power operation. Consistent with this guidance in NEI 12-06, Section 3.2.1.6, the staff finds the licensee has considered the maximum design-basis SFP heat load.

3.3.4.3 FLEX Pumps and Water Supplies

As described in the FIP, the SFP cooling strategy relies on one SFP FLEX pump to provide SFP makeup to both pools during Phase 2. The pump consists of a hydraulically driven submersible pump and the trailer mounted diesel driven booster pump that also drives the hydraulic pumping unit. The licensee has procured two pump assemblies including both the submersible and booster pumps to ensure a backup is available. Section 2.5.7.1 of the FIP reference calculation A181106, "FLEX Portable System, Spent Fuel Pool Subsystem, Phase 2," Version 4, describes the hydraulic performance criteria (e.g., flow rate, discharge pressure) for the SFP FLEX Pump. The calculation states the submersible pumps can provide 500 gpm (250 gpm per pool) at 270 psi and the booster pumps can provide 500 gpm at a discharge pressure of 196 psid [psi differential]. The staff noted that the performance criteria of FLEX pumps supplied from an NSRC for Phase 3 would allow the NSRC pump to fulfill the mission of the onsite FLEX pump if the onsite FLEX pump were to fail. As stated above, the SFP spray rate of 250 gpm to each pool exceeds the maximum SFP makeup requirements as outlined in the previous section of this SE.

3.3.4.4 Electrical Analyses

The licensee's mitigating strategies for the SFP do not rely on electrical power except for power to SFP level instrumentation. The licensee's Phase 1 electrical SFP cooling strategy is to monitor SFP level using installed instrumentation (the capability of this instrumentation is described in other areas of this SE). The FNP SFPLI has a backup battery with sufficient capacity to ensure a minimum of 24 hours of operation. Prior to the battery fully depleting, the licensee would restore power to the instrumentation using a 600 Vac FLEX DG.

The licensee's Phase 2 and 3 electrical SFP cooling strategy is to continue monitoring SFP level using installed instrumentation. As described and reviewed in Section 3.2.3.6 above, the licensee could utilize the 600 Vac FLEX DGs and NSRC supplied CTGs to provide power via the Class 1E dc distribution system to ensure indefinite SFP level monitoring capability.

Based on its review, the NRC staff finds that the licensee's strategy is acceptable to restore or maintain SFP cooling indefinitely during an ELAP event.

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

The industry guidance document, NEI 12-06, Table 3-2, 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. The Farley units each have a dry ambient pressure containment.

The licensee performed a containment evaluation, as documented in document SM-SNC458207-002, "Containment Analysis of FLEX Strategies," Revision 1.0, which was based on the boundary conditions described in Section 2 of NEI 12-06. The calculation analyzed the strategy for FNP and concluded that the containment parameters of pressure and temperature remain well below the respective updated final safety analysis report (UFSAR) Section 6.2.1 design limits of 54 psig and 280 °F for more than 120 hours. From its review of the evaluation, the NRC staff noted that the required actions to maintain containment integrity and required instrumentation functions have been developed, and are summarized below.

3.4.1 Phase 1

The Phase 1 coping strategy for maintaining containment functions only involves verifying containment isolation and monitoring containment temperature and pressure using installed instrumentation. No specific strategy is required to maintain containment integrity during Phase 1, 2, and 3 of an ELAP event. The FIP states that the containment conditions are monitored on the available plant instrumentation available for the duration of the ELAP.

3.4.2 Phase 2

During Phase 2, containment temperature and pressure are expected to remain below design limits for at least 120 hours; however, containment status will be monitored. A portable 600 Vac DG set is staged and functional, the batteries which are powering the containment pressure instrumentation will be recharged to maintain the monitoring function.

3.4.3 Phase 3

The licensee stated in its FIP that no additional specific Phase 3 strategy is required to maintain containment integrity. During Phase 3, the licensee plans to establish SW cooling and can use the NSRC DGs to repower the containment coolers.

3.4.4 Staff Evaluations

3.4.4.1 Availability of Structures, Systems, and Components

Baseline assumptions in 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

Section 3.8.1.1 of the FNP UFSAR states that the containment consists of a prestressed, reinforced concrete cylindrical structure with a shallow domed roof and a reinforced concrete foundation slab. It is a Category I structure designed to maintain its function following a SSE. Additionally, Section 3.5.1.2.1 of the UFSAR states that Category I structures are designed to withstand extreme wind phenomena including tornado effects. The staff finds that the containment is robust and is/are expected to be available at the start of an ELAP event consistent with NEI 12-06, Section 3.2.1.3.

Section 3.8.1.1 of the UFSAR shows that the internal free volume of the containment is 2.0 million cubic feet. The addition of mass and energy to the containment atmosphere during an ELAP event is driven by the assumed leakage from the RCP seals (see Section 3.4.4.2 for details). The relatively small amount of heat and mass being added to the containment atmosphere coupled with the very large net free volume of the containment results in a slow-moving response. As stated above, the licensee's calculation shows that even with no mitigating actions taken to remove heat from the containment, the containment parameters of pressure and temperature remain well below the respective design limits of 54 psig and 280 °F for at least 120 hours.

3.4.4.1.2 Plant Instrumentation

In NEI 12-06, Table 3-2, specifies that containment pressure is a key containment parameter which should be monitored by repowering the appropriate instruments. The licensee's FIP states that control room instrumentation would be available due to the coping capability of the station batteries and associated inverters in Phase 1, or the portable DGs deployed in Phase 2. If no ac or dc power is available, the FIP states that key credited plant parameters, including containment pressure, would be available using alternate methods.

3.4.4.2 Thermal-Hydraulic Analyses

During the audit process, the NRC staff reviewed calculation SM-SNC458207-002, which was based on the boundary conditions described in Section 2 of NEI 12-06. In this calculation, SNC utilized the Modular Accident Analysis Program (MAAP) 4.0.5 PWR code to model the containment response to an ELAP. The only additions of heat and mass to the containment atmosphere under ELAP conditions are the ambient heat losses from the surfaces of hot equipment and the leakage of reactor coolant from the RCP seals.

Using the input described above, the containment maximum pressure and temperature at 120 hours were determined to be approximately 5.4 psig and 223.3 °F with no operator actions taken. Since these values are still far below the UFSAR design parameters of 54 psig and 280 °F, the licensee has adequately demonstrated that there is significant margin before a limit would be reached.

3.4.4.3 FLEX Pumps and Water Supplies

The licensee does not plan to use any FLEX equipment to maintain containment integrity other than what has already been mentioned in other sections of this SE.

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 maintenance of containment integrity and required instrumentation continues to function. With an ELAP initiated, while FNP is in Modes 1-4, containment cooling would be lost for an extended period of time. Therefore, containment temperature and pressure will slowly increase.

The licensee's Phase 1 coping strategy for containment includes monitoring containment temperature and pressure using installed equipment. The licensee's strategy to repower instrumentation using the Class 1E station batteries for Phase 1 is described in Section 3.2.3.6 of this SE and is adequate to ensure continued containment monitoring.

The licensee's Phase 2 coping strategy is to continue the Phase 1 coping strategy. The licensee's strategy to repower instrumentation using a 600 Vac, 545 kW FLEX DG is described in Section 3.2.3.6 of this SE and is adequate to ensure continued containment monitoring.

The licensee's primary Phase 3 coping strategy is to extend its Phase 2 coping strategy. Since the licensee plans to continue its Phase 2 coping strategy, one 480 Vac CTG and a 480 Vac to 600 Vac step-up transformer could be used to replace a Phase 2 600 Vac FLEX DG while the other 480 Vac CTG could replace a Phase 2 480 Vac FLEX DG. Based on the licensee's analysis (SM-SNC458207-002, "Containment Analysis of FLEX Strategies," Revision 1), containment pressure and temperature should remain within design limits without active containment cooling until beyond 120 hours after the start of the event, at which time availability of the NSRC equipment will allow implementation of long-term strategies to control containment pressure and temperature. Operators will continue to monitor containment parameters to inform the Emergency Director/TSC staff when additional actions may be required to reduce containment temperature and pressure. Guidance in A181109, "FLEX Engineering Judgment Review – FLEX Actions Beyond 72 Hours," Revision 1, and A181103, "Phase 3 4160V Alternate Power Subsystem," Revision 2, provides for the use of NSRC equipment to establish containment cooling.

Based on its review, the NRC staff determined that the electrical equipment available onsite (e.g., Class 1E batteries and 600 Vac FLEX DGs) supplemented with the equipment that will be supplied from an NSRC (e.g., 4160 Vac CTGs, 480 Vac CTGs, and 480 Vac to 600 Vac step-up transformers), provides sufficient capacity and capability to supply the required loads to reduce containment temperature and pressure, if necessary, to ensure that the key components including required instruments remain functional.

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; severe storms with high winds; ice and extreme cold; and extreme high temperatures. The snow and flooding hazards were screened out for FNP.

References to external hazards within the licensee's mitigating strategies and this SE are consistent with the guidance in NEI-12-06 and the related 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 pursuant to Title 10 of the *Code of Federal Regulations* Part 50, Section 50.54(f) (ADAMS Accession No. ML12053A340), (hereafter referred to as the 50.54(f) letter), which requested that licensees reevaluate the seismic and flooding hazards at their sites using updated hazard information and current regulatory guidance and methodologies. Due to the time needed to reevaluate the hazards, and for the NRC to review and approve them, the reevaluated hazards were generally not available until after the mitigation strategies had been developed. The NRC staff has developed a proposed rule, titled "Mitigation of Beyond-Design-Basis Events," hereafter called the MBDBE rule, which was published for comment in the *Federal Register* on November 13, 2015 (80 FR 70610). The proposed MBDBE rule would make the intent of Orders EA-12-049 and EA-12-051 generically applicable to all present and future power reactor licensees, while also requiring that licensees consider the reevaluated hazard information developed in response to the 50.54(f) letter.

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

Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards" (ADAMS Accession No. ML15089A236)). The Commission provided guidance in an SRM to COMSECY-14-0037 (ADAMS Accession No. ML14309A256).

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. By letter dated September 1, 2015 (ADAMS Accession No. ML15174A257), the NRC staff informed the licensees that the implementation of mitigation strategies should continue as described in licensee's OIPs, and that the NRC SEs and inspections related to Order EA-12-049 will rely on the guidance provided in JLD-ISG-2012-01, Revision 0, and the related industry guidance in NEI 12-06, Revision 0. The hazard reevaluations may also identify issues to be entered into the licensee's corrective action program consistent with the OIPs submitted in accordance with Order EA-12-049.

As discussed above, licensees are reevaluating the site seismic and flood hazards as requested in the NRC's 50.54(f) letter. After the NRC staff approves the reevaluated hazards, licensees will use this information to perform flood and seismic mitigating strategies assessments (MSAs) per the guidance in NEI 12-06, Revision 2, Appendices G and H (ADAMS Accession No. ML16005A625). The NRC staff endorsed Revision 2 of NEI 12-06 in JLD-ISG-2012-01, Revision 1 (ADAMS Accession No. ML15357A163). The licensee's MSAs will evaluate the mitigating strategies described in this SE using the revised seismic hazard information and, if necessary, make changes to the strategies or equipment. Licensees will submit the MSAs for NRC staff review.

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

3.5.1 Seismic

In its FIP, the licensee described the current design-basis seismic hazard, or the SSE. As described in FNP UFSAR Section 3.10.1, the SSE seismic criterion for the site is one-tenth of the acceleration due to gravity (0.10g). It should be noted that the actual seismic hazard involves 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.

By letter dated October 27, 2015 (ADAMS Accession No. ML15194A015), the NRC staff made a determination to no longer expect any seismic evaluations from FNP based on "de minimis" exceedance of the reevaluated seismic hazard over FNP's design-basis SSE. Based this letter, FNP has no pending actions associated with NTTF Recommendation 2.1, "Seismic."

3.5.2 Flooding

In its FIP, the licensee described that the current design basis for the limiting site flooding event is the Probable Maximum Flood (PMF) event. As described in UFSAR Section 2.4.2.2, the PMF elevation is 144.2 ft MSL without wave runup. With wave runup, the water may reach as high as 153.3 ft MSL. The licensee stated that the grade elevation of the FNP safety-related structures is approximately 155 ft MSL and not susceptible to external flooding from the PMF event. The site is not adjacent to a large, enclosed, or partially enclosed body of water. The FIP also states that, in accordance with the NEI guidance, FNP is considered a dry site, and would not be adversely affected by external flooding.

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 proposed MBDBE rulemaking. The licensee has appropriately screened out this external hazard.

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 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.

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/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, "Design Basis Tornado for Nuclear Power Plants," Revision 1.

In its FIP, regarding the determination of applicable extreme external hazards, SNC stated that the site is located at 31° 13' North latitude and 85° 06' West longitude. In NEI 12-06, Figure 7-1, "Contours of Peak-Gust Wind Speeds at 10-m Height in Flat Open Terrain, Annual Exceedance Probability of 10-6," indicates the site is in a region where the hurricane wind speed exceeds 130 mph. In NEI 12-06, Figure 7-2, "Recommended Tornado Design Wind Speeds for the 1E-6/year Probability Level," indicates the site is in Region 1, where the tornado design wind speed exceeds 130 mph. Therefore, the plant screens in for an assessment for high winds, hurricanes and tornados, including missiles produced by these events.

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 NEI 12-06 Figure 8-2 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 at 31° 13' North latitude and 85° 06' West longitude. Per NEI 12-06 Section 8.2.1 guidance, the licensee stated that extreme snowfall is not a concern for FNP, which is located in the southeastern U.S. Snow is infrequent in the site region and heavy snow is very rare. The site is located within the region characterized by EPRI as ice severity level 4 (NEI 12-06, Figure 8-2, Maximum Ice Storm Severity Maps). Consequently, the site is subject to icing conditions that could cause severe damage to electrical transmission lines. An extreme minimum temperature of -1 °F was recorded at Blakely, AL in February 1899. The licensee concludes that the plant screens in for an assessment for ice, and extreme cold hazard.

In summary, based on the available local data and Figures 8-1 and 8-2 of NEI 12-06, the plant site does experience severe 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. The licensee noted that summers at the site may bring periods of extremely hot weather. An extreme maximum of 107 °F was recorded in Blakely, AL and 104 °F in Dothan, AL. 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 FIP, the licensee stated that the FLEX equipment is stored in the FSB. The FSB is a single 12,000 square foot concrete structure located outside the protected area, but within the owner controlled area. The licensee noted that the design criteria for the FSB meet the site design-basis weather effects in accordance with the requirements of ASCE 7-10, "Minimum Design Loads for Buildings and Other Structures." The FLEX equipment stored in the FSB consists of: the SG FLEX pumps, the SFP FLEX pumps, the 600 Vac and 480 Vac FLEX generators, FLEX fuel tankers, set of spray nozzles, and required hoses.
As described by the licensee in its FIP, debris removal equipment is also stored inside the FSB in order to reasonably protect it from the applicable external events such that the equipment remains functional and deployable to clear obstructions from the pathway between the FLEX equipment's storage location and its deployment location(s).

The logistics of equipment removal after a BDBEE was considered in the design of the FSB. The licensee noted that two equipment doors are provided and located 180° around the perimeter of the building from each other. The door opening size provides a minimum clearance for equipment of 14 ft in height and 16 ft in width. The design also includes two personnel entry/exit doors.

Other FLEX equipment is stored inside the robust AB. The skid mounted RCS makeup FLEX pumps, the skid mounted FLEX BI pumps and various FLEX portable ventilation fans are stored/deployed at the 100 ft elevation of the AB.

Below are additional details, provided in the FIP, on how FLEX equipment is protected from each of the applicable external hazards.

3.6.1.1 Seismic

In its FIP, SNC denotes that the FSB meets the plant's design-basis for the SSE. Additionally, large portable FLEX equipment such as pumps and power supplies are secured, as required, inside the FSB to protect them during a seismic event. Tie downs are integrated into the FSB floor slab for this purpose. These tie downs are used to secure any equipment that is not considered stable to ensure the stored FLEX equipment remains protected from damage during a seismic event.

It is further described, in FNP's FIP, that fire protection piping and HVAC were designed and installed to meet the FSB seismic design specifications. Additionally, the lighting, conduits, electrical, and fire detection components were not seismically installed because they are considered insignificant and not able to damage FLEX equipment and are only required to be functional before the event.

The AB is a seismically qualified structure capable of protecting the FLEX equipment.

3.6.1.2 Flooding

The licensee described the location of the FSB as being significantly above the upper-bound flood stage elevation. The FSB is described in the FIP as designed and constructed to prevent water intrusion. The AB is located at site elevation above the PMF thus affording flood protection to the skid mounted RCS makeup FLEX pumps and the skid mounted FLEX BI pumps stored and deployed inside the AB.

3.6.1.3 High Winds

In its FIP, the licensee described the FSB as a tornado-missile protected concrete structure. The doors are designed for design-basis tornado and wind loading and to be operational after tornado wind pressure loads and tornado-missile loads. The AB is designed for the tornado borne missile thus affording protection to the skid mounted RCS makeup FLEX pumps and the skid mounted FLEX BI pumps stored and deployed inside the AB.

3.6.1.4 Snow, Ice, Extreme Cold and Extreme Heat

In its FIP, the licensee stated that the FSB HVAC systems are designed to maintain a minimum indoor temperature of 50 °F and a maximum indoor temperature of 100 °F. Following a BDBEE, conditions within the AB will limit the maximum temperature to 125 °F. Connections to the RWST on the 100 ft elevation of the AB are not susceptible to freezing.

3.6.1.5 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that, if implemented as described in the FIP, 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.

The following equipment is stored in the FSB: three sets of trailer mounted SG FLEX pumps each sized to support one unit, two 600 Vac trailer mounted diesel driven generators and two 480 Vac trailer mounted diesel driven generators each type sized to support both units, two trailer mounted SFP pumps each sized to support both units, two fuel tankers, three sets of spray nozzles and hoses, two tow vehicles, and one medium wheeled loader.

The following equipment is stored at the 100 ft elevation within the AB: three sets of skid mounted electric motor driven RCS makeup FLEX pumps, each sized to support one unit and three sets of skid mounted electric motor driven FLEX BI pumps, each also sized to support one unit. The associated hoses and cables for these pump skids are also stored in the AB on the 100 ft level.

Hose and cable quantities are based on providing additional hose or cable equivalent to 10 percent of the total length of each type/size of hoses or cable necessary for the N capability. This is accordance with NEI 12-06, Revision 2.

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 as described, the licensee's FLEX strategies include a sufficient number of portable FLEX pumps, FLEX DGs, and equipment for RCS makeup and boration, SFP makeup, and maintaining containment consistent with the N+1 recommendation in Section 3.2.2.16 of NEI 12-06, Revision 2.

3.7 Planned Deployment of FLEX Equipment

In its FIP, the licensee stated that multiple haul routes are available from the FSB to any staging area. Alternative routes into the power block area exist on the south and east sides of the plant that could be utilized. The licensee determined through walk downs that all haul paths can support a minimum of two lanes of normal vehicular traffic. This will decrease the likelihood of a path being completely blocked, as well as reduce the time it will take to clear any debris adequately to deploy the FLEX equipment. Time to clear debris to allow equipment deployment is assumed to be up to 4 hours. The licensee considers this time to be conservative based on site reviews and the location of the FSB.

Deployments of the FLEX and debris removal equipment from the FSB are not dependent on off-site power. Equipment access and personnel access doors have the ability to be operated manually in the case of a loss of power.

3.7.1 Means of Deployment

The licensee performed a debris assessment for the site to determine debris removal equipment requirements. It was determined that the debris removal equipment should be capable of moving large debris such as automobiles, trees, pieces of buildings, switchyard structures, and concrete barriers, in addition to general assorted small debris such as limbs. Based on this assessment, SNC determined that a medium wheeled loader with the appropriate blade and horsepower can move the postulated debris in a single maneuver which simplifies and speeds the debris removal effort. Debris clearing equipment is stored in the FSB. This provides the equipment with direct access to the critical travel paths for timely debris removal. The FLEX equipment stored in the FSB will be towed by a heavy duty pickup truck or a small semi-tractor. The wheeled loader can also be used to tow equipment. Because advance warning of freezing weather would be available, licensee stated that actions will be taken per procedural guidance in advance to prepare for adverse icing conditions.

3.7.2 Deployment Strategies

Based on the results of a liquefaction potential assessment, the licensee concluded that the overall liquefaction potential at the FSB and across the designated travel paths is deemed low for the postulated seismic ground motions. The risk of surface displacement due to faulting or lateral spreading is also deemed low by the licensee.

The FLEX SFP pump is staged at the SW pond. The pump is a portable diesel-driven unit consisting of both the submersible pump and submersible hydraulic pumping unit. The pump is deployed to provide makeup to the SFP. The SW pond can also be used as a source of makeup to the CST and RMWST. The NSRC-supplied pumps and hoses would be utilized to take suction on the SW pond or the Chattahoochee River. The licensee evaluated the potential impact of extreme cold weather on the accessibility of the SW pond and the Chattahoochee

River. Temperature records indicate that icing of ponds and rivers is not a factor to be considered. There is no record of the Chattahoochee River icing over in the vicinity of FNP. Therefore, the licensee concluded that there is no risk of frazil ice, or freezing of the UHS water source, SW pond, or of ice blockage of the Chattahoochee River.

3.7.3 Connection Points

3.7.3.1 Mechanical Connection Points

Core Cooling

Section 2.4.5.1 of the licensee's FIP, states that the primary connection point for the SG FLEX pump inject into auxiliary feedwater discharge piping that both feed all three SGs. The licensee states that there are two connections that are located in each AB at plant grade and are protected from all applicable hazards and seismically robust. Two independent permanent pipes directs flow down the 100 ft elevation of the AB where hoses are connected to a fully protected and robust connection on the AFW discharge header. As described in Figure 8 of NMP-OS-019-163, "Farley Unit 1 SIG-3, Core Cooling," Version 1.0 and NMP-OS-019-183, "Farley Unit 2 SIG-3, Core Cooling," Version 1.0, the alternate connections for both units use the existing B.5.b connection to the main feedwater piping located in both units ABs. Additionally, the SG FLEX pump will take suction from a connection to the CST which the licensee stated in the FIP was fully protected from all applicable external hazards.

RCS Inventory Control/Makeup

Section 2.4.5.4 of the FIP, states that the discharge from the BI FLEX pump will be connected to the primary RCS tie-in on the charging pump discharge header located in the AB. Additionally, the alternate RCS connection is tied into the cold injection headers of the SI system. The licensee states in the FIP Section 2.4.5.4 that both connections are seismically robust and fully protected from all applicable hazards.

SFP Makeup

In the FIP, Section 2.5.4.1 describes the licensee's SFP makeup strategy connections. The licensee has two independent flow paths for providing SFP make up from the one of two available SFP FLEX pumps to both pools. The primary flow path utilizes hoses routed from the pump, to the refueling floor, and directly to the pool. The alternate connection is a flanged connection on the SFP cooling system which is located in the AB and thus protected from all applicable hazards.

Given the design and location of the primary and alternate connection points, as described in the above paragraphs, the staff finds that at least one of the connection points should be available to support core and SFP cooling via a portable pump during an ELAP caused by an external event, consistent with NEI 12-06 Section 3.2.2.

3.7.3.2 Electrical Connection Points

Electrical connection points are only applicable for Phases 2 and 3 of the licensee's mitigation strategies for a BDBEE.

During Phase 2, the licensee's strategy is to supply power to equipment required to maintain or restore core cooling, containment, and SFP cooling using a combination of permanently installed and portable components.

For the 600 Vac FLEX DGs, a 600 Vac FLEX terminal box for each unit is mounted on an inside wall of each AB. Missile-shield protected penetrations allow access to the terminal boxes, which are connected to load centers via transfer switches. The terminal box provides the color-coded connections for the 600 Vac FLEX DG to be plugged into the system. The primary staging location for a FLEX 600 Vac DG is near the Unit 2 AB. The 600 Vac FLEX terminal box at that location would power the Train A equipment on both units (load centers 1D and 2D). The alternate staging location, near the Unit 1 AB, would power the Train B equipment on both units (load centers 1E and 2E). Guidance in NMP-OS-019-105(125), "FSG-5, Initial Assessment And FLEX Equipment Staging," Revision 1, provides direction for deploying and staging the 600 Vac FLEX DG. NMP-OS-019-161, "Farley Unit S SIG-1, 600V Alternate Power," Revision 1, provides guidance for connecting, making electrical alignments, and operating the 600 Vac FLEX DG.

For the 480 Vac FLEX DGs, a wall-mounted receptacle is located near the BI and RCS makeup FLEX pump staging area on each unit. Power cable from each receptacle would be routed to the hot machine shop to a termination box at plant grade elevation. This termination box, when connected by temporary cabling to a 480 Vac FLEX DG outside the east missile shield door, would power the pumps on both units from either the primary location (within 350 ft of the Unit 2 AB East missile door) or the alternate location (within 350 ft of the Unit 1 AB East missile door). As an alternate, a 480 Vac FLEX terminal box, along with receptacles, is mounted on a portable cart that can be used to connect a 480 Vac FLEX DG to the pumps. Guidance in NMP-OS-019-105(125), provides direction for deploying and staging the 480 Vac FLEX DG. Guidance in NMP-OS-019-162, "Farley Unit S SIG-2, 480V Alternate Power," Revision 1, provides instructions for connecting, making electrical alignments, and operating the 480 Vac FLEX DG.

The licensee performed acceptance testing for the installed FLEX connectors that verified proper termination at each connector and that the phase rotation matched the existing plant configuration.

For Phase 3, the licensee will receive four 1 MW 4160 Vac CTGs and two 1,100 kW 480 Vac CTGs, and a 480 Vac to 600 Vac step-up transformer from an NSRC. Since the licensee plans to continue its Phase 2 coping strategy, one 480 Vac CTG and a 480 Vac to 600 Vac step-up transformer could be used to replace a Phase 2 600 Vac FLEX DG while the other 480 Vac CTG could replace a Phase 2 480 Vac FLEX DG. The licensee would stage the CTGs near the Phase 2 FLEX DG it would be replacing and utilize NMP-OS-019-161, NMP-OS-019-162, and NMP-OS-019-002, "TSC Support for Beyond Design Basis Events," as guidance for connecting, verifying proper phase rotation, and and making the appropriate electrical alignments.

If necessary, the 4160 Vac CTGs could be connected to the train opposite of the one powered during Phase 2 by connecting to the EDG control panel (spliced directly into the wiring that has been disconnected from the emergency plant DG control panels). For example, if the Phase 2 600 Vac FLEX DG is connected to load centers 1D and 2D, the Phase 3 4160 Vac CTGs would be connected to 4160 Vac Buses 1G and 2G. A181103 provides guidance on deploying and connecting the 4160 Vac CTGs. Guidance in NMP-OS-019-002 includes steps to verify proper phase rotation prior to energizing plant equipment.

Based on its review of single line electrical diagrams and station procedures, the NRC staff finds that the licensee's approach seems to be acceptable given the protection and diversity of the power supply pathways, the separation and isolation of the FLEX DGs from the Class 1E EDGs, and availability of procedures to direct operators how to align, connect, and protect associated systems and components.

3.7.4 Accessibility and Lighting

In its FIP, the licensee stated that the majority of areas for ingress/egress and deployment of FLEX strategies contain emergency lighting fixtures (Appendix "R" lighting) consisting of a battery, battery charger and associated light fixtures. These emergency lights are designed and periodically tested to insure the battery pack will provide a minimum of eight hours of lighting with no external ac power sources. Prior to the depletion of the Appendix "R" lighting, portable battery powered lighting could be deployed to support the FLEX strategy tasks, but are not required for compliance. Flashlights are the primary means of lighting to accomplish FLEX actions. All operators are required to have flashlights. In addition, the MCR and maintenance shop include a stock of flashlights and batteries to further assist the staff responding to a BDBEE event during low light conditions.

The licensee further described in its FIP, that there are no emergency lighting fixtures in the yard outside of the protected area to provide lighting in those areas where portable FLEX equipment is to be deployed. Therefore, the FLEX pumps and DGs are outfitted with light plants that are powered from either their respective DGs or batteries in order to support connection and operation. In addition to the lights installed on the FLEX equipment, diesel powered portable light plants are available to be deployed from the FSB as needed to support night time operations.

Emergency lighting in the MCR will be de-energized as part of the dc extended load shed. Portable, battery-powered lighting will be established prior to the dc extended load shed. The MCR emergency lighting will be reestablished once the 600 Vac FLEX DG has been staged and connected.

3.7.5 Access to Protected and Vital Areas

During the audit process, the licensee provided information describing that access to protected areas will not be hindered. The licensee has contingencies in place to provide access to areas required for the ELAP response if the normal access control systems are without power.

3.7.6 Fueling of FLEX Equipment

In its FIP, the licensee noted that the five underground diesel fuel oil storage tanks (DFOSTs) at FNP are seismically qualified, protected from missiles, and have a nominal capacity of 40,000 gallons each. The FNP Technical Specifications require that each DFOST contain at least 25,000 gallons of fuel. The licensee stated that the stored quantity of fuel in any one selected DFOST will meet the fuel demand for all of the diesel driven FLEX equipment well past 72 hours. Although not addressed in the FIP, procedure NMP-OS-019-157, "Farley Unit S SIG-7, Diesel Oil Transfer," Version 1.0, states that all FLEX diesel engines and FLEX Fuel Tankers will be stored fully fueled. Additionally, the procedure contains usage rates for each piece of diesel-driven FLEX equipment. The Phase 2 support strategy includes repowering an existing diesel fuel oil transfer pump to refill a FLEX fuel tanker from the chosen DFOST. Hoses are connected to a flanged connection in the transfer pump discharge piping. Breaker alignments will supply power from a 600V FLEX DG to the selected transfer pump motor. A FLEX fuel tanker will be towed to each diesel-driven FLEX component that needs refueling. An on board dc powered pump will dispense fuel oil from the tanker. The haul routes for transporting fuel are the same haul routes for deployment of the FLEX equipment, which are evaluated for accessibility following the applicable external hazards. Given the information above, the licensee should have sufficient fuel onsite for diesel-powered equipment, and that diesel-powered FLEX equipment should be refueled to ensure uninterrupted operation to support the licensee's FLEX strategies.

The FIP did not explicitly describe that the maintenance and test plan involves checking and replacing fluids for the FLEX equipment. However, the licensee clarified, during the audit process, that fuel quality will be monitored in accordance with the preventive maintenance (PM) guidance in EPRI Technical Report 3002000623, "Nuclear Maintenance Applications Center: Preventive Maintenance Basis for FLEX Equipment." The EPRI PM guideline recommends performing fluid analysis to check for age and contamination issues. Based on the above, the NRC staff finds that the FLEX equipment should be properly maintained (including fluids) and available at the start of a BDBEE.

3.7.7 Conclusions

The NRC staff concludes that the licensee has developed guidance that, if implemented as described in the FIP, 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 Joseph M. Farley Nuclear Plant 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, located near Memphis, Tennessee and Phoenix, Arizona, 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 (ADAMS Accession No. ML14265A107), 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.

The NRC staff noted that the licensee's SAFER Response Plan 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. For FNP, Alternate Staging Area D is not used. Staging Area C is the Abbeville Municipal Airport. Staging Area B is a pad located outside the protected area near the new FSB.

Use of helicopters to transport equipment is recognized as a potential need within the FNP SAFER Plan should the roads be impacted by seismic activity or floods 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 as described, 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 FNP, ventilation that provides cooling to occupied areas and areas containing required equipment will be lost. The primary concern with regard to ventilation is the heat buildup that occurs with the loss of forced ventilation in areas that continue to have heat loads.

The licensee performed loss of ventilation analyses to quantify the maximum steady-state temperatures expected in specific areas related to FLEX implementation to ensure the environmental conditions remain acceptable for personnel habitability or accessibility and within equipment limits. The key areas identified for all phases of execution of the FLEX strategy activities are the MCR, TDAFW Pump Room, Class 1E Battery and Switchgear Rooms, the AB 100 ft Elevation, and the containment.

Main Control Room

Licensee calculation SM-SNC458207-001, "Farley Main Control Room Heat up Evaluation during an Extended Loss of all AC Power," Revision 2, determined that mitigating actions are required to ensure that the MCR temperature remains below 110 °F. The licensee's Phase 1

FLEX strategy is to block open the MCR access doors within the first 2 hours after initiation of an ELAP event. Fourteen hours after the onset of an ELAP event, operators would deploy a 6,000 cubic feet per minute (cfm) fan. Procedure NMP-OS-019-105(125), directs operators to open doors and establish portable ventilation. This strategy should provide enough ventilation to equalize the MCR temperature to approximately that of the outside air. If the outside temperature is above 98 °F, then operators would not open the doors until the MCR temperature is in excess of the outside temperature. External temperatures above 98 °F are normally only exceeded for a limited time during the early afternoon hours. In addition, according to the licensee's analysis, there is on average a 22.7 °F difference between the daily high and low temperatures.

Based on the licensee's analysis and the availability of procedures to maintain temperatures 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, for electronic equipment to be able to survive indefinitely), the NRC staff finds that the electrical equipment in the MCR will not be adversely impacted by the loss of ventilation as a result of an ELAP event.

TDAFW Pump Room

Licensee calculation BM-96-1171-001, "Heat-Up of Turbine Driven Aux. FW Pump Room with Loss of Ventilation," Revision 0, determined that the TDAFW pump room temperature approaches an approximately steady-state temperature of 123 – 125 °F at 24 hours. Per NUMARC 87-00, the TDAFW pump room equipment can be exposed to thermal environments of 150 °F to 300 °F. The TDAFW pump would be operated entirely by manual controls approximately 2 hours after initiation of an ELAP event. Additionally, following plant cooldown and depressurization at 14 hours, the SG FLEX pump would be available to provide SG feed. Therefore, after 24 hours, manual operation of the TDAFW pump is not the only credited strategy available.

Based on temperatures remaining below the limits identified in NUMARC-87-00, the TDAFW pump being entirely operated with manual controls after approximately 2 hours after initiation of an ELAP event, and availability of the SG FLEX pump, the NRC staff finds that the electrical equipment in the TDAFW Pump Room will not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Class 1E Battery and Switchgear Rooms

Licensee calculation SM-SNC458207-005, "Farley Auxiliary Building DC Equipment Rooms Heat Up after an Extended Loss of All AC Power," Revision 1, determined that the FNP Class 1E Battery Rooms could reach temperatures as high as 114 °F over a 72-hour period with doors closed. The calculation also determined that with the doors opened and portable ventilation in operation, the temperature would reach as high as 118 °F over a 72-hour period in the dc equipment rooms (which house the switchgear, battery chargers, and inverters).

As stated by the licensee in its FIP, FNP will receive offsite resources and equipment from an NSRC following 72 hours after the onset of an ELAP event. The NRC staff finds that it is reasonable to expect that the licensee could utilize these resources to reduce or maintain temperatures within the Class 1E battery and switchgear rooms to ensure that required electrical equipment survives indefinitely.

Guidance in NMP-OS-019-104(124) directs operators to open doors within 1 hour of initiation of an ELAP event. Guidance in NMP-OS-019-105(125), directs operators to establish portable ventilation using three fans per unit (one with a trunk from the floor above) approximately 8 hours after the initiation of an ELAP event. The elevated temperature also has an impact by increasing the charging current required to maintain the float charging voltage set by the battery charger. The elevated charging current will in turn increase cell water loss through an increase in gassing. Based on this, periodic water addition may be required or the float charging voltage reduced per the guidance contained in the C&D Technologies vendor manual.

Based on the licensee's analysis and the availability of procedures to maintain temperatures 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, for electronic equipment to be able to survive indefinitely and a temperature that is below the battery manufacturer limits), the NRC staff finds that the electrical equipment in the Class 1E Battery and Switchgear Rooms should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Auxiliary Building 100 ft Elevation

The BI and RCS makeup FLEX pumps are stored/located on the AB 100 ft elevation. The licensee's analysis (SM-SNC458207-006, "Auxiliary Building El. 100' Corridor Heat up Evaluation During an Extended Loss of All ac Power," Revision 1), determined that temperatures in this area will remain below 125 °F for the initial 72 hours during an ELAP. The licensee procured the RCS FLEX pumps to withstand an ambient temperature of at least 125 °F.

The licensee stated in its FIP, that FNP will receive offsite resources and equipment from an NSRC 72 hours after the onset of an ELAP event. The licensee indicated that additional instructions for connection and utilization of NSRC equipment for long-term coping or recovery would be provided by TSC personnel if they determine a need after having assessed the condition of the plant and infrastructure, plant accessibility, and additional available offsite resources (both equipment and personnel) following the BDBEE. The NRC staff finds that it is reasonable to expect that the licensee could utilize these resources to reduce or maintain temperatures within the AB 100 ft elevation to ensure that required electrical equipment associated with the RCS makeup FLEX pumps survive indefinitely.

Containment

Licensee calculation SM-SNC458207-002, "Containment Analysis of FLEX Strategies," Revision 1, determined that for Modes 1-4 the containment design limits (54 psig and 280 °F) would not be exceeded. The calculation determined that containment pressure at 120 hours (5 days) would be 5.4 psig and the peak containment temperature at 120 hours would be 223.3 °F.

The required instrumentation located within containment meet Regulatory Guide 1.97 Category I design and qualification requirements for seismic and environmental qualification, single failure criterion, utilization of emergency standby power, immediately accessible display, continuous readout, and recording of display. These design requirements bound the expected environmental conditions during an ELAP; therefore required instrumentation should not be adversely impacted by a loss of ventilation as a result of an ELAP. Nonetheless, plant operators will continue to monitor containment parameters to inform the Emergency

Director/TSC staff when additional actions may be required to reduce containment temperature and pressure.

The accumulator isolation valves, reactor vessel head vents, and pressurizer power operated relief valves (PORVs) may be required within the first 24 hours following initiation of an ELAP event for RCS inventory and/or boration control. Either the head vent valves or the PORVs will be operated as required to allow for any additional RCS makeup or boration. The environmental qualification reports for these components demonstrate that the temperature test criteria applied to each component exceeds the expected containment conditions for ELAP event. Test conditions for the equipment that may be operated inside containment after 24 hours exceeds the expected post-ELAP containment temperature conditions based on the licensee's calculation at the 5-day point. Operators will continue to monitor containment parameters to inform the Emergency Director/TSC staff when additional actions may be required to reduce containment temperature and pressure. These include transition to the SG FLEX pump for SG makeup, additional SG depressurization, or use of the NSRC-supplied equipment. Documents A181109 and A181103, contain guidance for the use of NSRC equipment to establish containment cooling.

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, TDAFW Pump Room, Class 1E Battery and Switchgear Rooms, AB 100 ft elevation, and containment, the NRC staff finds that the equipment should perform their required functions at the expected temperatures as a result of loss of ventilation during an ELAP concurrent with loss of normal access to the UHS.

3.9.1.2 Loss of Heating

Operation of the TDAFW pump involves steam flow through the turbine and associated piping. The TDAFW pump is located in a temperature-controlled area of the AB and is relied upon immediately at the start of ELAP event. The staff finds it reasonable that low outside temperatures would not have an adverse effect on the TDAFW pump because of its location in an initially temperature-controlled area, steam flow through the components provides a heat load, and the components are in use early in the ELAP event.

The licensee states in its FIP, that the installed heat tracing for the RMWST and RWST is used to ensure nozzles and level instrumentation is maintained using heat tracing. The licensee states in Section 2.12.2 of the FIP, that they should be able to thaw the necessary connections so the water sources can be used in accordance with the times specified in the sequence of events. Additionally, the licensee stated in Section 2.7.4 of the FIP, that the FLEX equipment stored outdoors is designed for outdoor storage in cold environments and will be available during an ELAP event. Additionally, the licensee stated that mitigating actions are taken per procedure in advance of cold weather using the existing cold weather. Lastly, the licensee stated in the FIP Section 2.12.2, that they have special operating requirements for the FLEX pumps and DGs when the temperature falls below freezing.

The FNP Class 1E station battery rooms are located substantially internal to the plant and would not be exposed to extreme low temperatures. At the onset of the event, the Class 1E Battery

Rooms would be at their normal operating temperature and the temperature of the electrolyte in the cells would build up due to the heat generated by the batteries discharging and during recharging. Temperatures in the battery and switchgear rooms are not expected to be sensitive to extreme cold conditions due to their location, the concrete walls isolating the rooms from the outdoors, and lack of forced outdoor air ventilation during early phases of the ELAP event.

Based on the above, the NRC staff finds that the FNP station equipment required to support the FLEX mitigation strategy should perform the required functions at the expected temperatures as a result of loss of heating during an ELAP event consistent with NEI 12-06 Sections 3.2.2.12 and 8.3.2.

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. Guidance in NMP-OS-019-104(124) directs operators to open battery room doors within 1 hour of initiation of an ELAP event. Once battery charging has commenced, NMP-OS-019-105(125) directs operators to establish portable ventilation for the battery rooms. The licensee's analyses (SM-SNC458207-007, "Class 1E Battery Hydrogen Generation after an Extended Loss of ac Power (ELAP)," Revision 2, and A181113, "FLEX Portable System Ventilation Subsystem Battery Room and DC Switchgear Room," Revision 1) showed that the licensee's strategy to maintain the Battery and Switchgear Room temperatures below 120 °F was adequate to maintain hydrogen concentration in the Class 1E Battery Rooms within acceptable levels.

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

3.9.2 Personnel Habitability

3.9.2.1 Main Control Room

Section 2.12.1 of the FIP indicates that an evaluation of the temperature response inside the MCR concluded that the temperature will stay at or below 110 °F, assuming operators open the doors within 2 hours minutes into the ELAP event and place a 6,000 cfm fan in service within 14 hours of the event. Additionally, operators must place in service a 15,000 cfm portable fan within 13 hours of the start of the event. Procedure NMP-OS-019-105 (125), "Farley Unit 1 (2) FSG-5, Initial Assessment and FLEX Equipment Staging," Version 1.0, directs operators to open doors within 2.0 hours and place the fan in service within 14 hours. Based on the temperature remaining below 110 °F and operator actions to open the control room doors to provide ventilation in accordance with station procedures, the staff finds that station personnel can safely occupy and perform the necessary actions to support the FLEX mitigation strategy during an ELAP event, consistent with NEI 12-06, Section 3.2.2.

3.9.2.2 Spent Fuel Pool Area

Refer to SE Section 3.3.4.1.1 above for the detailed discussion of ventilation and habitability considerations in the SFP Area. In general, the licensee plans to establish ventilation at the Fuel Building and deploy hoses before the SFP boiling affects habitability. The licensee also has the ability to add water to the SFP from the installed SFP cooling piping without accessing the refueling floor.

3.9.2.3 Other Plant Areas

TDAFW Pump Room

The licensee states that continuous habitability of the TDAFW pump room is not required. If personnel entry is required, the licensee states that they will take protective measure in accordance with site procedures.

3.9.3 Conclusions

The NRC staff concludes that the licensee has developed guidance that, if implemented as described, 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

In its FIP, SNC provided a comprehensive list of onsite water sources considered for core cooling and SFP cooling coping strategies. This table considers each source's design robustness with respect to seismic events, high winds, and associated missiles. The CST, RMWST, RWST, SW pond, and Chattahoochee River meet the qualification guidelines of NEI 12-06 for an injection source that can be credited for the ELAP concurrent with loss of normal access to the UHS event. Other tanks and basins are included in the table to provide a comprehensive list of site water sources. The licensee stated these non-creditable water sources may be available, depending on the cause of the event, and although these are not credited, they will be considered for use during an actual event.

3.10.1 Steam Generator Make-Up

In its FIP, the licensee stated that, at the onset of an ELAP, the initial source of makeup water to the SGs is each unit's CST. The TDAFW pump starts automatically upon loss of ac all power and is aligned to the CST. The CSTs are seismic Category I tanks. Each CST is nominally a 500,000 gallon tank. However, only the bottom 12-foot section of the tank containing approximately 164,000 gallons of demineralized water is designed to protect against rupture caused by a tornado borne missile and credited for injection to the SGs for high wind hazards. The licensee determined that the 164,000 gallons of usable water can provide makeup to the SGs for approximately 12 hours. Prior to depletion of the CST inventory, RMWST can supply demineralized makeup water to the CST using the diesel driven SG FLEX pump. The RWST serves as an alternate supply of makeup water to the CST and RMWST. Both the RMWST and the RWST are seismically qualified and missile protected sources of water. Water from the RWST will be transferred to the CST or RMWST using the electric motor driven RCS makeup FLEX pump.

The licensee stated that the minimum usable RMWST capacity of approximately 160,000 gallons will provide a suction source to the TDAFW pump for minimum of 19 additional hours. When the TDAFW pump can no longer be operated due to the lowering SG pressure, a SG FLEX pump taking suction from either the CST or RMWST will be used to add water to the SGs. Following exhaustion of the CST, RMWST and RWST makeup to the CST may be provided from the SW pond utilizing the NSRC supplied water purification skid to limit the impact of raw water injection on the SGs. The SW pond is a seismically qualified structure which is designed to withstand the effects due to BDBEE hazards. The SW pond is common to both units and has a capacity of approximately 440,000,000 gallons. Lastly, the Chattahoochee River can be aligned to provide an indefinite source of makeup water.

In its FIP, the licensee provided a table listing other clean water sources that could be used for makeup to the SGs, if they survived the beyond-design-basis (BDB) hazard. These non-creditable water sources may be available for injection, depending on the cause of the event, and although these are not credited, the licensee expects that they will be considered for use during an actual event. The additional potential water sources are the demineralized water storage tank (200,000 gallons), filtered water storage tank (200,000 gallons), and the fire protection storage tanks (300,000 gallons), the condenser hotwell and the circulating water canal.

3.10.2 Reactor Coolant System Make-Up

In its FIP, the licensee noted that borated water will be added to the RCS for reactivity control and makeup using a motor-driven FLEX BI pump, powered by the FLEX 480 Vac DG. The BAT is the primary suction source for the FLEX BI pump. Each BAT (2 per unit) has a capacity of 21,000 gallons and a Technical Specification minimum capacity of 11,336 gallons. The BATs are seismically designed and being located inside the AB are protected from all applicable external hazards. The location of the tanks in the AB precludes boron precipitation concerns due to cold temperatures.

The RWST is also available as a source of borated water for reactor makeup if needed. The RWST is a seismic and missile protected structure and therefore designed to withstand all applicable external events. During normal power operation each RWST borated volume is maintained greater than 471,000 gallons at a boron concentration between 2,400 and 2,600 ppm. The RWST borated water source will be used following BAT depletion for the RCS injection strategy. The NSRC equipment is utilized to backup the Phase 2 equipment and to transition to Phase 3 coping. For RCS injection beyond 72 hours after the start of the event, boron mixing equipment (delivered from the NSRC) can be employed to restore the RWST inventory.

3.10.3 Spent Fuel Pool Make-Up

In its FIP, the licensee stated that no Phase 1 actions are required for SFP inventory control. For Phase 2, the SFP FLEX pump drawing water from the SW pond will be aligned and used to add water to the SFPs of both units to maintain level. The SW pond is the credited source of SFP makeup. The SW pond is a seismically qualified structure which is designed to withstand the effects due to BDBEE hazards. The inventory of the SW pond is capable of providing spray for both SFPs (500 gpm total flow) for well beyond 72 hours. The long-term strategy for SFP makeup is to continue the Phase 2 strategies. When supplemented by portable equipment delivered from off-site (NSRC), water from the Chattahoochee River can be used to replace depleted on-site seismically qualified water inventories.

3.10.4 Containment Cooling

As described in its FIP, the licensee determined that the containment pressure and temperature remains within design limits without active containment cooling until well beyond 72 hours after the start of the event. At that time availability of the NSRC equipment will allow implementation of long-term strategies to control containment pressure and temperature. NSRC-supplied high volume low pressure pumps and hoses would be utilized to take suction on the SW pond and discharge into the SW header feeding the containment coolers.

3.10.5 Conclusions

Based on the evaluation above, the NRC staff concludes that the licensee has developed guidance that, if implemented as described, 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 TDAFW 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 23.9 hours are available to implement makeup before boil-off results in the water level in the SFP dropping 15 ft above 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 the TDAFW pump and allow operators to release steam from the SGs (which typically occurs when the RCS has been cooled below about 300 °F), another strategy must be used for decay heat removal. The NRC-endorsed strategy is described in NEI 12-06. Section 3.2.3 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. In its FIP, the licensee stated that it would follow this guidance. During the audit process, the NRC staff observed that the licensee had made progress in implementing this guidance.

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 as described, 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, SNC described that the inability to predict actual plant conditions that require the use of BDB equipment has prompted the creation of a new set of procedures. These procedures, the FSGs, provide guidance for deployment of FLEX equipment. As such, the FSGs provide guidance that can be employed for a variety of conditions. When FLEX equipment is needed to supplement emergency operating procedures or severe accident mitigation guidelines (SAMGs), those procedures will direct the entry into and exit from the appropriate FSG procedure.

In its FIP, SNC stated that FLEX strategy support guidelines have been developed in accordance with PWROG guidelines. Strategy Implementation Guides (SIGs) were developed to have operator actions in the field included in a separate "operator friendly" procedure format. The FSGs and SIGs together are equivalent to the PWROG generic FSGs. The licensee stated that this procedure approach conforms to NEI 12-06, Section 11.4 guidance for the relationship between FLEX procedures and other relevant plant procedures.

3.12.2 Training

In its FIP, the licensee stated that training plans were developed for plant groups such as the emergency response organization (ERO), security, operations, engineering, and maintenance. The training plan development was done in accordance with licensee procedures using the Systematic Approach to Training.

The licensee described that the SNC general population is trained using the National Academy of Nuclear Training electronic Learning (NANTeL) courses provided by the Emergency Response Training Development (ERTD) Working Group (INPO facilitated). The ERTD conducted a job analysis to identify common training topics and coordinated the design and development of common training materials. The SNC staff responsible for the implementation of the FSGs also complete additional NANTeL training provided by the ERTD working group. The ERO Decision Makers receive additional training on directing actions and implementing strategies following a BDBEE.

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 issue, NEI submitted a letter to the NRC dated October 3, 2013 (ADAMS Accession No. ML13276A573), which included EPRI Technical Report 3002000623. By letter dated October 7, 2013 (ADAMS Accession No. ML13276A224), 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, SNC stated that they would conduct maintenance and testing of the FLEX equipment in accordance with the industry letter. In the absence of an EPRI FLEX template, existing maintenance templates (where available) were used to develop the specific maintenance and testing guidance. For all other equipment not covered by a maintenance template, manufacturer OEM or industry standards were used to determine the recommended maintenance and testing.

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 2

The licensee did not take alternatives to NEI 12-06, Revision 2.

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 27, 2013 (ADAMS Accession No. ML13059A388), the licensee submitted its OIP for FNP in response to Order EA-12-051. By letter dated August 1, 2013 (ADAMS Accession No. ML13203A210), the NRC staff sent a request for additional information (RAI) to the licensee. The licensee provided a response by letter dated August 21, 2013 (ADAMS Accession No. ML13233A111), and August 27, 2013 (ADAMS Accession No. ML13240A219), the licensee provided supplemental information. By letter dated October 21, 2013 (ADAMS Accession No. ML13294A496), the NRC staff issued an ISE and RAI to SNC.

By letters dated August 27, 2013, February 26, 2014, August 26, 2014, and February 26, 2015 (ADAMS Accession Nos. ML13240A219, ML14057A779, ML14239A328, and ML15057A302, respectively), SNC submitted its 6 month updates to the Integrated Plan. The Integrated Plan describes the strategies and guidance to be implemented by the licensee for the installation of reliable SFPLI which will function following a BDBEE, including modifications necessary to support this implementation, pursuant to Order EA-12-051. By letters dated June 26, 2015 (ADAMS Accession No. ML15182A175), and January 14, 2015 (ADAMS Accession No. ML15014A422), the licensee reported that full compliance with the requirements of Order EA-12-051 was achieved and provided responses to the RAIs in the ISE.

The licensee has installed a SFPLI system designed by Westinghouse. The NRC staff reviewed the vendor's SFPLI system design specifications, calculations and analyses, test plans, and test reports. The staff issued an audit report on August 18, 2014 (ADAMS Accession No. ML14211A346).

Given that the licensee declared full compliance with the requirements of Order EA-12-051 prior to the site audit, the NRC staff informed the licensee that SFPLI would not be part of the audit, as documented in the NRC audit plan for FNP (ADAMS Accession No. ML15289A065). This evaluation is based on the information provided during the audit process and its goal is to assist the inspection that will confirm compliance with Order EA-12-051.

4.1 Levels of Required Monitoring

In its August 27, 2013, RAI response letter (ADAMS Accession No. ML13240A219), the licensee identified Level 1 for both Unit 1 and Unit 2 as 153 ft - 4 inches (in) and provided a sketch. The staff previously reviewed and accepted Level 1 in the ISE. In both full compliance letters, the licensee clarified for both Unit 1 and Unit 2 that Level 3 is elevation 129 ft - 3.5 in and Level 2 is 10 ft above that at elevation 139 ft - 3.5 in. The staff confirmed from the sketch provided in the August 21, 2013, RAI response letter that Level 3 is at the top of the SFP racks consistent with the guidance. Level 2 is 10 ft above the top of the racks and is sufficient to provide adequate shielding for persons standing at the edge of the pool deck. Consistent with the guidance, no shielding calculation was required for Level 2 elevations 10 ft or greater above the top of active fuel.

Based on the evaluation above, the NRC staff finds that the licensee's proposed Levels 1, 2 and 3 appear to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of Order EA-12-051.

4.2 Evaluation of Design Features

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

4.2.1 Design Features: Instruments

In its OIP (ADAMS Accession No. ML13059A388), the licensee stated that the primary and backup instrument channels will consist of fixed components and that the nominal measured range will be continuous from the normal pool level elevation (153 ft - 10 in for both units) to within 1 ft of the top of the spent fuel racks.

The licensee also clarified in the Unit 1 and Unit 2 compliance letters (RAI 2), that the measurement range of the installed instruments is 153 ft - 10 in to 130 ft - 1.5 in which encompasses Level 1 and is within 1 ft of the top of the fuel rack (Level 3) at 129 ft - 3.5 in.

Based on the evaluation above, the NRC staff finds that the licensee's design, with respect to the number of channels and measurement range for its SFP, appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of Order EA-12-051.

4.2.2 Design Features: Arrangement

In its Unit 1 and Unit 2 compliance letters, the licensee provided sketches showing the primary and backup instruments for Unit 1 near the northwest and southeast corners of the Unit 1 SFP. The Unit 2 sketch shows primary and backup instruments near the northeast and southwest corners of the Unit 2 SFP. Cable routing for both units, also depicted in the sketches, maintained good separation of the primary and backup cables in the SFP areas. The NRC staff also reviewed photographs via the e-portal to confirm the installation for Unit 2.

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

Based on the discussion above, the NRC staff finds that, if implemented appropriately, the licensee's proposed arrangement for the SFPLI appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of Order EA-12-051.

4.2.3 Design Features: Mounting

Farley uses a cantilever style mounting bracket bolted to the deck of the refueling floor. The mounting bracket supports a launch plate which provides mounting points for the cable conduit and the probe. The licensee provided a sketch and description of the qualification in its third 6 month update (ADAMS Accession No. ML14239A328). The staff also saw photos of the final installation.

The transmitters and displays were seismically mounted in three separate AB locations. The staff confirmed the seismic mounting using photographs of the final installed configuration provided in an electronic reading room.

The staff reviewed qualification of the SFPLI during the Westinghouse vendor audit. The staff also reviewed documents LTR-SEE-II-13-47 and WNA-TR-03149 to verify the sloshing analysis for loading from sloshing pool water. The staff also reviewed document CN-PEUS-14-7 to verify plant specific equipment mounting details and seismic analysis including the potential impact of seismically induced sloshing on the poolside mounting bracket.

Based on the discussion above, the NRC staff finds that the licensee's proposed mounting design appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of Order EA-12-051.

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 instrument channel reliability shall be established by use of an augmented quality assurance process similar to that described in NEI 12-02.

Based on the discussion above, the NRC staff finds that, if implemented appropriately, this approach appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of Order EA-12-051.

4.2.4.2 <u>Instrument Channel Reliability</u>

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 component use for all instrument components,
> - effects of shock and vibration on instrument channel components used during any applicable event for only installed components, and
> - seismic effects on instrument channel components used during and following a potential seismic event for only installed components.

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

The NRC staff reviewed vendor qualification testing and results during the vendor audit which is documented in letter dated August 18, 2014 (ADAMS Accession No. ML14211A346). The FNP configuration has only passive components in the SFP area. These components contain no electronics devices. The transmitters are Seismic Category I mounted to concrete walls outside the SFP area. The display electronics are Seismic Category I mounted to concrete walls near each of the control rooms.

Following the on-site audit, using an electronic reading room provided by the licensee, the staff reviewed Farley design document DOEJ-FDSNC467145-M002 Revision 1 and Westinghouse documents EQ-QR-269, Revision 2, and WNA-TR-03149-GEN and confirmed the qualification and anticipated post-event ELAP conditions for each location where SFPLI equipment is installed. The staff notes that the equipment in the SFP area contains no active components and their performance is not susceptible to the anticipated radiological conditions. The vendor provided testing documentation shows the coaxial signal cable met the radiation aging criteria of 1E7 RAD. Shielding provided by the concrete walls for the electronic components outside the SFP area limited exposure to less than 1 E3 RAD.

Temperature and humidity conditions in the pool area, per NEI 12-02, are assumed to be 212 °F condensing. Westinghouse testing confirms temperature does not impact the performance of the equipment in the SFP area. The condensing steam conditions, however, may have minor impact to the instrument accuracy, but as determined in the vendor audit, the impact is less than the accuracy criteria in NEI 12-02. The staff confirmed the anticipated maximum temperature of the SFPLI AB locations during ELAP is within the 140 °F qualification temperature of the transmitter and display. The staff noted the equipment locations did not contain significant heat sources during ELAP conditions.
Seismic qualification was discussed in the mounting Section 4.2.3 above. The staff notes the peak acceleration for FNP is very low and the staff review, combined with the earlier review of

qualification testing during the vendor audit, confirmed the seismic qualification is consistent with the NEI 12-02 guidance.

Based on its photo review of installed instruments following the on-site audit, the NRC determined that the as-installed configuration is consistent with the guidance for shock and vibration.

Based on the evaluation above, the NRC staff finds that the licensee's proposed instrument qualification process appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of Order EA-12-051.

4.2.5 Design Features: Independence

As noted in Section 4.2.2 above, the licensee provided sketches showing adequate separation of the installed primary and secondary instruments for each unit's SFP's including the conduit routing paths inside and outside the SFP areas. The staff also reviewed photos of the completed installation. The staff found the installed configuration at FNP appears to meet the guidance for physical separation.

The licensee stated it will use portable generators to provide power for the SFPLI systems following an ELAP. This is consistent with the guidance and meets the independence criteria. The staff also confirmed in the June 26, 2015, full compliance letter (ADAMS Accession No. ML15182A175), in the RAI 11 response, that the licensee powered the primary and secondary SFPLIs for each unit from separate electrical busses, further supporting the electrical separation criteria.

Based on the evaluation above, the NRC staff finds that the licensee's proposed design, with respect to instrument channel independence, appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements Order EA-12-051.

4.2.6 Design Features: Power Supplies

The NRC staff confirmed in the RAI 11 response of the licensee's June 26, 2015, full compliance letter that the primary and secondary SFPLI for each unit are powered from separate electrical buses.

The licensee stated, in part, on page E1-4 of its June 26, 2015, full compliance letter that it will use portable generators to provide power for the SFPLI systems following an ELAP. The licensee confirmed the SFPLI internal battery back-up provided a minimum of 24 hours of operation during the site acceptance which provides sufficient time to relocate and configure the portable generators. The licensee also confirmed establishing PM procedures for the portable generators and completing training for the operations staff.

The NRC staff notes that the internal backup battery supply was qualified by the vendor to power the system for up to 72 hours. The staff reviewed the qualification and battery hold-up calculation during the vendor audit. Details are available in the August 18, 2014 vendor audit report (ADAMS Accession No. ML14211A346).

Based on the evaluation above, the NRC staff finds that the licensee's proposed power supply design appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of Order EA-12-051.

4.2.7 Design Features: Accuracy

The NRC staff reviewed the accuracy of the Westinghouse SFPLI system during the vendor audit and found that it met the guidance. Details are available in the August 18, 2014, vendor audit report (ADAMS Accession No. ML14211A346). The licensee stated, in part, in its June 26, 2015 full compliance letter that accuracy and accuracy following a power interruption were confirmed on the installed systems during the site acceptance test.

Based on the evaluation above, the NRC staff finds that the licensee's proposed instrument accuracy appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of Order EA-12-051.

4.2.8 Design Features: Testing

The NRC staff reviewed the testing and calibration of the Westinghouse SFPLI system during the vendor audit and found that it met the guidance. Details are available in the August 18, 2014, vendor audit report. The Westinghouse system's probe is detachable and can be placed in a separate fixture with a movable depth simulator for the calibration process.

Based on the evaluation above, the NRC staff finds that the licensee's proposed SFP instrumentation design allows for testing consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of Order EA-12-051.

4.2.9 Design Features: Display

The primary and backup display locations for Units 1 and 2 were described in the response to RAI 15 of the June 26, 2015, full compliance letter. The primary instrument displays for both units are located in Room 2452 on elevation 155 ft. The secondary instrument displays for both units are located in Room 345 on elevation 139 ft. All display locations are within approximately 200 ft of the MCR and are promptly accessible. The staff confirmed the environmental conditions of these areas in FNP design document DOEJ-FDSNC467145-M002, Revision 1. The maximum temperatures during ELAP conditions in these locations are expected to be 104 °F and 110 °F. The staff noted the aux control rooms proximity to the MCR meets the prompt accessibility requirements of the NEI 12-02 guidance.

Based on the evaluation above, the NRC staff finds that the licensee's proposed location and design of the SFP instrumentation displays appear to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of Order EA-12-051.

4.3 Evaluation of Programmatic Controls

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

4.3.1 Programmatic Controls: Training

The licensee stated, in part, in its June 26, 2015, full compliance letter (ADAMS Accession No. ML15182A175) that the systematic approach to training had been used to evaluate and develop personnel training for the SFP level instrumentation. Also, SNC stated, in part, that training had been completed for instrumentation and control technicians for maintenance and calibration procedures, and for operators on system operation and implementation of backup power supplies.

Based on the evaluation above, the NRC staff finds that the licensee's plan to train personnel in the operation, maintenance, calibration, and surveillance of the SFP level instrumentation, including the approach to identify the population to be trained appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of Order EA-12-051.

4.3.2 Programmatic Controls: Procedures

In its June 26, 2015, full compliance letter, the licensee stated, in part, that the following six procedures had been created or modified to support the SFPLI strategies: FNP-1-SOP-54.0, FNP-1-SOP-36.4, FNP-2-SOP-36.4, FNP-1-AOP-30.0, FNP-1-STP-30.0, and NMP-OS-019-013. The licensee also provided specific descriptions of the changes for each procedure.

Based on the evaluation above, the NRC staff finds that the licensee's procedure development appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of Order EA-12-051.

4.3.3 Programmatic Controls: Testing and Calibration

In its June 26, 2015, full compliance letter (ADAMS Accession No. ML15182A175), SNC stated, in part,

> While the SFP is operating within design basis and at normal level, the indicators may be compared to fixed marks within the SFP by visual observation to confirm indicated level. The periodic calibration verification will be performed within 60 days of a refueling outage considering normal testing scheduling allowances (e.g., 25 %). Calibration verification will not be required to be performed more than once per 12 months. These calibration requirements are consistent with the guidance provided in NEI 12-02 section 4.3. Periodic calibration verification procedures have been developed based on information provided by Westinghouse in WNA-TP-04709-GEN. "Spent Fuel Pool Instrumentation System Calibration Procedure." Preventive maintenance procedures include tests, inspection, and periodic replacement of the backup batteries based on recommendations from Westinghouse.

In its letter dated August 27, 2013 (ADAMS Accession No. ML13240A219), in response to RAI 17 the licensee stated, in part, that

> In the event a channel of SFP level instrumentation is out of service for any reason, a condition report will be entered to restore the channel to service within 90 days. Functionality of the other channel will be confirmed via appropriate surveillance measures within the following 7 days and every 90 days thereafter

until the non-functioning channel is restored to service. If both channels are determined to be non-functional, SNC will initiate appropriate actions within 24 hours.

The staff reviewed the above information provided by the licensee and found it is consistent with the guidance.

Based on the evaluation above, the NRC staff finds that the licensee's proposed testing and calibration plan appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of Order EA-12-051.

4.4 Conclusions for Order EA-12-051

In its letter dated February 27, 2013 (ADAMS Accession No. ML13059A388), the licensee stated that they would meet the requirements of Order EA-12-051 by following the guidelines of NEI 12-02, as endorsed by JLD-ISG-2012-03. In the evaluation above, the NRC staff finds that, if implemented appropriately, the licensee has conformed to the guidance in NEI 12-02, as endorsed by JLD-ISG-2012-03. In addition, the NRC staff concludes that if the SFPLI is installed at FNP according to the licensee's proposed 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 in December 2015 (ADAMS Accession No. ML16014A734). The licensee reached its final compliance date on December 13, 2016, and has declared that both of the reactors are in compliance with the orders. The purpose of this SE is to document the strategies and implementation features that the licensee has committed to. Based on the evaluations above, the NRC staff concludes that the licensee has developed guidance and proposed designs that if implemented appropriately should adequately address the requirements of Orders EA-12-049 and EA-12-051. The NRC staff will conduct an onsite inspection to verify that the licensee has implemented the strategies and equipment to demonstrate compliance with the orders.

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JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2 – SAFETY EVALUATION REGARDING IMPLEMENTATION OF MITIGATING STRATEGIES AND RELIABLE SPENT FUEL POOL INSTRUMENTATION RELATED TO ORDERS EA-12-049 AND EA-12-051 DATED APRIL 24, 2017

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