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

October 28, 2016

Mr. Mano Nazar
Executive Vice President
and Chief Nuclear Officer
NextEra Energy
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SUBJECT: TURKEY POINT NUCLEAR GENERATING, UNITS 3 AND 4 – 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. MF0982, MF0983, MF0988, AND MF0989)

Dear Mr. Nazar:

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 26, 2013 (ADAMS Accession No. ML13072A038), Florida Power and Light Company (FPL, the licensee) submitted its OIP for Turkey Point Nuclear Generating, Units 3 and 4 (Turkey Point) in response to Order EA-12-049. At six month intervals following the submittal of the OIP, the licensee submitted reports on its progress in complying with Order EA-12-049. These reports were required by the order, and are listed in the attached safety evaluation. By letter dated August 28, 2013 (ADAMS Accession No. ML13234A503), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" (ADAMS Accession No. ML082900195). By letters dated February 6, 2014 (ADAMS Accession No. ML14002A160), and November 12, 2015 (ADAMS Accession No. ML15307A314), the NRC issued an Interim Staff Evaluation (ISE) and audit report, respectively, on the licensee's progress. By letter dated June 20, 2016 (ADAMS Accession No. ML16181A189), FPL 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 26, 2013 (ADAMS Accession No. ML130720690), the licensee submitted its OIP for Turkey Point in response to Order EA-12-051. At six month intervals following the submittal of the OIP, the licensee submitted reports on its progress in complying with Order EA-12-051. These reports were required by the order, and are listed in the attached safety evaluation. By letters dated November 19, 2013 (ADAMS Accession No. ML13280A177), and November 12, 2015 (ADAMS Accession No. ML15307A314), the NRC staff issued an ISE and audit report, respectively, on the licensee's progress. By letter dated March 26, 2014 (ADAMS Accession No. ML14083A620), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-051 in accordance with NRC NRR Office Instruction LIC-111, similar to the process used for Order EA-12-049. By letter dated January 6, 2016 (ADAMS Accession No. ML16028A143), FPL submitted a compliance letter in response to Order EA-12-051. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-051.

The enclosed safety evaluation provides the results of the NRC staff's review of FPL's strategies for Turkey Point. The intent of the safety evaluation is to inform FPL on whether or not its integrated plans, if implemented as described, appear to adequately address the requirements of Orders EA-12-049 and EA-12-051. The staff will evaluate implementation of the plans through inspection, using Temporary Instruction 2515-191, "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 Jason Paige, Orders Management Branch, Turkey Point Project Manager, at Jason.Paige@nrc.gov.

Sincerely,

Mandy K Halter

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

Docket Nos.: 50-250 and 50-251

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

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

FLORIDA POWER AND LIGHT COMPANY

TURKEY POINT NUCLEAR GENERATING, UNITS 3 AND 4

DOCKET NOS. 50-250 AND 50-251

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 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.

Enclosure

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

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

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

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

On 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.
>
> 1. The spent fuel pool level instrumentation shall include the following design features:
>
> 1.1 Instruments: The instrumentation shall consist of a permanent, fixed primary instrument channel and a backup instrument channel. The backup instrument channel may be fixed or portable. Portable instruments shall have capabilities that enhance the ability of trained personnel to monitor spent fuel pool water level under conditions that restrict direct personnel access to the pool, such as partial structural damage, high radiation levels, or heat and humidity from a boiling pool.
>
> 1.2 Arrangement: The spent fuel pool level instrument channels shall be arranged in a manner that provides reasonable protection of the level indication function against missiles that may result from damage to the

structure over the spent fuel pool. This protection may be provided by locating the primary instrument channel and fixed portions of the backup instrument channel, if applicable, to maintain instrument channel separation within the spent fuel pool area, and to utilize inherent shielding from missiles provided by existing recesses and corners in the spent fuel pool structure.

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

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

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

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

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

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

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

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

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

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

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

On August 24, 2012, following several NEI submittals and discussions in public meetings with NRC staff, the NEI submitted document NEI 12-02, "Industry Guidance for Compliance With NRC Order EA-12-051, To Modify Licenses With Regard to Reliable Spent Fuel Pool Instrumentation," Revision 1 (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 26, 2013 (ADAMS Accession No. ML13072A038), Florida Power and Light Company (FPL, the licensee) submitted its Overall Integrated Plan (OIP) for Turkey Point Nuclear Generating, Units 3 and 4 (Turkey Point) in response to Order EA-12-049. By letters dated August 21, 2013 (ADAMS Accession No. ML13248A311), February 26, 2014 (ADAMS Accession No. ML14073A454), August 27, 2014 (ADAMS Accession No. ML14253A162), February 26, 2015 (ADAMS Accession No. ML15076A195), August 11, 2015 (ADAMS Accession Nos. ML15233A417), and February 23, 2016 (ADAMS Accession No. ML16109A160), 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 February 6, 2014 (ADAMS Accession No. ML14002A160), and November 12, 2015 (ADAMS Accession No. ML15307A314), the NRC issued an Interim Staff Evaluation (ISE) and an audit report on the licensee's progress. By letter dated June 20, 2016 (ADAMS Accession No. ML16181A189), 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.

Turkey Point is a Westinghouse pressurized-water reactor (PWR) with a dry ambient pressure containment. The licensee's three-phase approach to mitigate a postulated ELAP event, as described in the FIP, is summarized below. The ELAP event that results from a hurricane has a significantly different sequence of events. As stated in the FIP, the plant will be shut down and cooled to Mode 5 two hours before arrival of a hurricane. This significantly reduces heat removal and makeup requirements. The following discussions generally refer to the more limiting sequence of events from non-hurricane-induced ELAP.

At the onset of an ELAP, both reactors are assumed to trip from full power. The reactor coolant pumps (RCPs) coast down and flow in the reactor coolant system (RCS) transitions to natural circulation. Operators will take prompt actions to minimize RCS inventory losses by isolating potential RCS letdown paths and RCP controlled bleed-off (CBO). Decay heat is removed by steaming to the atmosphere from the steam generators (SGs) through the main steam safety valves (MSSVs) or, if available, the Steam Dump to Atmosphere (SDTA) valves. The SDTA valves are air-operated valves supported by a backup nitrogen system, which is not robust. Therefore, the credited strategy for maintaining RCS pressure and temperature is via the MSSVs, until nitrogen bottles and hand loaders are put in place to permit local SDTA operation. Plant cooldown will not commence until nitrogen bottles are available for SDTA operation. Makeup to the SGs is initially provided by the turbine-driven auxiliary feedwater (TDAFW) pump taking suction from the condensate storage tanks (CSTs) (one per unit). If both CSTs do not survive the external event, cooldown is deferred until an additional source of water is made available. If both CSTs survive the external event and use of SDTA is available, the operators would commence a cooldown and depressurization of the RCS as soon as 6 hours but no later than 12 hours into the ELAP event . The SGs would be depressurized in a controlled manner to about 220 pounds per square inch gage (psig) over a period of several hours and then maintained at this pressure while the operators borate the RCS. Depressurizing the SGs reduces RCS temperature and pressure. The licensee plans to complete this cooldown no later than 14 hours from the start of the event. The reduction in RCS temperature 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 reactor coolant pump (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.

The water supply for the TDAFW pumps is initially from the CSTs. The CSTs are seismically robust, but not protected from wind-borne (i.e. tornado or hurricane) missile hazards. However, the two CSTs are separated by several hundred feet and intervening structures. Therefore, it is assumed that only one tank would be lost to a wind-borne missile, and that the remaining tank would survive to supply suction to the TDAFW pumps. With both CSTs available, they will provide a minimum of 12 hours of RCS decay heat removal, in addition to absorbing the sensible heat associated with the planned RCS cooldown. For a single surviving tank, it will provide decay heat removal for both units for about 12 hours, but this volume is not sufficient to remove the sensible heat associated with a deliberate plant cooldown. Therefore, if one CST is lost, operators will delay plant cooldown until the Phase 2 FLEX well pump has been deployed and made ready to provide makeup to the CST, which would be accomplished at approximately 9 hours after the event (non-hurricane event). Regardless if one or two CSTs survives the event, the operators will place a FLEX well pump in service at approximately 9 hours into the event (non-hurricane event) to refill the CST(s) from an artesian well drawing from the Floridan aquifer. Additionally, the FLEX well pump can inject water from the well directly to the SGs when the TDAFW pumps are no longer available due to loss of steam pressure. For hurricane events, the FLEX well pump will be deployed and start supplying water within 23 hours of the ELAP event.

As discussed in its cooldown timeline, the licensee expects to stop the RCS cooldown when SG pressure reaches 220 psig due to it effectively stabilizing RCS pressure. Subsequent to cooling and depressurization of the RCS, operators would need to perform a number of supporting actions including injecting additional boric acid into the RCS to avoid the potential for recriticality and isolating the accumulators using electrical power from FLEX generators to avoid the potential for excessive accumulator injection to the point that the nitrogen cover gas could enter the RCS. In addition, as noted in the FIP, by approximately 5 days into the event, the licensee expects to use FLEX equipment from offsite response centers to restore the residual heat removal (RHR) system and supporting equipment.

The operators will implement a dc load shed to extend the life of the vital batteries. The degree of load shed depends on the ELAP scenario (ELAP only and ELAP with a severe hurricane (e.g. Category 4 or 5)). The first scenario (ELAP only) involves a deep load shed occurring within 90 minutes and credits the use of the spare battery. The second scenario (ELAP with a severe hurricane) also involves a deep load shed occurring within 90 minutes and credits the use of the spare battery, but also credits the transfer of some loads to a 120 volt alternating current (Vac) FLEX DG. The dc load shed strategies, ELAP only and ELAP with a severe hurricane, should ensure that the batteries have sufficient capacity to supply power to the required loads for at least 21 hours and 49 hours, respectively. Following dc load stripping and prior to battery depletion, one 550-kilowatt (kW), 480 Vac generator will be deployed from the FLEX equipment storage building (FESB) to each unit. For non-hurricane events, the portable generators will be used to repower essential battery chargers within 8 hours of ELAP initiation, as well as repowering charging pumps, boric acid transfer pumps, and ventilation. However, for hurricane events, the portable generators will be deployed within 18 hours of ELAP initiation.

The RCS makeup and boration will be initiated within 13 hours of the ELAP to ensure that natural circulation, reactivity control, and boron mixing is maintained in the RCS. Operators will provide reactor coolant makeup by using the Phase 2 FLEX DGs to re-power the installed charging pumps and boric acid transfer pumps. One of the three charging pumps (per unit) and one of the two re-powered boric acid transfer pumps (per unit) will inject borated water to the RCS from the unit's boric acid storage tank (BAST). Before the BASTs are depleted, long-term RCS makeup will be accomplished via newly installed connections on the existing primary makeup water line, which will allow non-borated water from the FLEX well pump to combine with borated water from the BAST in the installed boric acid blender.

In addition, a National Strategic Alliance of FLEX Emergency Response (SAFER) Response Center (NSRC) will provide high capacity pumps and large turbine-driven DGs which could be used to restore one RHR cooling train per unit to cool the cores in the long term. There are two NSRCs in the United States.

The SFP for each unit is located in the unit's fuel handling building (FHB). Upon initiation of the ELAP event, the SFP will heat up due to the unavailability of the normal cooling system. The licensee has calculated that boiling could start as soon as 2.7 hours (following a full core offload) after the start of the event. To maintain SFP cooling capabilities, the licensee determined that it would take approximately 33 hours for SFP water level to drop to a level requiring the addition of makeup to preclude fuel damage. Makeup water would be provided using a FLEX SFP pump taking suction from the intake canal or better quality water from the non-robust raw water tanks, if available. Ventilation of the generated steam is accomplished by opening specified doors in the auxiliary building.

For Phases 1 and 2 the licensee's calculations demonstrate that no actions are required to maintain containment pressure below design limits for over 72 hours. In Phase 2, the licensee will continue to monitor temperature and pressure using installed instrumentation and maintain decay heat removal using SGs to exhaust RCS heat out to the atmosphere using the MSSVs or the SDTAs. For Mode 5 and 6 without SG heat removal available, the containment temperature and pressure will not be challenged as long as ventilation is established. During Phase 3, containment cooling and depressurization would be accomplished by using the 4160 Vac turbine-driven DG supplied by the NSRC to repower the emergency containment cooling (ECC) fans and restoring component cooling water (CCW) flow to the ECC 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 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. 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 for the ELAP with loss of normal access to the UHS event presumes that, per endorsed guidance from NEI 12-06, both units would have been operating at full power prior to the event. Therefore, the SGs may be credited as the heat sink for core cooling during the ELAP with loss of normal access to the UHS event. Maintenance of sufficient 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 evaluation.

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 FPL's FIP, the heat sink for core cooling in Phase 1 would be provided by the three SGs at each unit, which would be fed simultaneously by the TDAFW pumps with inventory supplied from the CST(s). Three redundant TDAFW pumps are installed at Turkey Point, which supply feedwater to both units' SGs. The two CSTs (one per unit) each have a minimum volume of 210,000 gallons (per the plant's technical specifications) and a maximum volume of 250,000 gallons. The CSTs are seismically robust, but not protected from wind-borne (i.e. tornado or hurricane) missile hazards. The licensee states that since the two CSTs are separated by several hundred feet and intervening structures, the plant's FLEX strategy assumes that only one tank would be lost to a wind-borne missile, and that the remaining tank would survive to supply suction to the TDAFW pumps. The licensee states that this assumption is consistent with the plant's current licensing basis. The licensee calculates that a single CST with minimum volume would be able to supply enough makeup water to both units' SGs to remove decay heat (but not the sensible heat associated with an RCS cooldown) for 12 hours. The licensee's timeline for cooling the RCS following an ELAP event would change if a CST is lost. Section 3.2.2 of this SE discusses these variations in the FLEX strategy.

Following closure of the main steam isolation valves, as would be expected in an ELAP event, steam release from the SGs to the atmosphere would be accomplished via the MSSVs or the SDTA valves, if available. The SDTA valves are air-operated valves supported by a backup nitrogen system, which is not robust. Therefore, the credited strategy for maintaining RCS pressure and temperature is via the MSSVs, until nitrogen bottles and hand loaders are put in place to permit local SDTA operation. Plant cooldown will not commence until nitrogen bottles are available for SDTA operation.

Turkey Point's FLEX strategy does not credit the use of SDTA valves in Phase 1, since the installed nitrogen system is not robust; however, if both CSTs survive the external event and use of SDTA is available, the operators would commence a cooldown and depressurization of the RCS approximately 6 hours into the ELAP event. The RCS cooldown is described in greater detail in the following section, as the licensee's credited core cooling strategy requires the use of Phase 2 equipment.

3.2.1.1.2 Phase 2

In its FIP, the licensee states that the primary 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 pumps. The TDAFW pumps will continue feeding the SGs as long as there is sufficient steam pressure to drive the turbines. A portable, diesel driven FLEX well pump, with a capacity of 625 gallons per minute (gpm) at 500 psig, will be deployed to refill the surviving CST(s) from the FLEX well, an artesian well drawing from the Floridan aquifer. The FLEX well is the ultimate water source for SG makeup for the duration of the event. The licensee has evaluated the well water chemistry and determined that it would support the required heat transfer for the duration that it would be used.

The FLEX well pump will be deployed and ready for operation at approximately 9 hours into the event. While the TDAFW pumps are in use, the FLEX pump will provide sufficient makeup to the CST(s) to support cooldown of both units' reactor cores. Additionally, the FLEX pump can inject water from the FLEX well directly to the SGs when the TDAFW pumps are no longer available.

Once operation of the SDTA valves is restored, either with nitrogen bottles and hand loaders or remotely from the main control room, operators would begin a cooldown and depressurization of the RCS via the SDTA valves. This cooldown would commence no later than 9 hours into the event. The required operator actions to restore functionality of the SDTAs were time-validated by the licensee and supports this timeline. The cooldown would proceed at a rate of approximately 75 °F/hr and end when SG pressure reaches 220 psig. Stabilizing SG pressure (and RCS temperature and pressure) at this point will prevent injection of the nitrogen cover gas from the safety injection accumulators into the RCS. Cooldown and depressurization of the RCS significantly extends the expected coping time under ELAP conditions because it (1) reduces the potential for damage to RCP seals (as discussed in Section 3.2.3.3 of this safety evaluation (SE)) and (2) allows coolant stored in the nitrogen-pressurized accumulators to inject into the RCS to offset system leakage.

3.2.1.1.3 Phase 3

According to its FIP, Turkey Point's Phase 3 core cooling strategy would be to restore normal functions for decay heat removal, which would require the deployment of equipment from the NSRC. A high-flow, low-pressure NSRC pump will take suction from the ultimate heat sink (canal water) via piping in the intake cooling water (ICW) system, and discharge to the CCW heat exchangers. The CCW system provides cooling to the RHR heat exchangers, RHR pump seal coolers, and other components. The CCW pumps and RHR pumps would be re-powered by 1- megawatt (MW) 4160-volt turbine generators supplied by the NSRC, which would be available for use within 72 hours according to the FIP.

3.2.1.2 RCS Makeup Strategy

3.2.1.2.1 Phase 1

Following the reactor trip at the start of the ELAP event, operators will isolate RCS letdown pathways, including controlled bleed-off (CBO) isolation, and confirm the existence of natural circulation flow in the RCS. A small amount of RCS leakage will occur through the RCP low leakage 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. There is no requirement to initiate boration or RCS makeup within the first several hours of the event.

3.2.1.2.2 Phase 2

Phase 2 RCS inventory control and boration strategies rely on depressurization of the RCS to induce passive injection from the accumulators, and re-powering the installed charging pumps for active RCS makeup and boration. The volume injected by accumulators is credited by the licensee for RCS inventory control, but not for reactivity control (see Section 3.2.3.4 of this SE). As noted above, stopping the RCS cooldown when SG pressure reaches 220 psig will effectively stabilize RCS pressure, preventing injection of nitrogen gas from the accumulators. When the cooldown is complete, operators will isolate the accumulators by shutting the 480 Vac accumulator isolation valves, which would be re-powered by the 480 Vac, 550 kW FLEX DGs. The Phase 2 FLEX DGs will also re-power the battery chargers (which in turn supply power to the Class 1E switchgear) and the installed charging pumps and boric acid transfer pumps. Per the procedures in FLEX support guideline (FSG) 0-FSG-99, “FSG Supplemental Guidance,” each FLEX DG would connect to either the unit’s “B” train 480V load centers (primary strategy) or its “A” train 480V load centers (alternate strategy).

The charging pumps at Turkey Point are located in the Class 1 auxiliary building, within the flooding protection barriers, and are fully protected from all applicable external events as defined in NEI 12-06. Additionally, the load centers which power the pumps are located in a robust structure. When Phase 2 RCS makeup begins, one of the three charging pumps (per unit) and one of the two re-powered boric acid transfer pumps (per unit) will inject borated water to the RCS from the unit’s BAST. The positive-displacement charging pumps each have a design capacity of 77 gpm. The credited charging rate is 69 gpm, based on the capacity of one boric acid transfer pump to supply the charging pump suction. The charging pumps can discharge to the RCS through either the normal charging lines or the RCP injection lines, which represent primary and alternate connection points. The charging pumps require cooling water to their hydraulic drive coolers, which during a FLEX scenario would be supplied by the FLEX well pump via the existing emergency service water “quick connect” connections. The NRC staff has identified the licensee’s use of the charging pumps during Phase 2 an alternative to NEI 12-06 and is discussed in more detail in Section 3.14 of this SE.

Each BAST is fully robust for all applicable external hazards as defined in NEI 12-06, and contains at least 11,800 gallons of water, which is borated to a concentration of at least 5,245 parts per million (ppm), and no higher than 7,000 ppm. In its FIP, the licensee states that heat tracing is not required to maintain boric acid solubility in the BASTs, due to the rarity of persistent cold temperatures in South Florida and the ambient heat generated by the nearby Unit 4 charging pumps. Before the BASTs are depleted, long-term RCS makeup will be accomplished via newly installed connections on the existing primary makeup water line, which will allow non-borated water from the FLEX well pump to combine with borated water from the BAST in the installed boric acid blender. Discharge from the blender goes directly to the charging pump suction line.

Per the sequence of events in the licensee's FIP, requisite supporting actions are expected to be completed such that borated RCS injection can be commenced via the licensee's FLEX strategy no later than 13 hours into the ELAP event.

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 and water treatment equipment supplied by the NSRC. The availability of offsite resources will allow demineralized water to replace water from the FLEX well as makeup to the boric acid batching tank. The licensee's FIP also states that a portable NSRC high pressure pump will be available as a backup to the installed charging pumps.

3.2.2 Variations to Core Cooling Strategy for High Wind Event

As noted in Section 3.2.1.1 of this SE, the two CSTs at Turkey Point are not protected from wind-borne missiles. The licensee states that, consistent with the current licensing basis, one CST is assumed to survive the event since the two tanks are separated by several hundred feet, as well as protected from intervening structures. For a hurricane (Category 4 or 5) event, the surviving CST is credited to retain its maximum volume of 250,000 gallons, since operators would have "topped off" both tanks during the advance warning period associated with a hurricane. Additionally, plant procedures direct operators to shut down the reactors and place the plant in Mode 5 at least 2 hours prior to the arrival on-site of hurricane-force winds. For a tornado event, the surviving CST is assumed to contain only its minimum inventory of 210,000 gallons; therefore, for Modes 1 through 4, the tornado event is the more limiting event with respect to core cooling time constraints.

The licensee calculates that the minimum volume in a single surviving CST can provide decay heat removal for both units for about 12 hours, but that this volume is not sufficient to remove the sensible heat associated with a deliberate plant cooldown. Therefore, if one CST is lost, operators will delay plant cooldown until the Phase 2 FLEX well pump has been deployed and made ready to provide makeup to the CST. This would be accomplished at approximately 9 hours after the event (non-hurricane events). The FLEX well pump does have sufficient capacity to provide decay heat removal and sensible heat removal for both units. The licensee also noted that the worst-case scenario assumes that the SDTA valves are unavailable until Phase 2 nitrogen bottles and hand loaders are in place to permit SDTA operation; thus, operators will not begin the RCS cooldown until both conditions (FLEX makeup to the CST, and enabling local SDTA operation) are met.

Another variation to the plant's FLEX strategy for a hurricane event is that prior to the arrival of hurricane Category 4 or 5 winds, the units are shut down and one portable 6-kW DG at each unit would be pre-deployed during the hurricane preparation time. These DGs would be fully protected against the hurricane in their pre-deployed locations, and would power the 120V vital ac buses. The inverter loads would be removed from the batteries, extending the batteries' life span (49 hours) until it is safe to deploy the FLEX 480V DGs for battery charging. The licensee's timeline to deploy the FLEX 480V DGs and FLEX well pump for the hurricane scenario is to align these within 18 hours of the ELAP event. Additional details on the licensee's electrical strategy for hurricane events is discussed in Section 3.2.3.6 of this SE.

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

Core Cooling

The licensee provided descriptions in its FIP for the permanent plant SSCs to be used to support core cooling for Phases 1 and 2. The licensee indicated that there are three TDAFW pumps with dc-powered flow control valves (FCV), which will automatically start and deliver TDAFW flow to the SGs. The TDAFW pumps are located in the auxiliary feedwater (AFW) cage inside the turbine building, which is protected from all applicable external hazards as defined in NEI 12-06. The licensee stated that the FCVs would be operated from the control room with safety-related and seismically mounted nitrogen supply bottles. The FCVs can be controlled with replacement nitrogen bottles once the initial nitrogen bottles are used or by using hand-wheels. The licensee also described in its FIP that the two CSTs supply SG makeup water through the TDAFW pumps. The CSTs are protected from all applicable external hazards as defined in NEI 12-06 except tornado missiles or similar missiles generated by hurricane events. The licensee cited separation and intervening structures between the two CSTs so that one CST will be credited for the tornado or hurricane generated missile events. The licensee further described in the FIP the newly installed FLEX well, which will serve to provide makeup to the CSTs for the use of the TDAFW pumps or direct injection into the SGs using the FLEX well pumps. The FLEX well is protected from all applicable external hazards as defined in NEI 12-06.

Based on the design and location of the water sources and the permanent plant SSCs, as described in the FIP, the NRC staff concludes that the licensee's strategy should be available to support core cooling during an ELAP caused by a BDBEE, and appears to be consistent with Condition 4 of NEI 12-06, Section 3.2.1.3.

RCS Inventory Control

The FIP describes that RCS makeup in Phase 2 is supplied by a charging pump from either train of electrical power in each unit. The charging pumps are located in the auxiliary building, which is a Seismic Category 1 structure and protected from all applicable external hazards as defined in NEI 12-06. The licensee stated that the charging pumps are powered from the FLEX DGs to energize the load centers from each train, which will be electrically tied together such that all four in each unit are powered. The discussion of the use of charging pumps in place of FLEX equipment for Phase 2 RCS makeup is discussed in further detail in Section 3.14 of this SE as an alternate to NEI 12-06. The licensee described the use of the accumulators to make up for losses from the RCP seals and for contraction of the primary coolant due to cool down. Accumulators are protected from all applicable external hazards as defined in NEI 12-06. The MSSVs are credited in the licensee's strategy for maintaining RCS pressure and temperature during Phase 1. The MSSVs will maintain RCS temperature and pressure slightly above normal no-load values so that the pressurizer power operated relief valves (PORVs) or RCS safety relief valves will function normally.

The licensee also described in the FIP the borated water sources available to support RCS makeup for Phase 2 and Phase 3. Three BASTs, which are shared between both units, provide borated water through the charging and boric acid transfer pumps. The BASTs are located inside the auxiliary building, which is a seismic Category I building that is protected from all applicable external hazards as defined in NEI 12-06. The licensee further described in the FIP that the refueling water storage tank (RWST) is used to support RCS makeup for Modes 5 and 6. The licensee credited the RWSTs to survive all applicable external hazards as defined in NEI 12-06, except tornado missiles. One RWST would be expected to survive the tornado missile event due to separation and intervening structures in between the RWSTs similar to the CSTs. In either case, the licensee also described that the new FLEX well will be used with the boric acid batching tank to batch the required borated water source to fill the BASTs and directly make up to the RCS.

Based on the location and the availability of charging pumps after the FLEX DG is connected, the available borated water sources, and permanent plant SSCs to support RCS cooldown, the NRC staff concludes that the licensee's strategy should be available to support RCS inventory control during an ELAP caused by a BDBEE, and appears to be consistent with Condition 3 of NEI 12-06, Section 3.2.1.3.

3.2.3.1.2 Plant Instrumentation

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

- SG level
- SG pressure
- RCS pressure
- pressurizer level
- RCS hot leg temperature (T_{hot})
- RCS cold leg temperature (T_{cold})
- core exit thermocouple temperature

- reactor vessel level
- neutron flux
- dc bus voltage
- CST level
- RWST level

All of these instruments are powered by safety-related batteries, and could be lost if the batteries were allowed to deplete. Therefore, to prevent loss of vital instrumentation, operators will extend battery life by shedding unnecessary loads within 90 minutes of the event. This will retain monitoring function for one channel of the essential parameters until the FLEX DGs are available to supply all channels of required instrument loads. The licensee reviewed all instrumentation for environmental effects and determined that reliable indication will be available.

Guidance document 0-FSG-07, "Loss of Instrumentation or Control Power," provides the procedure for obtaining local readings of these key parameters, should dc power be lost. The procedure directs the use of portable FLEX equipment which is supplied with the local instrumentation needed to operate the equipment.

3.2.3.2 Thermal-Hydraulic Analyses

As described in the FIP, the mitigating strategy for Turkey Point is based on plant-specific analysis with the RETRAN-3D thermal-hydraulic code. The RETRAN-3D code and corresponding evaluation model were not assessed under the NRC staff's audit review of generic analytical methods for demonstrating compliance with Order EA-12-049. Although the generic NOTRUMP-based analytical modeling effort for Westinghouse PWRs developed by the PWROG and the corresponding generic review conducted by the NRC staff provide insight into the ELAP behavior expected for Turkey Point, the licensee opted to base its strategy on additional simulations with RETRAN-3D. Therefore, the adequacy of the RETRAN-3D code's capability to simulate the analyzed ELAP event for Turkey Point was considered during the NRC staff's audit of the mitigating strategy.

The RETRAN-3D code is an industry-developed, best-estimate thermal-hydraulic code for the analysis of transients at light-water reactors. Initial development on the RETRAN code family began in the mid-1970s and was based on the NRC-sponsored RELAP4/MOD3 code. Significant development during the 1980s and 1990s led to the release of code versions which contained improved modeling capabilities (e.g., consideration of non-equilibrium two-phase flow and three-dimensional neutron kinetics). Specifically, the RETRAN-3D code was developed in the 1990s and submitted to the NRC staff for review in 1998 as part of an evaluation model for performing design-basis safety analysis for analyzed events other than the loss-of-coolant accident (LOCA). Of particular interest to the ELAP event, RETRAN-3D expands upon the original three-field-equation homogeneous equilibrium model formulation, including options for four- and five-equation models that permit simulation of unequal phase velocities and temperatures (five-equation model only). In 2001, the NRC staff issued a SE for the RETRAN-3D-based non-LOCA evaluation model.

The PWR non-LOCA transients for which application of the RETRAN-3D-based evaluation model discussed above has been found acceptable by the NRC staff primarily involving single-phase flow. In contrast, the beyond-design-basis ELAP event involves the potential for separated two-phase flow in a stratified RCS. As a result, the NRC staff concluded that application of the approved RETRAN-3D non-LOCA transient evaluation model to the ELAP event is beyond the scope of the NRC staff's previous review.

The NRC staff observed that the Turkey Point RETRAN-3D analysis incorporates a drift flux model which augments the homogeneous equilibrium model by allowing for slip between the liquid and vapor phases. In the four-field-equation model used by Turkey Point, when both phases are present, thermal equilibrium is enforced, which influences the prediction of a number of phenomena that affect the ELAP event progression, including subcooled boiling and condensation. The NRC staff recognized the limitations associated with the use of the RETRAN-3D model for the two-phase flow conditions that may develop during later stages of the ELAP event. The NRC staff's audit review also noted that validation for the applicable drift-flux correlation in RETRAN-3D is incomplete for larger diameter RCS loop piping and plenums. Unlike typical PWR non-LOCA events, significant two-phase flow may be present in these large-diameter pipes and components during the later stages of an analyzed ELAP event.

Similar to its review of other codes used to analyze the ELAP event for PWRs (e.g., NOTRUMP, CENTS), the NRC staff questioned whether the RETRAN-3D code would provide reliable coping time predictions in the reflux 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. In the PWROG core cooling position paper, which was provided in a letter dated January 30, 2013, the PWROG recommended that the reflux or boiler-condenser cooling phase be avoided because of uncertainties in operators' ability to control natural circulation following reflux cooling and the impact of diluted pockets of water on criticality. Due to the challenge of resolving the above issues within the compliance schedule specified in Order EA-12-049, the NRC staff requested that PWR licensees 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 allowable 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 legs and condenses on the SG tubes, with a fraction of the condensate subsequently draining back into the reactor vessel through the hot legs in countercurrent fashion. Quantitatively, Turkey Point's analysis uses the same criterion for identifying the threshold for entry into reflux cooling as described in the PWROG-sponsored technical report PWROG-14064-P, Revision 0, "Application of NOTRUMP Code Results for Westinghouse Designed PWRs in Extended Loss of AC Power Circumstances," namely, the point at which the 1-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 evaluation, 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. Based upon its audit of the licensee's analysis, the NRC staff considered the flow quality criterion of 0.1 to be appropriate for determining the threshold for entering reflux cooling in the RETRAN-3D analysis performed for Turkey Point.

In its review of the mitigating strategy for South Texas Project (STP), Units 1 and 2, the NRC staff had previously conducted an audit review of a white paper concerning the RETRAN-3D code that the NRC staff considered relevant to its review of the mitigating strategy for Turkey Point. This white paper, which was submitted by STP Nuclear Operating Company, generally discussed the capabilities of RETRAN-3D relative to the analyzed ELAP event and further provided calculations comparing code predictions for the analyzed ELAP event at STP using the RETRAN-3D code against the more-sophisticated models in the RELAP5/MOD3.3 code. Based upon its audit of the white paper, the NRC staff observed that simplifications in the modeling of two-phase flow phenomena in STP's RETRAN-3D-based evaluation model may have significantly impacted its capability to predict the timing of reflux cooling. However, the predictive deviations observed with respect to the RELAP5/MOD3.3 code were in the conservative direction for the simulation performed for STP. Considering this information, the NRC staff concluded that, for STP, the RETRAN-3D-based evaluation model could likely provide a conservative estimate of the time to reflux cooling. Based on the limited review completed during the audit, the causes of the discrepancies observed in the code comparison were not definitively identified such that a general conclusion could be made concerning the generic application of RETRAN-3D to the analyzed ELAP event for other reactors. Due to the significant time margin between the licensee's planned time to commence active RCS injection (13 hours) and its prediction of the onset of reflux cooling (greater than 36 hours), the NRC staff determined that it was not necessary to perform additional detailed review of the RETRAN-3D code models to investigate further in this area for Turkey Point.

The RETRAN-3D analysis performed for Turkey Point examined two cases. Case A, the upper-bounding case, assumed maximum RCS leakage (4.25 gpm/RCP for the duration of the transient, beginning at 30 minutes after reactor trip). Case B, a "more realistic" case (according to the FIP) assumed partial degradation of the RCP seal elastomers, but no complete seal failures (seal leakage was assumed to be 0.04 gpm/RCP after 30 minutes, and 1.7 gpm/RCP after 8 hours). Both simulated transients were terminated after 36 hours. In both cases, the analysis concluded that no voiding occurred at the top of the SG tubes, and that the quality of the reactor coolant flow through the SG tubes did not approach conditions for reflux cooling. The NRC staff conducted an audit of this analysis and made the following key observations:

- In the RETRAN-3D analysis, RCS heat losses were taken from the lower plenum of the reactor vessel. Whereas, the NRC staff expects that realistically modeling the fraction of the heat loss that would occur in the subcomponent containing the saturated interface (i.e., pressurizer vapor space or RPV upper head) would provide a more realistic assessment of the RCS pressure trend. Ultimately, the NRC staff expects that the modeling employed in the RETRAN-3D analysis would tend to over-predict RCS pressure and fluid subcooling.

- The RCP seal leakage assumptions in this analysis are inconsistent with the Flowserve white paper and staff endorsement letter (see Section 3.2.3.3 below). The conclusion that initiation of reflux cooling will not occur within the first 36 hours of the event does not appear justified, although the time to reflux is likely well in excess of the planned time (13 hours) to establish active RCS makeup.

- By 13 hours into the event, the RCS inventory for Case A (the upper bounding case) has decreased to the top of the RCS hot leg. Although RCS hot leg level is not a criterion for reflux cooling, this observation was questioned by the NRC staff during the audit. However, per the licensee's FIP, the RCS cooldown would be performed no later than 9 hours into the event, as opposed to commencing cooldown at 12 hours as the RETRAN analysis assumed. This will cause accumulator injection well before the onset of reflux cooling; moreover, the licensee plans to start active RCS makeup at 13 hours (which was not assumed to occur in the analysis). As such, the behavior observed in the licensee's calculation does not match the expected plant behavior during the analyzed ELAP event.

Therefore, based on the evaluation above, and particularly given the large margin between the licensee's planned time to RCS makeup and the predicted onset of reflux cooling, the NRC staff concludes that the licensee's sequence of events for reactor core cooling, including time-sensitive operator actions, and evaluating the required equipment to mitigate the analyzed ELAP event, including pump sizing and cooling water capacity, appear to be acceptable.

3.2.3.3 Reactor Coolant Pump (RCP) Seals

Leakage from 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 the potential for increased seal leakage and the 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.

Flowserve NX seal packages have been installed on all RCPs at Turkey Point. One of the design objectives for the NX seal was to provide low-leakage performance under loss-of-seal-cooling conditions during events such as a station blackout. According to measured data from Flowserve's 1988 N-Seal station blackout test, following CBO isolation at 0.5 hours, over the course of the succeeding period of 6 to 7 hours during which CBO isolation was maintained, the average seal leakage rate was slightly less than 0.05 gpm. The licensee indicated that these results are applicable to Turkey Point, since the FLEX strategies for both units would isolate CBO flow within 30 minutes of the event. Although the NRC staff agreed that it is appropriate to allow credit for demonstrated performance, during its review of the Flowserve white paper (discussed below), the staff questioned the extrapolation of evidence from a limited test period of 6 to 7 hours to the indefinite coping period associated with the ELAP event. Therefore, while the NRC staff ultimately agreed with the credit Flowserve's N-Seal white paper allowed for CBO isolation in determining the short-term thermal exposure profile of seal elastomers, the staff did not endorse direct application of the average leakage rate measured with the CBO isolated in the 1988 test for an indefinite period in the absence of demonstrated long-term seal performance.

In support of its customers' efforts to address the ELAP event (which similarly involves a loss of seal cooling) in accordance with Order EA-12-049, on August 3, 2015, Flowserve submitted to the NRC staff its "White Paper on the Response of the N-Seal Reactor Coolant Pump (RCP)

Seal Package to Extended Loss of All Power (ELAP)" (ADAMS Accession No. ML15222A366). The N-Seal white paper contains information regarding the expected leakage rates over the course of an ELAP event for each PWR at which Flowserve N-Seals are currently installed. In a letter dated November 12, 2015 (ADAMS Accession No. ML15310A094), the staff endorsed the leakage rates described in the white paper for the beyond-design-basis ELAP event, subject to certain limitations and conditions.

During the audit, the licensee addressed the status of its conformance with the white paper and the limitations and conditions in the NRC staff's endorsement letter. In particular, during the audit, the licensee confirmed that the plant design and planned mitigation strategy at Turkey Point are consistent with, or conservative relative to, the information assumed in the calculation performed by Flowserve, which is summarized in Table 1 of the white paper. Additionally, the peak cold-leg temperature prior to the RCS cooldown assumed in Flowserve's analysis was found to be approximately equivalent to the saturation temperature corresponding to the lowest setpoint for MSSV valve lift pressure. However, the licensee acknowledged that condition (4) of the Flowserve endorsement letter (cited below) was not met:

> (4) In its white paper, Flowserve has generally specified leakage rates in volumetric terms. For converting the specified volumetric flow rates to mass flow rates, licensees should use a density of 62 lbm/ft^3 (approximately 993 kg/m^3) throughout the ELAP event. This condition reflects observations made during testing conducted by Flowserve that simulated a loss of seal cooling, wherein the seal leakage mass flow rate remained roughly constant as the test apparatus underwent a significant cooldown and depressurization.

During the audit, the licensee stated that Case A (the upper-bounding case) of its plant-specific RETRAN-3D calculations assumed an RCP volumetric seal leakage rate of 4.25 gpm/RCP starting 30 minutes into the ELAP event and persisting throughout the simulation. An additional 1 gpm/pump was added to account for unidentified RCS losses. The RETRAN-3D analysis determined fluid density as a function of RCS temperature and pressure throughout the transient, which was therefore lower than the 62 lbm/ft^3 recommended by the NRC staff's endorsement letter. The licensee stated its view that the lower fluid density assumed in its calculations would be offset by other conservatisms, namely that the Case A analysis assumed a larger volumetric seal leakage rate than that provided by the Flowserve white paper (4.25 versus 1.7 gpm/RCP) and that the analysis did not assume any active RCS injection, which according to the FIP would commence by 13 hours into the event at 69 gpm. The staff further noted that the licensee's claim that Case A of the RETRAN-3D analysis assumed a constant volumetric seal leakage rate is inaccurate; graphs generated by the RETRAN-3D simulation indicate that the calculation maintained a constant flow area rather than volumetric flow rate.

Further confirmatory calculations by the NRC staff, however, indicated that the integrated leakage calculated during the initial phase of Case A of the licensee's analysis should bound the expected leakage for the analyzed ELAP event. Specifically, for the first 13 hours (prior to any active or passive RCS injection) the total RCS mass loss predicted by the licensee's RETRAN-3D simulation slightly exceeds the RCS mass loss that the NRC staff calculated using data from the 1988 SBO test along with the method described in the Flowserve white paper (including limitations and conditions in the NRC staff's endorsement letter). The licensee performed similar calculations of integrated leakage that resulted in a similar conclusion; however, the

NRC staff did not consider the licensee's assumptions consistent with the approved white paper and ultimately concluded that the licensee had over predicted the available margin. In summary, while the staff does not necessarily agree with the conclusions drawn from the licensee's RETRAN-3D analysis (as discussed in Section 3.2.3.2), the staff does conclude that the RCP seal leakage rate assumed by the RETRAN-3D analysis satisfies the intent of condition (4) of the NRC's endorsement of the Flowserve white paper.

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 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.

During the audit, the NRC staff reviewed the licensee's shutdown margin calculation. The licensee has a Phase 2 boration strategy which consists of re-powering the installed charging pumps from FLEX DGs. One of the three charging pumps (at each unit) together with a re-powered boric acid transfer pump would inject highly borated water from the BAST. Primary and alternate injection pathways to the RCS are available (i.e., the normal charging path and via the RCP seal injection line). The licensee calculated that, without crediting borated water injected by the accumulators, positive reactivity due to xenon decay would cause shutdown margin to fall below 1 percent at 14.6 hours after shutdown. The licensee's calculation assumed the most limiting values for core time-in-life and power history, and also assumed a core cooldown to 396 °F, which corresponds to a SG pressure of 220 psig, consistent with the licensee's core cooling strategy. Accordingly, the FLEX strategy at Turkey Point entails commencing RCS boration using a re-powered charging pump no later than 13 hours into the ELAP/LUHS event.

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.

The intent of this condition is satisfied because the licensee's planned timing for establishing borated makeup does not credit any boration from accumulator injection (i.e., no RCS leakage), which results in the more limiting required time for RCS boration.

> 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 adds a margin of 1.6 hours (13.0 hours as opposed to 14.6 hours) which bounds the 1-hour period to account for boric acid mixing; furthermore, during this one-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 Turkey Point 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.

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. FSG-08, "Alternate RCS Boration," directs operators to vent the RCS via the dc-powered reactor vessel head vent valves if additional boration is required and RCS conditions are not sufficient for boration, i.e. pressurizer level is 53 percent or greater or RCS pressure is 2,235 psig or greater. The vent valves would be operable from the control room following installation of fuses in the control cabinets. The head vent system is designed to ensure that RCS liquid loss through the vent path cannot exceed the makeup capacity of the chemical and volume control system (CVCS) system, should a vent valve fail open. Pressurizer PORVs will not be used to vent the RCS.

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 FIP described the FLEX well pump to be used for providing makeup water from the FLEX well to the CSTs or directly to the hose connections on the discharge lines of the Train 1 and Train 2 for both units. Deployment and staging of the FLEX well pump begins 3 hours after an ELAP and is initiated for CST makeup around 9 hours after an ELAP. The licensee also indicated that the FLEX well pump can provide makeup water supply to the charging pump oil cooler, to the boric acid batching tank, and to the boric acid blender. The licensee indicated that one FLEX well pump is needed to supply makeup to both units. The licensee stated that two FLEX well pumps will be stored in the FESB to meet the "N+1" criteria outlined by Section 3.2.2 of NEI 12-06. The FLEX well is also described in the FIP for various makeup strategies for both CST and RCS during Phases 2 and 3. As described above in Section 3.2.3.1.1, the FLEX well is constructed within the ground to be protected from all applicable external hazards as defined in NEI 12-06 and allows access to unlimited water for makeup. The licensee also referenced the use of the NSRC high pressure pump during Phase 3 to backup the charging pumps. The NSRC high pressure pump takes suction from the RWST or BAST and injects into the normal charging lines or the RCP injection lines.

During the audit review, the staff reviewed FLEX hydraulic calculations PTN-BFSM-14-003, "SG/RCS FLEX and RRC Pumps Hydraulic Calculation," Revision 0, and PTN-BFSM-14-010, "FLEX Strategy: Charging Pump Cooler Minimum Flow and Borated Water Makeup Minimum Flow," Revision 2, which both evaluated the use of the FLEX well pump receiving makeup water from the FLEX well to makeup to the CST(s), provide direct SG injection, and provide makeup water to the RWST and/or the BASTs. The staff was able to confirm that flow rates and pressures evaluated in the hydraulic calculations were reflected in the FIP for the respective SG and RCS makeup strategies based upon the above FLEX well pumps being deployed and implemented as described in the FSGs. The staff also conducted a walkdown of the hose deployment routes for the above FLEX well pumps during the audit to confirm the evaluations of the hose distance runs in the above hydraulic analyses.

Based on the FLEX pumping capabilities at Turkey Point, as described in the above hydraulic analyses and the FIP, the NRC staff concludes that the licensee's portable FLEX well pumps should perform as intended to support core cooling, CST makeup, and RCS inventory control during ELAP caused by a BDBEE, and appears to be 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 and LUHS. The licensee's strategy for RCS inventory control uses the same electrical strategy as 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. Furthermore, the electrical coping strategies are the same for all modes of operation.

The NRC staff reviewed the licensee's FIP, conceptual electrical single-line diagrams, summaries of calculations for sizing the FLEX diesel and turbine generators and station batteries, and summaries of calculations that addressed the effects of temperature on the electrical equipment credited in the FIP as a result of loss of heating, ventilation, and air conditioning (HVAC) during an ELAP, as a result of a BDBEE.

According to the licensee's FIP, operators would declare an ELAP following a loss of offsite power, loss of all emergency diesel generators, and the loss of any alternate ac power with a simultaneous loss of access to the UHS. The plant's indefinite coping capability is attained through the implementation of pre-determined FLEX strategies that are focused on maintaining or restoring key plant safety functions. A safety function-based approach provides consistency with, and allows coordination with, existing plant emergency operating procedures (EOPs). The FLEX strategies are implemented in support of EOPs using FSGs.

During the first phase of the ELAP event, Turkey Point would rely on the station's 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/PCS inventory control, and containment integrity). The Turkey Point Class 1E station batteries and associated direct current (dc) distribution systems are located within the control building annex, which is a seismic Category I structure. The Class 1E station batteries are therefore protected from the applicable extreme external hazards as defined in NEI 12-06. Licensee procedures 3-EOP-ECA-0.0, "Loss of All AC Power," Revision 10, 4-EOP-ECA-0.0, "Loss of All AC Power," Revision 10A, and 0-FSG-04, "ELAP DC Load Shed / Management," Revision 0, directs operators to conserve dc power during the event by stripping non-essential loads. The plant operators would commence stripping, or shedding dc loads within 30-60 minutes after the occurrence of an ELAP event. The licensee evaluated two non-essential load shed scenarios

(ELAP only and ELAP with a severe hurricane (e.g. Category 4 or 5)). The first scenario (ELAP only) involves a deep load shed being completed within 90 minutes to conserve battery power and credits the use of the spare battery. The second scenario (ELAP with a severe hurricane) also involves a deep load shed occurring within 90 minutes, but additional actions are taken to extend the Class 1E station batteries coping time until it is safe to deploy the 480 Vac FLEX DGs. The licensee plans to power the 120 Vac vital buses with a portable 6 kW FLEX DG staged on the mezzanine level outside the cable spreading room, de-energize the static uninterruptible power supplies (SUPSs), and credit the use of the spare battery.

Turkey Point has five Class 1E station batteries that were manufactured by Exide Technologies (GNB Flooded Classic model). Battery 3A and 4B are model NCN-25 with a capacity of 1810 ampere-hours (A-H). Battery 3B and 4A are model NCN-17 with a capacity of 1200 A-H. The spare battery is a model NCN-27 with a capacity of 1944 A-H. In the FIP, the licensee stated that the spare battery is normally not aligned to a dc bus and is available as a backup for any of the four Class 1E station batteries. A kirk key interlock is provided to ensure the spare battery is only aligned to one dc electrical train at a time. Once non-essential loads are shed from the dc bus, the spare battery has the capability to safely power all four dc electrical trains simultaneously. Four additional kirk keys are available to allow connecting all four dc electrical trains to the spare battery during an ELAP event. For the ELAP only scenario, after performing a deep load shed and using the spare battery, the 125 Vdc and 120 Vac buses would be available for 21 hours. For the ELAP with a severe hurricane scenario, after performing a deep load shed, powering the 120 Vac vital buses using portable 6 kW generators (one per unit), de-energizing the static inverters, and using the spare battery, the 125 Vdc and 120 Vac power would be available for over 49 hours.

In its FIP, the licensee noted that it had followed the guidance in NEI white paper, "EA-12-049 Mitigating Strategies Resolution of Extended Battery Duty Cycles Generic Concern" (Adams Access No. ML13241A186), when calculating the duty cycle of the batteries. By letter dated September 16, 2013 (ADAMS Accession No. ML13241A188), the NRC staff endorsed the NEI white paper. 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 of 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 evaluation above, the NRC staff concludes that the Turkey Point load shed strategies, ELAP only and ELAP with a severe hurricane, should ensure that the batteries have sufficient capacity to supply power to the required loads for at least 21 hours and 49 hours, respectively.

During the onsite audit, the NRC staff reviewed the licensee's dc coping calculation FPL065-CALC-009, "Turkey Point Battery Discharge Capacity During Extended Loss of AC Power," Revision 2, which verified the capability of the dc system to supply the required loads during the first phase of the Turkey Point FLEX mitigation strategy plan for an ELAP event. The licensee's evaluation identified the required loads and their associated ratings (ampere (A) and minimum required voltage) and the non-essential loads that would be shed within 90 minutes to ensure battery operation during an ELAP only event and an ELAP event with a severe hurricane for least 21 hours and 49 hours, respectively.

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

For the ELAP only scenario, the licensee's Phase 2 strategy includes repowering 480 Vac buses within 8 hours after initiation of an ELAP using portable 550 kW 480 Vac FLEX DGs (one per unit). There are three portable FLEX 480 Vac DGs to satisfy the "N+ 1" requirement. The portable 480 Vac FLEX DGs would supply power to each units' vital 480 Vac vital bus circuits providing continuity of key parameter monitoring and other required loads. The 550 kW FLEX DGs would provide power to 480 Vac load centers, battery chargers, charging pumps, boric acid transfer pumps, and ventilation. For the ELAP with a severe hurricane event, prior to the arrival of hurricane Category 4 or 5 winds, the licensee plans to stage 6-kW portable FLEX DGs and associated cabling within the turbine building mezzanine level where they are protected from the effects of wind and wind-driven missiles. During the period of a hurricane event when the Phase 2 equipment is not accessible, the generators would supply power to vital ac panels until the 550 kW 480 Vac FLEX DGs are operational.

The NRC staff reviewed the licensee engineering change documents EC-279532, "Unit 3 Fukushima FLEX Modifications – Electrical," Revision 4, and EC-279533, "Unit 4 Fukushima FLEX Modifications - Electrical," Revision 3, procedures 0-FSG-04, 0-FSG-05, "Initial Assessment and Equipment Staging," Revision 0, 0-FSG-99, "FSG Supplemental Guidance," Revision 0A, conceptual single line diagrams, and the separation and isolation of the FLEX DGs from the Class 1E emergency DGs. Based on the NRC staff's review, Turkey Point's minimum required loads for the Phase 2 550kW FLEX DG is 503 kW per unit. Therefore, one 550 kW FLEX DG per unit is adequate to support the electrical loads required for the licensee's Phase 2 strategies. Furthermore, the licensee's Phase 2 electrical strategy ensures that the safety-related battery chargers will be energized prior to the batteries depleting below minimum acceptable voltage.

For Phase 3, the licensee plans to continue the Phase 2 coping strategy with additional assistance provided from offsite equipment/resources. The offsite resources that will be provided by an NSRC includes four (2 per unit) 1- MW 4160 Vac combustion turbine generators (CTGs), two (1 per unit) 1100 kW 480 Vac CTGs, and distribution panels (including cables and connectors). Each portable 4160 Vac CTGs is capable of supplying approximately 1 MW, and the licensee plans to operate two CTGs in parallel to provide a total of approximately 2 MW. Based on the licensee's documents EC-279532 and EC-279533, the minimum required loads for the 4160 Vac CTGs equates to 755 kW. Based on the margin available for the 4160 Vac CTGS and the 480 Vac CTGS providing backup to the Phase 2 portable FLEX DGs, the NRC staff concludes that the 4160 Vac and 480 Vac equipment being supplied from an NSRC should have sufficient capacity and capability to supply the required loads.

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 appears to 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 one acceptable approach for the SFP cooling strategies. This approach uses a portable injection source to provide 1) makeup via hoses on the refueling floor capable of exceeding the boil-off rate for the design basis heat load; 2) makeup via connection to SFP cooling piping or other alternate location capable of exceeding the boil-off rate for the design basis heat load; and 3) spray via portable monitor nozzles from the refueling floor using a portable pump capable of providing a minimum of 200 gpm per unit (250 gpm to account for overspray). This approach will also provide a vent pathway for steam and condensate from the SFP. The spray capability is not required for SFPs that cannot be drained, due to a substantial portion of the pool being below ground level with no open structures beneath it.

As described in NEI 12-06, Section 3.2.1.7 and JLD-ISG-2012-01, Section 2.1, strategies that have a time constraint to be successful should be identified and a basis provided that the time can be reasonably met. In NEI 12-06, Section 3 provides the performance attributes, general criteria, and baseline assumptions to be used in developing the technical basis for the time constraints. Since the event is a BDBEE, 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 assume to operate at nominal setpoints and capacities. Guidance document 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.

Section 3.2.1.1 in NEI 12-06, 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 sections below address the effects of a BDBEE on SFP cooling during operating, pre-fuel transfer, post-fuel transfer operations, and full core offload.

3.3.1 Phase 1

The FIP described the Phase 1 strategy for the SFP as mainly monitoring the SFP level using instrumentation installed as required by NRC Order EA-12-051. The licensee stated that the FSGs would direct operators to take actions around 2.7 hours after ELAP for an emergency full core offload conditions following a refueling outage. This would involve establishing ventilation and creating pathways for hose runs to the refueling floor of the SFP. For severe hurricane scenarios, the licensee indicated that the hoses and nozzles would be pre-deployed inside the auxiliary building prior to the hurricane event.

3.3.2 Phase 2

The FIP described the Phase 2 strategies to involve initiating SFP makeup using the hoses on the refueling floor of the SFP, hose connections to SFP cooling piping, and establishing the vent pathway for steam from the SFP. The SFP makeup is projected to begin 20 hours after the ELAP event once the FLEX SFP pump and associated hoses and nozzles are deployed and staged. FSG procedures direct ventilation in the fuel handling area of the auxiliary building by directing operators to open doors and running hoses from the portable FLEX SFP pump to the refueling floor. The licensee described the alternate strategy for the hose connection to the SFP cooling piping as a small section of piping upstream of the emergency SFP cooling water pump modified with a new flange to install an isolation valve and a hose connection. The FLEX SFP pumps (one to supply both units' SFP, the second FLEX SFP pump serves as the "N+1") are stored in the FESB and deployed to the 18 ft. elevation in the SFP pump and heat exchanger room in the auxiliary building, which is protected from all applicable external hazards as defined in NEI 12-06. The hoses and nozzles are also deployed from the FESB either 2.7 hours after the ELAP event or pre-staged prior to the hurricane scenario.

3.3.3 Phase 3

The FIP described that the Phase 3 strategies would continue the SFP cooling and makeup strategy from Phase 2 indefinitely. The licensee indicated that additional plant equipment may be placed in service as they become available. The SFP heat exchanger can be used to provide SFP cooling indefinitely once the CCW system is reestablished with the use of the SFP cooling pump.

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.

During the audit review, the licensee provided calculation FPL77-CALC-006, "Turkey Point Extended Loss of AC Power Decay Heat and Makeup Requirements," Revision 0, for the staff's review. The purpose of the calculation is to determine the time after a BDBEE when the SFP exceeds the temperature limit for habitability. The calculation and the FIP indicate that boiling could begin as soon as 2.7 hours for full core offload after an ELAP event. 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 2 hours from ELAP 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 anticipated actions. However, the licensee does establish a ventilation path to cope with temperature, humidity and condensation from evaporation and/or boiling of the SFP. The operators are directed by the FSGs to prop open doors to the fuel handling area of the auxiliary building. The licensee described for the hurricane scenario that the lower temperatures and wind outside will create heat transfer through the ventilation plenum until the doors can be opened safely.

The licensee's Phase 2 and Phase 3 SFP cooling strategy involves use of the FLEX SFP pump and associated hoses and fittings, with suction from the intake canal or the available non-robust raw water tanks on site.

3.3.4.1.2 Plant Instrumentation

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

3.3.4.2 Thermal-Hydraulic Analyses

Section 11.2 of NEI 12-06 states, in part, that design requirements and supporting analysis should be developed for portable equipment that directly performs a FLEX mitigation strategy for core, containment, and SFP that provides the inputs, assumptions, and documented analysis that the mitigation strategy and support equipment will perform as intended. In addition, NEI 12-06, Section 3.2.1.6, Condition 4 states that SFP heat load assumes the maximum design basis heat load for the site. In accordance with NEI 12-06, the licensee performed a thermal-hydraulic analysis of the SFP as a basis for the inputs and assumption used in its FLEX equipment design requirements analysis. During the audit, the licensee referenced calculation FPL77-CALC-006, "Turkey Point Extended Loss of AC Power Decay Heat and Makeup Requirements," to provide the thermal-hydraulic analysis for the SFP of each unit. The calculation concluded that the maximum expected SFP heat load immediately following a full core offload (applicable during refueling will reach a bulk boiling temperature of 212°F in approximately 2.7 hours and boil off to the top of the active fuel in approximately 33 hours. The licensee referenced in calculation PTN-BFSM-14-009, "SFP FLEX Pump Hydraulic Calculation," Revision 0, that the SFP FLEX pump will provide for adequate makeup to restore the SFP level for both units. The staff reviewed both calculations to confirm that the implementation and performance of the FLEX SFP pump will meet the makeup requirements for the SFP in accordance to the time to boil and evaporation rate of the SFP.

Based on the information contained in the FIP and the above hydraulic calculation, the NRC staff concludes that the licensee has provided an analysis that considered maximum design-basis SFP heat load during operating, pre-fuel transfer or post-fuel transfer operations, the basis for assumptions and inputs used in determining the design requirements for FLEX equipment used in SFP cooling, and appears to be consistent with NEI 12-06 Section 3.2.1.6, Condition 4 and Section 11.2.

3.3.4.3 FLEX Pumps and Water Supplies

As described in the FIP, the SFP cooling strategy relies on one of two FLEX SFP pumps to provide SFP makeup for both units during Phases 2 and 3. In the FIP, Section 3.3.4.5 describes the hydraulic performance criteria (e.g., flow rate, discharge pressure) for the FLEX

SFP pump. During the audit, the licensee referenced hydraulic calculation PTN-BFSM-14-009, "SFP FLEX Pump Hydraulic Calculation," Revision 0, to provide the hydraulic calculation for the SFP FLEX pump. One FLEX SFP pump is needed to deliver 500 gpm to provide 250 gpm to each SFP. Two FLEX SFP pumps with associated hoses and nozzles are stored in the FESB to meet the "N+1" criteria in NEI 12-06. The staff reviewed the hydraulic calculation and the specifications of the FLEX SFP pump to confirm that the FLEX SFP pump can meet the makeup requirements for the SFP.

Based on the above evaluation of the SFP makeup requirements for both units, the NRC staff concludes that the licensee has demonstrated that its FLEX SFP pumps, if aligned and operated as described in the FSGs and the FIP, should perform as intended to support SFP cooling during an ELAP caused by a BDBEE, and appears to be consistent with NEI 12-06, Section 11.2.

3.3.4.4 Electrical Analyses

The licensee's FIP defines strategies capable of mitigating a simultaneous loss of all ac power and loss of normal access to the UHS resulting from a BDBEE, by providing the capability to maintain or restore core cooling, containment, and SFP cooling at all units at Turkey Point.

The staff reviewed the licensee's electrical strategies, which includes the SFP cooling strategy. The only electrical components credited by the licensee as part of its FLEX mitigation strategies, outside of instrumentation to monitor SFP level (which is described in other areas of this SE), are the 4160 Vac CTGs and distribution panels (including cables and connectors) that will be supplied by an NSRC. According to the licensee's FIP, these generators could be used to re-power SFP cooling system pumps, if necessary. The staff reviewed licensee's documents EC-279532 and EC-279533, and concluded that the 4160 Vac CTGs being supplied from the NSRCs should have sufficient capacity and capability to supply SFP cooling systems, if necessary.

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 appears to 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.

In accordance with NEI 12-06, the licensee performed a Turkey Point containment evaluation, FPL077-CALC-003, "MAAP [Modular Accident Analysis Program]Containment Analysis Calculation" Revision 1, which was based on the boundary conditions described in Section 2 of NEI 12-06. The calculation concludes that the containment parameters of pressure and temperature remain well below the respective design limits of 55 psig and 283°F (Updated Final Safety Analysis Report (UFSAR) Section 5.1.2.1). 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 licensee's containment analysis shows that there are no Phase 1 actions required for Modes 1-4 and Mode 5 with SGs available. The licensee indicated that containment pressure and temperature will be monitored using installed instrumentation. For Modes 5 and 6 without SGs available, the licensee stated that the containment pressure and temperature would increase due to the discharge of the core decay heat during "feed and bleed" cooling and direct heat transfer from the RCS. Heat loss from the containment would be negligible without containment venting or the operation of a cooling system. Therefore, the licensee indicated that the FSGs will direct operators to establish a vent path utilizing an open airlock or the containment equipment hatch prior to RCS starting to boil. The action of opening either the airlock or the containment equipment hatch would greatly reduce the capability of significant containment pressurization.

3.4.2 Phase 2

The licensee's containment analysis shows that there are no Phase 2 actions required. Containment pressure and temperature will continue to be monitored using installed instrumentation and maintain decay heat removal using SGs to exhaust RCS heat out to the atmosphere using the MSSVs or the SDTAs. For Modes 5 and 6 without SG heat removal available, the containment temperature and pressure will not be challenged with both doors on any airlock or the containment equipment hatch open.

3.4.3 Phase 3

Necessary actions to reduce containment temperature and pressure and to ensure continued functionality of the key parameters will utilize existing plant systems restored by off-site equipment and resources during Phase 3. The most significant need is to provide NSRC 4160 Vac CTGs power to the ECC fans and restoring CCW flow to the ECC coolers. The licensee stated that the heat will be removed from the CCW system by a NSRC cooling water pump connected to the ICW strainers. In Modes 5 and 6, containment temperature and pressure increase is mitigated by maintaining a containment vent path open until RHR cooling is recovered and RCS boiling is halted.

3.4.4 Staff Evaluations

3.4.4.1 Availability of Structures, Systems, and Components

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

3.4.4.1.1 Plant SSCs

Section 1.2.1 in the UFSAR describes Turkey Point as having two containment structures, each with a right vertical, post-tensioned reinforced concrete cylinder with pre-stressed tendons in the vertical wall, a reinforced and post-tensioned concrete hemispherical domed roof and a substantial base slab of reinforced concrete. The containment is designed to withstand environmental effects and the internal pressure and temperature accompanying a loss-of-coolant accident. It also provides adequate radiation shielding for both normal operation and accident conditions.

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. Turkey Point stated in its FIP that the key parameters for the containment integrity function are containment pressure and containment temperature, which can be obtained from essential instrumentation.

The above essential instrumentation will be available prior to and after load stripping of the dc and ac buses during Phase 1. All indications will be in the control room. Should any of the signal cabling to the control room indicators be damaged or dc power lost, all process parameters can be obtained at remote locations with hand held devices. Procedure 0-FSG-07, "Loss of Vital Instrumentation or Control Power," Revision 0, provides location and termination information in the control room for all essential instrumentation. The hand held devices have built in power supplies which can be used to provide loop power. Portable FLEX equipment is supplied with the local instrumentation needed to operate the equipment. The use of these instruments is detailed in the associated FSGs for use of the equipment. These procedures are based on inputs from the equipment suppliers, operation experience, and expected equipment function in an ELAP.

Based on this information, the licensee should have the ability to appropriately monitor the key containment parameters as delineated in NEI 12-06, Table 3-2.

3.4.4.2 Thermal-Hydraulic Analyses

During the audit process, the licensee provided the staff access to calculation FPL077-CALC-003, "MAAP Containment Analysis Calculation," Revision 1, which was based on the boundary conditions described in Section 2 of NEI 12-06. In this calculation, the licensee utilized the MAAP computer code, Version 4.0.7, to model the containment response to an ELAP. This MAAP model utilized mass and energy release rates taken from the calculation FPL065-CALC-010, "MAAP Analysis," Revision 0.

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. The assumed initial reactor coolant leakage is 4.25 gpm per each of the three RCPs and 1 gpm from unidentified sources for a total leakage of 13.75 gpm. The only heat removal mechanisms credited in this MAAP analysis were the passive heat sinks and the ambient heat loss from the containment structure to the outside atmosphere. Using the input described above, the containment pressure and temperature parameters were calculated to peak at approximately 18.8 per square inch absolute (psia) and 190°F. As previously stated, the UFSAR containment pressure and temperature limits are 55 psig and 283°F, so the licensee appears to have adequately demonstrated that there is significant margin before a limit would be reached.

3.4.4.3 FLEX Pumps and Water Supplies

The NSRC is providing a high capacity low pressure pump which will be used to provide cooling loads through the intake canal system during Phase 3. The NSRC pumps would provide flow through the ICW and CCW heat exchangers. The CCW and ECC systems would be repowered from the NSRC 4160 Vac CTGs to allow forced cooling of the containment buildings.

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 to determine the temperature and pressure increase in the containment vessels resulting from an ELAP as a result of a BDBEE. Based on the results of the evaluation, the licensee developed required actions to ensure maintenance of containment integrity and required instrumentation function. With an ELAP initiated, while either unit is in Modes 1-4, containment cooling for that unit is also lost for an extended period of time. Therefore, containment temperature and pressure will slowly increase. Structural integrity of the reactor containment building due to increasing containment pressure will not be challenged during the first few days of an ELAP event. However, with no cooling in the containment, temperature and pressure in the containment are expected to rise and could reach a point where continued reliable operation of key instrumentation might be challenged. The licensee's evaluations have concluded that containment temperature and pressure will remain below containment design limits and that key parameter instruments subject to the containment environment will remain functional. Therefore, actions to reduce containment temperature and pressure and to ensure continued functionality of the key parameters will not be required immediately.

The licensee's Phase 1 coping strategy for containment involves initiating and verifying containment isolation per procedures 3(4)-EOP-ECA-0.0. These actions ensure containment isolation following an ELAP event. Phase 1 also includes monitoring containment pressure and temperature. Containment pressure and temperature monitoring is available via normal plant instrumentation. Control room indication for containment pressure and containment temperature is available for the duration of the ELAP event.

The licensee's Phase 2 coping strategy is to continue monitoring containment temperature and pressure, and maintaining decay heat removal using SGs to exhaust RCS heat out to the atmosphere using the MSSVs or the SDTAs.

For Phase 3, the licensee plans to maintain the same strategies utilized during Phase 2, and use the NSRC supplied equipment as necessary. If necessary, the NSRC supplied 4160 Vac CTGs could repower the ECC fans and the CCW pumps to restore containment cooling.

Based on its review, the NRC staff concludes that the electrical equipment available onsite (i.e., 480 Vac FLEX DGs) supplemented with the equipment that will be supplied from the NSRCs (e.g., 480 Vac and 4160 Vac CTGs), there appears to be sufficient capacity and capability to supply the required loads to reduce containment temperature and pressure, if necessary, and to ensure that 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 appears to adequately address the requirements of the order.

3.5 Characterization of External Hazards

Sections 4 through 9 of NEI 12-06 provide the methodology to identify and characterize the applicable BDBEEs for each site. In addition, NEI 12-06 provides a process to identify potential complicating factors for the protection and deployment of equipment needed for mitigation of applicable site-specific external hazards leading to an ELAP and loss of normal access to the UHS.

Characterization of the applicable hazards for a specific site includes the identification of realistic timelines for the hazard, characterization of the functional threats due to the hazard, development of a strategy for responding to events with warning, and development of a strategy for responding to events without warning.

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

References to external hazards within the licensee's mitigating strategies and this SE are consistent with the guidance in NEI-12-06 and the related 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 (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. ML14309A256). The Commission provided guidance in an SRM to COMSECY-14-0037 (ADAMS Accession No. ML15089A236). The Commission approved the staff's recommendations that licensees would need to address the reevaluated flooding hazards within their mitigating strategies for BDBEEs, and that licensees may need to address some specific flooding scenarios that could significantly impact the power plant site by developing scenario-specific mitigating strategies, possibly including unconventional measures, to prevent fuel damage in reactor cores or SFPs. The NRC staff did not request that the Commission consider making a requirement for mitigating strategies capable of addressing the reevaluated flooding hazards be immediately imposed, and the Commission did not require immediate imposition. In a letter to licensees dated September 1, 2015 (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. The design criteria for Turkey Point accounts for two design-basis earthquake spectra: Design Basis Earthquake and the Safe Shutdown Earthquake (SSE). The ground accelerations for these spectra are 0.05 g and 0.15 g, respectively. 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.

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

3.5.2 Flooding

In its FIP, the licensee described that the current design-basis for the limiting site flooding event is wave run-up resulting from probable maximum hurricane (PMH) considerations. As described in UFSAR Sections 2.7 and 5G.5, the west side of the plant is protected up to an elevation of 20 ft. mean low water (MLW) and on the east side of the plant protection is provided to an elevation of 22 ft. MLW to account for wave run-up.

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 in this external hazard and identified the hazard levels to be evaluated.

3.5.3 High Winds

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

The screening for high wind hazards associated with hurricanes should be accomplished by comparing the site location to NEI 12-06, Figure 7-1 (Figure 3-1 of U.S. NRC, "Technical Basis for Regulatory Guidance on Design Basis Hurricane Wind Speeds for Nuclear Power Plants," NUREG/CR-7005, December, 2009); if the resulting frequency of recurrence of hurricanes with wind speeds in excess of 130 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, Revision 1.

In its FIP, the licensee stated that the site is located at 25° North latitude and 85° West longitude. In NEI 12-06, Figures 7-1 and 7-2, recommended hurricane and tornado design wind speeds for the 1E-6/year probability level indicates that the site is in a region where the hurricane and 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 Figure 8-2 should address the impact of ice storms.

The licensee indicated in its FIP that Turkey Point is located at approximately the 25° North latitude. Per Section 8 of NEI 12-06, snow, ice, or extreme cold hazard conditions do not apply to Turkey Point and provisions for this hazard will not be included in the FLEX strategy.

Therefore, snow, ice, and extreme cold are not applicable to the plant site. The licensee has appropriately screened out the snow, ice, and extreme cold hazard.

3.5.5 Extreme Heat

The licensee stated in its FIP that the climate at Turkey Point is typical of that in southern Florida, being hot and humid in the summer and mild in the winter. However, due to Turkey Point being situated on the coast, more moderate maximum temperatures are experienced, owing to the heat transfer with the adjacent ocean waters. In its FIP, the licensee stated that although most states have experienced temperatures in excess of 120°F, historically Miami, Florida, has recorded one day where temperatures reached 100°F dating back to 1895. Temperatures in the hot summers months are typically in the mid-90's.

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 appears to be consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and appears to 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 described that FLEX equipment will be stored in the FESB. The FESB is a precast concrete panel building of approximately 9,000 sq. ft. located at the southeast corner of the protected area. The FESB is protected from the hazards as described above. Below are additional details on how FLEX equipment is protected from each of the external hazards.

3.6.1.1 Seismic

In its FIP, the licensee described that FLEX equipment will be stored in the FESB, which meets the plant's design-basis for the SSE. In addition, equipment in the FESB is protected from seismic events and evaluated to ensure that seismic interactions that could damage equipment will not occur. The licensee concluded that due to the low seismic accelerations for the site, tie down of the equipment is not required.

3.6.1.2 Flooding

The plant grade is at elevation +18 ft. referenced to site MLW datum for both units. As stated above, based upon the high water level due to the PMH wave run-up level, flood protection is provided to +20 ft. MLW using stop logs at entrances to the North, South, and West sides of the facility. Additional wave run-up protection is provided at +22 ft. MLW on the eastside of the facility. Per administrative procedures, preparations begin 72 hours prior to the projected arrival of tropical storm force winds and subsequent flooding. The preparations include shutting down the units, topping off major water tanks, pre-staging small DGs and diesel powered pumps, as well as increasing plant staffing and supplies. Therefore, prior to the arrival of hurricane induced flooding and high winds, the plant is shut down and well prepared to cope with the event.

In its FIP, the licensee stated that the FESB finished floor is above flood stage elevation. However, during a hurricane induced flooding event, access to areas in the plant, as well as access to the FESB, could be restricted due to flood waters and high winds. Therefore, the licensee's strategy was developed such that access to FLEX equipment would not be required until the flood waters have receded.

3.6.1.3 High Winds

In its FIP, the licensee stated that the FESB is designed to withstand high winds and tornado/hurricane generated missiles. According to the licensee, this robust pre-cast concrete panel FLEX storage structure provides reasonable protection and deployment of FLEX equipment following a BDBEE high wind event.

3.6.1.4 Snow, Ice, Extreme Cold and Extreme Heat

As stated in the FIP, the guidelines provided in NEI 12-06 exclude the need to consider extreme snowfall at plant sites in the southeastern U.S. below the 35th parallel. Turkey Point is located below the 35th parallel and thus the capability to address impedances caused by extreme snowfall with snow removal equipment need not be provided.

FLEX equipment has been selected to be capable of operating in hot weather at or in excess of the site extreme maximum temperature. Thus, it is not expected that FLEX equipment and deployment would be affected by high temperatures. Storage of FLEX equipment in the FESB includes ventilation to aid in the relief of increasing temperatures that might develop within the storage building prior to an extreme heat BDBEE causing a loss of ac power.

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.

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 concludes that, if implemented appropriately, 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, and appears to be consistent with the "N+1" recommendation in Section 3.2.2.16 of NEI 12-06.

3.6.3 Conclusions

Based on the licensee's plan to store all of their onsite portable FLEX equipment in a fully protected structure, the NRC staff review concludes that the licensee has provided a storage location that is appropriately protected from the applicable external hazards for the site in accordance with the provisions of NEI 12-06. Further, the NRC staff concludes that the licensee has stored sufficient equipment to accomplish the elements of their overall strategy that depend on this equipment (primarily Phase 2 operations). Therefore, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should protect the FLEX equipment during a BDBEE consistent with NEI 12-06, as endorsed, by JLD-ISG-2012-01, and appears to adequately address the requirements of the order.

3.7 Planned Deployment of FLEX Equipment

The licensee stated in its FIP that pre-determined, preferred haul paths have been identified and documented in the FSGs. Figure 8 of the FIP shows the haul paths from the FESB to the various deployment locations. These haul paths have been reviewed for potential soil liquefaction and the licensee determined that soil liquefaction will not preclude FLEX strategy implementation..

3.7.1 Means of Deployment

The deployment of onsite FLEX equipment to implement coping strategies beyond the initial plant capabilities (Phase 1) requires that pathways between the FESB and various deployment locations be clear of debris resulting from seismic, high wind, or flooding events. The stored FLEX equipment includes debris removal equipment that provides a means to move or remove debris from the needed travel paths. In addition, tow vehicles will be used to deploy the FLEX equipment.

The licensee may need to open doors and gates that rely on electric power for opening and/or locking mechanisms. The licensee has contingencies for access upon loss of all ac/dc power as part of the security plan. Access to the owner-controlled area, the plant protected area, and areas within the plant structures will be controlled under this access contingency.

In its FIP, the licensee identified three predetermined, preferred haul paths for Turkey Point, and these haul paths have been reviewed for possible obstructions. However, high winds can cause debris from distant sources to interfere with planned haul paths. Therefore, debris removal equipment is stored inside the FESB, which protects the equipment from severe storm and high wind hazards such that the equipment remains functional and deployable to clear obstructions from the pathway between the FESB and its deployment location(s).

Phase 3 of the FLEX strategies involves the receipt of equipment from offsite sources including the NSRC and various commodities such as fuel and supplies. Transportation of this equipment can be through airlift or via ground transportation. Debris removal for the pathway between the site and the four NSRC receiving locations for Turkey Point and from the various plant access routes may be required. The same debris removal equipment used for on-site pathways will be used to support debris removal to facilitate road access to the site.

3.7.2 Deployment Strategies

In its FIP, the licensee stated that the haul paths were reviewed for potential soil liquefaction. The licensee determined that soil liquefaction will not preclude FLEX strategy implementation. The NRC staff walked down and reviewed the licensee's travel paths during the onsite audit to verify the licensee's conclusions and the NRC staff believes that liquefaction should not inhibit the necessary equipment deployment after an earthquake.

For the RCS cooling strategy, the licensee will deploy a FLEX well pump to refill the CST(s) from the FLEX well using hose connections. The FLEX well supplied by the Floridan aquifer is the credited backup water supply following exhaustion of the surviving CST(s). The FLEX well pump is supplied by this well and discharges to the CST(s) if the AFW pumps are still in use, or discharges directly to the steam generators via connections installed in the AFW system if the SGs have been depressurized. The CST connections are designed to seismic Class 1 requirements and the hose runs will be through the turbine building, which has been evaluated for seismic loads.

For RCS makeup, the FLEX RCS strategy relies on the utilization of the charging pumps for RCS makeup for all modes of operation. However, depending on the mode of operation during the ELAP event, the charging pumps will take suction from the BASTs or RWSTs. To replenish borated water before these tanks are depleted, a FLEX well pump will be deployed to produce additional borated water by mixing with water from the boric acid batch tank.

For the electrical strategy, two FLEX 480 Vac DGs are deployed into the protected area. For hurricane events, prior to the arrival of the Category 4 or 5 winds, the licensee plans to stage 6-kW portable FLEX DGs and associated cabling within the turbine building mezzanine level where they are protected from the effects of wind and wind-driven missiles.

3.7.3 Connection Points

3.7.3.1 Mechanical Connection Points

Core Cooling (SG) Primary and Alternate Connections

In its FIP, the licensee described that the primary and alternate connections for SG injection would be made from the FLEX well pump into discharge connections for the Unit 3 and Unit 4 SGs. The licensee indicates that two flanged hose connections in the AFW "A" & "B" pump discharge lines (two trains for each units' SGs) for have been installed downstream of the pumps. These connections are used to attach temporary flanged hose adapters after an ELAP event and are angled to provide ease of connecting the flanged hose adapter and the hose. These flanged hose connections will support the FLEX well pump and NSRC equipment. The licensee cited the use of valve manipulation from Train 'A' or 'B' and the physical separation of the piping would permit for the primary and alternate pathways for SG injection. The FLEX well pump connections are located in the AFW cage where the TDAFW pumps and turbine drivers are located. The turbine building provides overall protection for the AFW cage and associated piping to the AFW system from applicable external hazards as defined in NEI 12-06, along with additional flood barriers around the outside of the turbine building to divert any possible flood water from entering. The connections are located above grade level and within the flood protected boundary therefore protected from external flooding.

The licensee also described in its FIP, the capability to provide makeup to the Unit 3 and Unit 4 CSTs to supply water to the SGs. The licensee described the primary connection for CST makeup as being located on an abandoned-in-place level transmitter line inside the CST cage (for each unit) and consists of an isolation valve and a permanent hose connection. The licensee described the alternate connection as being located in the CST roof manhole cover in each CST. The CST manhole cover has been modified to include an elbow and a permanent hose connection angled downwards. The CSTs are protected from all applicable external hazards as defined in NEI 12-06, except tornado missiles. The licensee cited the separation and intervening structures in between both CSTs for being able to survive the impact of a tornado missile striking one CST. The CSTs are cross-tied, so the operators would need to provide the CST makeup within 9 hours if the one CST is available to supply the SGs for both units.

RCS Inventory Control Primary and Alternate Connections

The licensee described the primary and alternate connections for RCS makeup in its FIP as a modification on the existing primary makeup water line, which includes a new isolation valve and 2 flanged connections to supply the boric acid blender. The water from the FLEX well and the BAST are supplied to the boric acid blender for boron mixing and distribution to the charging pump suction line for makeup to the RCS through either the normal charging or reactor coolant pump seal injection lines (alternate pathway). The connections to the primary makeup water line to the boric acid blender are located in the charging pump room within the auxiliary building, which is protected from all applicable external hazards as defined in NEI 12-06.

SFP Makeup Primary and Alternate Connections

In its FIP, the licensee described that the primary method for providing SFP makeup would come from using hoses and installing nozzles capable of spray coverage over the edge of the SFP. These components would be deployed early and staged in the SFP building in the hurricane scenario. The alternate method for SFP makeup will be provided by the flanged hose connections in the emergency SFP cooling pump suction line of each unit. The licensee indicated that a flanged connection has been installed in the emergency SFP pump suction line, and it is located in the SFP heat exchanger room for each unit. The flanged connection has a permanent hose adapter angled downwards and the hose connection is threaded for ease in installing the hoses to reduce installation times. The SFP heat exchanger room is located in the SFP building, which is protected from all applicable external hazards as defined in NEI 12-06.

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 has developed a primary, alternate, and contingency strategy for supplying power to equipment required to maintain or restore core cooling, containment, and SFP cooling using a combination of permanently installed and portable components. There are three portable 480 Vac FLEX DGs provided for the strategy. The 480 Vac FLEX DG staging location for Turkey Point, Unit 3 is on the discharge road near the Unit 3 startup transformer. The 480 Vac FLEX DG staging location for Turkey Point, Unit 4 is on the discharge road near the Unit 4 main transformer.

The licensee's primary strategy for the 480 Vac FLEX DGs is to re-power the 'B' Train 480 Vac vital bus via the 'B' and 'D' (3B/3D and 4B/4D) load centers. The licensee installed new circuit breakers in spare cubicles on load centers 3B, 3D, 4B, and 4D. The licensee also installed a terminal box (primary) on each unit along with permanent raceway and cables that connect the terminal box to the load centers. The licensee's alternate strategy is to restore power to the 'A' Train via the 'A' and 'C' (3A/3C and 4A/4C) load centers. The licensee installed new breaker insert assemblies in spare cubicles on load centers 3A, 3C, 4A, and 4C. The licensee also installed two terminal boxes (alternate terminal box hardwired to load center terminal box) on each unit to connect to the load center inserts. The licensee's contingency strategy provides connection directly from the portable 480 Vac FLEX DG to the load center inserts. Procedure 0-FSG-99, provides direction for repowering load centers and ensuring proper phase rotation before attempting to power equipment from a 480 Vac FLEX DG.

For Phase 3, the licensee will receive four 1-MW 4160 Vac (two per unit) and two 1100 kW 480 Vac (one per unit) CTGs from an NSRC. The licensee plans to use the incoming circuit breakers from the 'C' Bus as the incoming feeders for the NSRC supplied 4160 Vac CTGs. Plant operators would route the cables from the CTGS to either the 3B/4B (primary) or 3A/4A (secondary) 4160 Vac switchgear. Plant operators would also disconnect the existing feeders from the 'C' Bus and then the plant operators would connect new temporary cables onto the breaker load-side terminals thus repowering the 4160 Vac bus when the breaker is closed. The NSRC supplied 4160 Vac CTGs will be staged on the north side of the Turkey Point, Unit 3 diesel fuel oil tank berm (for Unit 3) and the turbine laydown area (for Unit 4). The NSRC supplied 480 Vac CTGs will be staged in the vicinity of the portable FLEX 480 Vac DGs, if necessary. Procedure 0-FSG-99, provides direction for ensuring proper phase rotation before attempting to power equipment from the 4160 Vac and 480 Vac CTGs.

3.7.4 Accessibility and Lighting

During the onsite audit, the licensee stated that the potential impairments to required access are: 1) doors and gates, and 2) site debris blocking personnel or equipment access. The coping strategy to maintain site accessibility through doors and gates is applicable to all phases of the FLEX coping strategies, and is immediately required as part of the immediate activities required during Phase 1. Doors and gates serve a variety of barrier functions on the site. One primary function is security and is discussed below. However, other barrier functions include fire, flood, radiation, ventilation, tornado, and high energy line break. As barriers, these doors and gates are typically administratively controlled to maintain their function as barriers during normal operations.

The licensee noted that following an BDBEE and subsequent ELAP event, FLEX coping strategies require the routing of hoses and cables to be run through various barriers in order to connect beyond-design-basis (BDB) equipment to station fluid and electric systems or require the ability to provide ventilation. For this reason, certain barriers (gates and doors) will be opened and remain open. This deviation of normal administrative controls is acknowledged and is acceptable during the implementation of FLEX coping strategies. The ability to open doors for ingress and egress, ventilation, or temporary cables/hoses routing is necessary to implement the FLEX coping strategies.

In its FIP, the licensee described that Appendix R emergency battery pack lights have an expected life of 8 hours. In addition, since the ELAP event extends beyond 8 hours, alternate portable lighting is provided. Normal lighting and emergency lighting units are non-safety-related, therefore, portable lighting is provided for deployment of FLEX strategies. Pump and generator skids are supplied with self-powered lighting mounted on and powered by the portable equipment to provide lighting of controls for operating portable equipment. For illumination of personnel routes within and around buildings, as well as the continuously manned control room, portable lighting is provided. The FLEX temporary lights have up to 24 hour life and are stored in the control room and FESB. Generators are provided to recharge batteries. The EOPs and FSGs address the use of temporary and portable lighting.

3.7.5 Access to Protected and Vital Areas

During the onsite audit, the licensee stated that contingencies are available to open security doors and gates that rely on electric power to operate opening and/or locking mechanisms. The security force will initiate an access contingency upon loss of power as part of the Security Plan. Access to the owner controlled area, site protected area, and areas within the plant structures will be controlled under this access contingency as implemented by security personnel.

3.7.6 Fueling of FLEX Equipment

In its FIP, the licensee stated that Turkey Point will utilize the Unit 4 diesel oil storage tanks (DOST) as the primary source of fuel oil for portable equipment. The Unit 4 DOST contains about 34,700 gallons of fuel oil and is located in the Unit 4 EDG building, which is a seismic Class I structure and protected from all external hazards as defined in Section 3.5 of this SE. The licensee plans to use a transfueler on a trailer, which is deployed from the FESB. The transfueler can store about 1,000 gallons of fuel oil, which is then deployed to refill the FLEX equipment fuel tanks throughout the site. The licensee indicated that all diesel fuel oil will be routinely sampled and tested to assure fuel oil quality is maintained to American Society for Testing and Materials (ASTM) standards. This sampling and testing surveillance program also assures the fuel oil quality is maintained for operation of the station emergency DGs. The licensee's evaluation of the overall fuel oil to be consumed after declaration of an ELAP is about 118.7 gal/hr, in which the fuel oil in the Unit 4 DOST can supply the FLEX equipment on site for approximately 12 days. The licensee indicated that additional fuel oil would be provided by local or regional providers once the on-site fuel oil is nearly consumed. The licensee also indicated that the fuel oil needed for the high pressure RCS injection pump, low pressure / high flow dewatering pump, the 480 V turbine generator, and additional fuel tanks will be provided from the NSRC. Fuel oil to support this equipment would be available from local or regional providers within 12 hours.

During the audit, the staff reviewed procedure 0-FSG-99, "FSG Supplemental Guidance," Revision 0, which described the refueling strategy for the FLEX equipment and the FLEX equipment slated to be used after an ELAP. A refueling timeline for major FLEX components has been developed and placed in 0-FSG-99.

3.7.7 Conclusions

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

3.8 Considerations in Using Offsite Resources

3.8.1 Turkey Point SAFER Plan

The industry has collectively established the needed off-site capabilities to support FLEX Phase 3 equipment needs via the SAFER Team. SAFER consists of the Pooled Equipment Inventory Company 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 Turkey Point Alternate Staging Area D is at the Homestead Air Reserve Base (HARB) and it is used for helicopter transport should the plant access roads be impassible. Staging Area C is the Hialeah Railyard, which is immediately west of the Miami International airport. Staging Area B is located on a portion of a contractor parking lot west of the plant. Two alternate locations for Staging Area B are on an open field and parking lot near the site's daycare and security training facility on Palm Drive.

Use of helicopters to transport equipment from Staging Area D to Staging Area B is recognized as a potential need within the Turkey Point SAFER Plan.

3.8.3 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should allow utilization of offsite resources following a BDBEE consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and appears to 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 Turkey Point, ventilation providing cooling to occupied areas and areas containing FLEX strategy equipment will be lost. Per the guidance given in NEI 12-06, FLEX strategies must be capable of execution under the adverse conditions (unavailability of installed plant lighting, ventilation, etc.) expected following a BDBEE resulting in an ELAP.

The primary concern with regard to ventilation is the heat buildup which occurs with the loss of forced ventilation in areas that continue to have heat loads. The licensee performed several 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 and within equipment qualification limits.

The key areas identified for all phases of execution of the FLEX strategy activities are the control room, AFW pump cages, and dc equipment and battery rooms. The licensee evaluated these areas to determine the temperature profiles following an ELAP event. With the exception of the control room, results of the calculation have concluded that temperatures remain within acceptable limits based on conservative input heat load assumptions for all areas with no actions initially being taken to reduce heat load or to establish either active or passive ventilation (e.g., portable fans, open doors, etc.).

Main Control Room

The NRC staff reviewed calculation FPL077-CALC-005, "Control Building Heatup," Revision 0, which modeled the control room temperature transient through 12 hours following a BDBEE resulting in an ELAP. The calculation uses the GOTHIC Version 7.2b computer program (Generation of Thermal-Hydraulic Information for Containments). The acceptance criterion for the calculated temperatures is based on the guidance in NUMARC-87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," Revision 1, which states that a control room temperature of 120°F is an acceptable limit for control room equipment operability. The calculation determined that maximum temperatures remain below 110°F for 12 hours without opening doors to the control room. The analysis used normal heat loads and an outside temperature of 95°F that are conservative for the ELAP event. Under ELAP conditions, all non-vital control room electrical ac loads will be de-energized and at least 50 percent of the 120 Vac vital instrument (battery backed) / 125 Vdc loads and vital 120 Vac loads will be deenergized due to load shedding within the first 90 minutes of the event. The licensee indicated that due to the FLEX 480 Vac DG repowering load centers around 8 hours after an ELAP, no additional components such as portable fans would be needed and procedure 0-FSG-05, Initial Assessment and Equipment Staging," will direct the opening of control room doors to help keep the control room temperature below 110°F until control room ventilation is restored. The NRC staff reviewed the calculation and performed a walkdown of the control room during the audit and was able to confirm that the room configuration and the availability of restoring control room ventilation would keep the temperature from rising above 110°F.

AFW Pump Cages

The TDAFW pumps are installed in an outdoor environment within the turbine building. No ventilation fans are required for safety-related design functions or post-ELAP conditions. TDAFW pump bearings do not rely on external cooling systems. Electrical equipment and instrumentation that are relied upon during an ELAP are environmentally qualified for their safety related design function and do not require cooling to be available during the ELAP. The dc powered active valves that admit steam to and pass flow from the TDAFW pumps are qualified to operate under design outdoor environmental conditions. The NRC staff performed a walkdown of the AFW pump cages during the audit and confirmed that the AFW pumps do not require additional ventilation or cooling to perform their functions for FLEX strategies.

DC Equipment and Battery Rooms

Calculation FPL077-CALC-005, "Control Building Heatup," Revision 0, concluded that the temperature inside the dc equipment rooms will remain below the equipment temperature limit of 135°F for 12 hours without cooling. After this period of time normal cooling will be restored using the FLEX DGs. The NRC staff identified no habitability issues with the equipment in the dc equipment rooms as long as the FLEX 480 Vac DGs are established and battery room ventilation power is restored within 8 hours after ELAP.

The licensee typically maintains temperature in the Turkey Point safety-related battery rooms at 82°F. The concrete walls, floors and ceiling in the safety-related battery rooms function as a large heat sink following loss of ventilation. Procedure 0-FSG-05 directs plant operators to address ventilation concerns in the dc equipment rooms and safety-related battery rooms shortly after the onset of an ELAP. Specifically, 0-FSG-05 directs plant operators to open dc equipment room, battery room and cable spreading room doors. Plant operators would establish battery room ventilation using procedure 0-FSG-99.

Heat loads in the dc equipment and safety-related battery rooms following an ELAP are minimal (lighting, dc-powered loads) compared to normal operating loads such as large transformers and breakers, battery chargers, and motors. Additionally, following an ELAP, plant operators would strip loads from the station's safety-related batteries to prolong the life of the batteries. The heat load from batteries during discharge and charging is a function of the internal resistance and the square of the current. Since the licensee expects load shedding to be completed within 90 minutes from the onset of an ELAP event, the heat generated in the battery rooms will be minimized due to the lower current draw, and the rate of release into the battery rooms will be slow due to the large mass of electrolyte. Furthermore, the heat sinks in the battery rooms minimize the rate of temperature increase or decrease in the battery rooms, regardless of the outside ambient temperature.

Based on the above, the NRC staff concludes that the licensee's ventilation strategy, in combination with the effect of the heat sinks in the dc equipment rooms and the open doorways between the these rooms and other rooms, will maintain the battery room temperature below the maximum temperature limit (120°F) of the batteries, as specified by the battery manufacturer (Exide Technologies). Therefore, the NRC staff concludes that the Turkey Point safety-related batteries should perform their required functions at the expected temperatures as a result of loss of ventilation during an ELAP event.

Containment

See Section 3.4 of this SE for the NRC staff's evaluation of the licensee's mitigating strategy for maintaining containment temperature to ensure the functionality of required instrumentation and equipment.

3.9.1.2 Loss of Heating

The licensee described in its FIP that the BAST temperature for solubility is 63°F when at the maximum concentration of 7,000 ppm. The licensee credits the thermal inertia in the auxiliary building to maintain temperatures well above freezing and local temperatures have historically not gone below 40°F no more than 2 days. For ELAP events, the charging pumps will be running when repowered from the FLEX 480 Vac DGs. The BAST tanks room is located adjacent to the charging pump rooms, and operators will be directed by FSGs to open the door to allow the heat from the charging pumps to enter the BASTs room. The licensee indicated that due to the location of the BASTs inside the auxiliary building, local external temperatures not approaching freezing throughout the year, and the ability to allow heat from the charging pump motors into the BASTs room, heat tracing would not be required. The licensee did not identify any other plant SSCs in the FIP that would require heat tracing for ELAP mitigation strategies.

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. Procedure 0-FSG-05 directs plant operators to open dc equipment and battery room doors shortly after the onset of an ELAP. Procedure 0-FSG-99 directs plant operators to restore battery room ventilation after load centers and motor control centers are repowered from the portable 480 Vac FLEX DGs to provide cooling and prevent a buildup of hydrogen in the battery rooms.

Based on its review of the licensee's battery room ventilation strategy, the NRC staff concludes that hydrogen accumulation in the Turkey Point safety-related battery rooms should not reach the combustibility limit for hydrogen (4 percent) during an ELAP as a result of a BDBEE since the licensee plans to open battery room doors and restore battery room ventilation when the battery chargers are repowered during Phase 2 and Phase 3.

3.9.2 Personnel Habitability

To address room heat-up concerns during an ELAP, the licensee referenced calculation FPL077-CALC-005, "Turkey Point NGS Control Building Heatup for Extended Loss of AC Power," Revision 0, and procedure 0-FSG-05, Initial Assessment and Equipment Deployment," which describe the strategies and compensatory actions for operators to manage high temperatures when performing actions during ELAP events.

3.9.2.1 Main Control Room

The NRC staff reviewed calculation FPL077-CALC-005, "Control Building Heatup," Revision 0, which modeled the control room temperature transient through 72 hours following a BDBEE resulting in an ELAP. The acceptance criterion for the calculated temperatures is based on the guidance in NUMARC 87-00, which states that a control room temperature of 110°F is an acceptable limit for control room personnel habitability. As described in its FIP, the licensee indicated that the maximum temperature for the control room would remain below 110°F for 12 hours based on the normal heat loads and external temperature of 95°F for an ELAP event. The calculation determined that during the ELAP event after the load shed, the control room should have a 50 percent reduction in the electrical heat loads. The licensee determined that portable fans are not expected to be required and the opening of control room doors should be adequate to maintain the environment below 110°F for the 8 hour period without air conditioning. The FLEX 480 Vac DGs will be expected to restore power to load centers and restore control room ventilation within 8 hours of an ELAP. The licensee further stated that the FSGs provide provisions to deploy door blocks and/or portable fans with portable DGs from the FESB, if needed. In addition, adverse weather preparations ensure water inventories for fluid replenishment are staged in the control room.

Based on the licensee's evaluation of the control room temperature remaining below 110°F for 8 hours and the FSGs allowing for actions and the use of portable equipment to provide additional cooling to the control room, the NRC staff concludes that the long term personnel habitability in the control room should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

3.9.2.2 Spent Fuel Pool Area

Per NEI 12-06 guidance, a baseline capability for SFP cooling is to provide a vent pathway for steam and condensate from the SFP. The FLEX strategies for Turkey Point SFP cooling include opening doors and deploying hoses in Phase 1 prior to habitability in the auxiliary building being degraded. The timing for the opening of the SFP doors is provided in the timeline as occurring between 1 and 2 hours following an ELAP. For hurricane events, FSG-5 directs operators to deploy the FLEX SFP pump with associated hoses and nozzles to the auxiliary building for pre-staging prior to the hurricane. The operators would not be expected to open the above doors due to uncertainty of the hurricane event, but lower external temperatures and wind will create sufficient heat transfer through the ventilation plenum until the doors can be opened once conditions are safe to do so. Procedure 0-FSG-5 includes guidance on the coping strategies to establish SFP ventilation.

Based on the procedures designated in the FSGs, the NRC staff concludes that the actions required to employ the SFP cooling strategy appear to be acceptable due to the licensee accounting for creating ventilation early after an ELAP is declared and for the capability to deploy and prestage FLEX equipment for SFP makeup for hurricane scenarios.

3.9.2.3 Other Plant Areas

AFW Pump Cages

The TDAFW pumps are located in an enclosed, but grated area open to the environment on all sides and no forced ventilation system is needed. The maximum temperature is based on the outdoor temperature expected for the site. The only action to take place in the room is when the TDAFW pumps are not available and the operators have to hook a FLEX connection to a flange that provides discharge of makeup water directly to the SGs. Natural driven wind ventilation keeps the AFW pump cage accessible to personnel during all phases of an ELAP. The NRC staff noted that the design of the AFW cage would allow the operators to perform SG injection tasks without habitability concerns due to the open environment of the AFW cages.

3.9.3 Conclusions

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

3.10 Water Sources

Condition 3 of NEI 12-06, Section 3.2.1.3, states that cooling and makeup water inventories contained in systems or structures with designs that are robust with respect to seismic events, floods, and high winds, and associated missiles are available. The staff reviewed the licensee's planned water sources to verify that each water source is robust as defined in NEI 12-06.

3.10.1 Steam Generator Make-Up

In its FIP, the licensee stated that for SG makeup, the CSTs would be used to provide the preferred water source to the TDAFW pumps to supply the SGs in both units. Each CST is described to be credited for 233,075 gallons (about 12 hours of water inventory for each CST) available for use by the AFW pumps. Both CSTs are capable of being cross-tied, which would allow for additional inventory to be available as needed. The cross-tie includes check valves which prevent draining of the surviving CST. The CSTs are protected from all applicable external hazards as defined in NEI 12-06, except for tornado missiles and hurricane events. The licensee credits one CST to be available for both scenarios due to the separation of the

CSTs and the intervening structures in between both CSTs. The licensee stated that CST makeup would begin at 9 hours as directed by FSGs to ensure that water inventory would be available to at least one CST as part of the credited SG makeup strategy. The licensee also discussed in its FIP that the newly installed FLEX well would be the robust water source to either refill the CSTs or provide direct SG injection for both units using the FLEX well pump. The water inventory for the FLEX well is an indefinite water source and serves to backup the CSTs. The licensee also stated in its FIP that additional non-robust water sources on-site would be used for CST makeup if they are available prior to using the FLEX well as the last resort.

The staff walked down the locations of the above water sources to confirm that the licensee did account for the distances and intervening structures for the CSTs and FLEX well respectively. The staff noted that the licensee has multiple protected water sources available on the site after an ELAP is declared and concludes that the above water sources appear to be adequate for implementation of FLEX strategies of providing makeup to the SGs for all three phases.

3.10.2 Reactor Coolant System Make-Up

In its FIP, the licensee stated that for RCS inventory control during Phase 2, the BASTs are the preferred source of borated makeup water for supplying the charging pumps. The BASTs are located in the auxiliary building, which is a seismic Category I structure that is protected from all applicable external hazards as defined in NEI 12-06. The BASTs receive water from the FLEX well and the boric acid batching tanks to provide borated water mixture through the boric acid transfer pumps and eventually through the charging lines or RCPs seal injection lines. The charging pumps will supply the RCS makeup from the BASTs at approximately 13 hours after an ELAP and should remain capable for makeup for at least 72 hours. The charging pumps and boric acid transfer pumps will be re-powered from the FLEX 480 Vac DGs. The licensee also described that the RWSTs would be used for RCS makeup for Modes 5 and 6 for Phase 3. Similar to the CSTs, the RWSTs are protected from all applicable external hazards as defined in NEI 12-06, except for tornado missiles. Based on the location and intervening structures in between both RWSTs, the licensee credits the availability of one RWST for its overall RCS makeup strategy. The staff walked down the locations of the borated water sources to confirm the availability and hazard protection in the instance of RCS makeup for Phases 2 and 3.

3.10.3 Spent Fuel Pool Make-Up

In its FIP, the licensee stated that the SFP makeup for Phase 2 would be obtained from either the intake canal or available non-robust water sources throughout the site. The licensee stated that the protected water source would be the intake canal, whereas the available non-robust water sources will be used prior to the intake canal, if possible.

3.10.4 Containment Cooling

In its FIP, the licensee stated that the water supply will be provided by the intake canal system, and the NSRC pumps would provide flow through the ICW and CCW heat exchangers.

3.10.5 Conclusions

Based on the evaluation above, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should maintain satisfactory water sources following a BDBEE consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and appears to 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 33 hours are available to implement makeup before boil-off results in SFP uncover of the fuel assemblies (full core offload), 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 steam-powered 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. On September 18, 2013 (ADAMS Accession No. ML13273A514), NEI submitted to the NRC a position paper entitled "Shutdown/Refueling Modes," which described methods to ensure plant safety in those shutdown modes. By letter dated September 30, 2013 (ADAMS Accession No. ML13267A382), the NRC staff endorsed this position paper as a means of meeting the requirements of the order.

For containment, review of once-through-cooling scenarios for Modes 5 and 6 without SGs indicates containment venting will be required to prevent exceeding containment design conditions. The NRC staff reviewed calculation FPL077-CALC-003, "MAAP Containment Analysis Calculation," Revision 1, which used the MAAP computer code, version 4.0.7. The analysis covers plant operating Modes 5 and 6 by utilizing the half-loop mode of MAAP to simulate "feed and bleed" scenario where the RCS is allowed to boil off through an opening in the pressurizer while make-up is provided to the cold leg. The calculation concluded that the containment pressure will rise to the peak value of 18 psia, which is well below the design pressure of 55 psia. The calculation also indicated that the containment temperature would reach 190°F, which is below the design temperature of 283°F.

The position paper provides guidance to licensees for reducing shutdown risk by incorporating FLEX equipment in the shutdown risk process and procedures. Considerations in the shutdown risk assessment process include maintaining necessary FLEX equipment readily available and potentially pre-deploying or pre-staging equipment to support maintaining or restoring key safety functions in the event of a loss of shutdown cooling. The NRC staff concludes that the position paper provides an acceptable approach for demonstrating that the licensees are capable of implementing mitigating strategies in shutdown and refueling modes of operation. The licensee stated in its FIP, that Turkey Point will abide by the guidance in the September 18, 2013, position paper. During the audit process, the NRC staff observed that the licensee had made progress in implementing this position paper.

Based on the information above, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should maintain or restore core cooling, SFP cooling, and containment following a BDBEE in shutdown and refueling modes consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and appears to adequately address the requirements of the order.

3.12 Procedures and Training

3.12.1 Procedures

Regarding procedures, the licensee stated in its FIP that the inability to predict actual plant conditions that require the use of BDB equipment makes it impossible to provide specific procedural guidance. As such, the FSGs will provide guidance that can be employed for a variety of conditions. Clear criteria for entry into FSGs will ensure that FLEX strategies are used only as directed for BDBEE conditions, and are not used inappropriately in lieu of existing procedures. When BDB equipment is needed to supplement EOPs or off-normal operating procedures (ONOPs) strategies, the EOPs or ONOPs will direct the entry into and exit from the appropriate FSG procedure.

FLEX strategy support guidelines have been developed in accordance with PWROG guidelines. FSGs will provide available, preplanned FLEX strategies for accomplishing specific tasks in the EOPs or ONOPs. The FSGs will be used to supplement (not replace) the existing procedure structure that establishes command and control for the event. Procedural interfaces have been incorporated into 3/4-ECA-0.0, "Loss of All AC Power" and ONOPs to the extent necessary to include appropriate reference to FSGs and provide command and control for the ELAP.

The licensee also stated in its FIP that FSG maintenance will be performed by the Operations department as delineated in the FLEX overall program document. In addition, the licensee stated that validation has been accomplished via walk-throughs or drills of the guidelines to ensure the strategy is feasible.

3.12.2 Training

In its FIP, the licensee stated that initial training has been provided and periodic training will be provided to site emergency response leaders on beyond-design-basis emergency response strategies and implementing guidelines. In addition, personnel assigned to the direct execution of mitigation strategies for BDBEEs have received the necessary training to ensure familiarity with the associated tasks, instructions, and mitigating strategy time constraints. The training plan development was done in accordance with the Systematic Approach to Training (SAT).

Based on the description provided above, the NRC staff concludes that, as described, the licensee's established procedural guidance appears to meets the provisions of NEI 12-06, Section 11.4 (Procedure Guidance). Similarly, the NRC staff concludes that the training plan, including use of the SAT for the groups most directly impacted by the FLEX program, appears to meet the provisions of NEI 12-06, Section 11.6 (Training).

3.12.3 Conclusions

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

3.13 Maintenance and Testing of FLEX Equipment

As a generic issue, NEI submitted a letter dated October 3, 2013 (ADAMS Accession No. ML13276A573), which included EPRI Technical Report 3002000623, "Nuclear Maintenance Applications Center: Preventive Maintenance Basis for FLEX Equipment." 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. Preventative maintenance templates for the major FLEX equipment have also been issued.

In its FIP, the licensee stated that Turkey Point followed the EPRI generic industry guidance program for maintenance and testing of FLEX equipment, as endorsed by the NRC staff on October 7, 2013. The licensee described that FLEX mitigation equipment has been initially tested to verify performance conforms to the limiting FLEX requirements. The licensee states in its FIP, that preventive maintenance procedures and intervals have been established to ensure FLEX equipment reliability is being achieved. Similarly, in its FIP, the licensee stated that surveillance procedures and intervals have been created to perform testing to verify design requirements of the FLEX equipment.

Based on the use of the endorsed program, which establishes and maintains a maintenance and testing program in accordance with NEI 12-06, Section 11.5, the NRC staff concludes that the licensee appears to have adequately addressed equipment maintenance and testing activities associated with FLEX equipment.

3.14 Alternatives to NEI 12-06, Revision 2

The licensee's strategy of repowering installed charging pumps to provide RCS makeup to mitigate an ELAP event conflicts with the guidance provided in NEI 12-06, Section 3.2.2(13) that calls for the use of portable equipment. However, the NRC staff noted that the licensee's strategy involves:

- The capability to use one of three 100 percent-capacity, redundant pumps for each unit.
- The use of a NSRC high pressure pump to provide RCS makeup for Phase 3 as an alternative.
- Diverse injection paths from the discharge of each charging pump are provided through either charging lines or an alternate path through the RCPs seal injection lines.
- Suction can be taken from either the BASTs or the RWSTs.
- Charging pumps will receive cooling water from the FLEX well for operation.

- The charging pumps are energized from the FLEX DGs in Phase 2 to restore RCS makeup and reactivity control capability. Load centers from each train are located in the same room, and will be electrically tied together such that all four load centers in each unit are powered. Redundant and diverse connections are provided for the FLEX DGs connections to the load centers.

Having considered the points made above, the NRC staff concludes that the licensee has a strategy to provide RCS makeup that should prevent damage to the core during an ELAP event, which meets the requirement of Order EA-12-049. Therefore, the NRC staff concludes that the licensee's use of installed charging pumps as an acceptable alternative to NEI 12-06.

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 26, 2013 (ADAMS Accession No. ML130720690), the licensee submitted its OIP for Turkey Point in response to Order EA-12-051. By letter dated July 11, 2013 (ADAMS Accession No. ML13191A134), the NRC staff sent a request for additional information (RAI) to the licensee. The licensee provided a response by letter dated July 30, 2013 (ADAMS Accession No. ML13224A160). By letter dated November 19, 2013 (ADAMS Accession No. ML13280A177), the NRC staff issued an ISE and RAI to the licensee.

By letters dated August 21, 2013 (ADAMS Accession No. ML13248A313), February 26, 2014 (ADAMS Accession No. ML14073A066), August 15, 2014 (ADAMS Accession No. ML14245A057), February 13, 2015 (ADAMS Accession No. ML15075A023), and August 11, 2015 (ADAMS Accession No. ML15233A418), the licensee submitted status reports for the Integrated Plan. The Integrated Plan describes the strategies and guidance to be implemented by the licensee for the installation of reliable SFP level instrumentation which will function following a BDBEE, including modifications necessary to support this implementation, pursuant to Order EA-12-051. By letter dated January 6, 2016 (ADAMS Accession No. ML16028A143), the licensee reported that full compliance with the requirements of Order EA-12-051 was achieved for Turkey Point.

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

The staff performed the onsite audit to review the implementation of SFP level instrumentation related to Order EA-12-051. The scope of the audit included verification of (a) site's seismic and environmental conditions enveloped by the equipment qualifications, (b) equipment installation met the requirements and vendor's recommendations, and (c) program features met the requirements. By letter dated November 12, 2015 (ADAMS Accession No. ML15307A314), the NRC issued an audit report on the licensee's progress. Refer to Section 2.2 above for the regulatory background for this section.

4.1 Levels of Required Monitoring

In its letter dated July 30, 2013, the licensee stated:

> To determine the higher of the two levels the following was taken into consideration:
>
> (1) The level at which reliable suction loss occurs due to uncovering the coolant inlet pipe or any weirs or vacuum breakers associated with suction loss is established based on nominal coolant inlet pipe elevation. There are no siphon breakers in the suction lines at either unit at PTN [Turkey Point]. There are two pump suction lines in each pool; an 8" line located at elevation 53'-7" and a 10" line located at elevation 51'-4". Normal cooling pump alignment has the A pump aligned to the 8" pool outlet pipe at elevation 53'-7" and the B pump aligned to the 10" pool outlet pipe at elevation 51'-4". If water were to decrease below the 53'-7" elevation the A pump would lose suction, but the B pump would continue to run.
>
> (2) The existing plant NPSH [net positive suction head] calculation is based on a nominal pool water level of 56.8 feet (elevation 56'-9"). The recommended normal operating configuration is with both the suction and discharge cross connections isolated. In this configuration the hydraulic model has the A pump aligned to the 8" pool outlet line and the B pump aligned to the 10" pool outlet line (i.e., the normal operation configuration). The A pumps are located at elevation 22'-1 1/4" (Unit 3) and 21'-6 1/2" (Unit 4) and the B pumps are located at 21'-5" (Unit 3) and 22'-1 3/4" (Unit 4). At saturated conditions, the NPSH margin for this configuration is 2'-8" for the A pump and 7'-10" for the B pump. This means that adequate NPSH is no longer available for the A pump at 54'-1" (56' 9"- 2'-8"), which is above the pool outlet/pump suction line elevation of 53'-7". The B pump will lose suction at elevation 48'-11" (56'-9"- 7'-10"), which is below the pool outlet/pump suction line elevation of 51'-4".

To summarize, the licensee stated that the 'A' pump has inadequate NPSH available at elevation 54 ft. 1 in. and loses suction at elevation 53 ft. 7 in. by uncovering the suction line. The 'B' pump has inadequate NPSH available at elevation 48 ft. 11 in. and loses suction at elevation 51 ft. 4 in. by uncovering the suction line. In the OIP, the highest elevation that results in total loss of normal pool cooling capability was stated as 51 ft. 4 in. based on the fact that one pump would continue to operate down to this level. At this elevation with the normal pump lineup, the 'A' pump would not be available but the 'B' pump would still be operational, providing some degree of pool cooling capability. With one pump in operation and the maximum design basis heat load, SFP maximum temperature would reach approximately 177°F, which is less than boiling and therefore meets the Turkey Point design-basis UFSAR criteria for unplanned shutdowns. This appears to meet the NEI 12-02 definition of "the actual point that supports adequate cooling system performance." However, NEI 12-06 guidance requires assumption of the maximum design basis SFP heat loads. For Turkey Point, this is up to 80 assemblies 36 days old and an additional full core offload 72 hours after shutdown.

Given this heat load, both SFP heat exchangers and pumps are required to maintain the administrative limit of 150°F. In addition, it is not prudent to allow level to drop to the elevation where either SFP pump is allowed to run to its cavitation or runout point, which would likely result in damage to the pump. After further review, the licensee has determined that a more appropriate and conservative approach would be to utilize the highest point at which either pump becomes unavailable as Level 1. This point is elevation 54 ft. 1 in., where the 'A' pump becomes unavailable assuming saturation conditions. Therefore, the licensee revised Level 1 from what was provided in the OIP to be elevation 54 ft. 1 in.

In its OIP, the licensee stated that Level 2 would be set at elevation 42 ft. 11 in., which is approximately 10 ft. above the top of the fuel racks.

In its letter dated July 30, 2013, the licensee provided a sketch showing the elevations identified as Levels 1, 2 and 3 and the top of the fuel racks. This sketch shows Level 2 at an elevation of 42ft. 11 in., which is approximately 10ft. above the top of the fuel rack.

In its OIP, the licensee stated that Level 3 would be set at elevation 32ft. 11 in., which is the nominal level of the highest fuel rack.

In its letter dated July 30, 2013, the licensee stated:

> NEI 12-02 describes Level 3 as the level where fuel remains covered and actions to implement make-up water addition should no longer be deferred. Level 3 corresponds nominally (i.e., +/- 1 foot) to the highest point of any fuel rack seated in the spent fuel pool. Level 3 is defined in this manner to provide the maximum range of information to operators, decision makers and emergency response personnel. PTN previously designated Level 3 as the actual top of the fuel storage racks. PTN is now designating Level 3 as the water level greater than 1 foot above the top of the fuel storage racks plus the accuracy of the SFP level instrument channel, which is yet to be determined. Designation of this level as Level 3 is conservative; its selection assures that the fuel will remain covered, and at that point there would be no functional or operational reason to defer action to implement the addition of make-up water to the pool. Accordingly, the previous Level 3 elevation of 32'-11" for PTN (both units) is being revised to 33'-11".

The NRC staff found the licensee selection of the SFP measurement level adequate based on the following:

- Level 1 is the level at which the water height, assuming saturated conditions, above the centerline of the cooling pump suction provides the required NPSH specified by the pump manufacturer or engineering analysis. Thus, the designated Level 1 setpoint would allow the licensee to identify a level in the SFP adequate to support operation of the normal SFP cooling system and represent the higher of the options described in NEI 12-02.

- Level 2 meets first option described in NEI 12-02 for Level 2, which is 10 feet (+/- 1 foot) above the highest point of any fuel rack seated in the SFPs. The designed Level 2 represents the range of water level where any necessary operations in the vicinity of the SFP can be completed without significant dose consequences from direct gamma radiation from the SFP consistent with NEI 12-02.

- Level 3 is 1 foot above the highest point of any fuel storage rack seated in the SFP. This level allows the licensee to initiate water make-up with no delay meeting the NEI 12-02 specifications of the highest point of the fuel racks seated in the SFP. Meeting the NEI 12-02 specifications of the highest point of the fuel racks conservatively meets the Order EA-12-051 requirement of a level where the fuel remains covered.

Based on the evaluation above, the NRC staff concludes 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 appears to adequately address the requirements of the order.

4.2 Evaluation of Design Features

Order EA-12-051 required that the SFP level instrumentation shall include specific design features, including specifications on the instruments, arrangement, mounting, qualification, independence, power supplies, accuracy, testing, and display. Refer to Section 2.2 above for the requirements of the order in 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, the licensee stated that for both Unit 3 and Unit 4, 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 of 57 ft. 0 in to the top of the spent fuel racks at elevation 32 ft. 11in.

The NRC staff noted that the specified measurement range will cover Level 1, 2, and 3 as described in Section 4.1 above. The staff concludes that the licensee's design, which in respect to the number of channels and measurement range for its SFP level instrumentation, appears to be consistent with NEI 12-02 guidance, as endorsed, by JLD-ISG-2012-03, and appears to adequately address the requirements of the order.

4.2.2 Design Features: Arrangement

In its OIP, the licensee stated that:

> The two SFP level instrument channels will be installed in diverse locations, 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 SFP. As indicated above, SFP level sensors will be installed in the North side of the Unit 3 SFP, and the South side of the Unit 4 SFP, with primary and backup channel sensors located as close to the opposite corners as practical to maintain maximum attainable separation. Sensor conditioning electronics and battery backup will be mounted in a remote location separated from the SFP by a reinforced concrete wall(s) which will provide suitable radiation shielding for the electronics. The equipment will be protected from all design basis external events.

Guidance document NEI 12-02 recommends mounting the sensors on opposite site or corners of the pool area, if practical. During the onsite audit, the staff reviewed EC280521-C-004, "Spent Fuel Pool Plan View at Elevation 58'-0" with conduit routing," Revision 1; EC280521-E-003, "Conduit Routing Overview," Revision 1; EC280521-C-001, "Aux. Bldg. Room Plan View," Revision 0; 5610-C-206, "Spent Fuel Pool General Details," Revision 4; and 5610-M-56, "Ground Floor Plant Elevation 18'-0," Revision 66. During the walkdown, the NRC staff observed that the locations chosen by the licensee are physically separated by a distance comparable to the short side of the pool to provide protection and to minimize the possibility of a single event or missile damaging both channels. The staff also 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 evaluation above, the NRC staff concludes that, if implemented appropriately, the licensee's proposed arrangement for the SFP level instrumentation appears to be consistent with NEI 12-02 guidance, as endorsed, by JLD-ISG-2012-03, and appears to adequately address the requirements of the order.

4.2.3 <u>Design Features: Mounting</u>

In its OIP, the licensee stated that:

> Mounting will be Seismic Class I. Installed equipment will be seismically qualified to withstand the maximum seismic ground motion considered in the design of the plant area in which it is installed.

By letter dated August 11, 2016 (ADAMS Accession No. ML16243A041), the licensee stated that the design criteria used for the spent fuel pool instrumentation system (SFPIS) are contained in the Westinghouse specification WNA-DS-02957-GEN. This specification established the requirements for the SFPIS and includes the following requirements: Functional, Performance, Design, Manufacturing, Testing and Acceptance. It also lists the design constraints, including normal and abnormal plant conditions, under which the SFPIS must operate. The requirements and design constraints meet NRC Order 12-051 requirements and NEI 12-02 guidance.

The SFP bracket was seismically analyzed by Westinghouse in calculation CN-PEUS-14-14, "Seismic Analysis of the SFP Mounting Bracket at Turkey Point Plant Nuclear Generating Units 3 & 4," using the seismic response spectra that are used for rigid buildings of low aspect ratios such as the auxiliary building and adjacent FHBs.

The Westinghouse calculation in Section 4.6.2.3 analyzes the hydrodynamic load due to seismic effects. Additionally, Section 4.6.2.4 analyzes the seismic loading on the bracket. Section 4.6.3 analyzes the combined load effects on the mounting plate. Calculation PTN-0LHC-14-2003 was completed to capture the seismic evaluation of spent fuel pool level instrumentation bracket anchorage, instrument panel support and unique conduit support. The equipment used at Turkey Point to monitor the SFP level is seismically qualified in accordance with IEEE 344-2004 and Regulatory Guide 1.100 as documented in Westinghouse evaluations WNA-TR-03149-GEN and EQ-QR-269.

Each water level measurement device consists of a flexible stainless steel sensor cable probe (LE-3-651A/B) suspended in the SFP from a seismically qualified bracket attached to the operating deck at the side of the pool. The seismically qualified bracket is attached to the SFP floor with 4 stainless steel Hilti anchor bolts. The Turkey Point installation does not include a stilling well in its design.

During the onsite audit, the NRC staff reviewed the mounting specifications and seismic analyses for the SFPLI, including the methodology and design criteria used to estimate the total loading on the mounting devices. The staff also reviewed the design inputs and the methodology used to qualify the structural integrity of the affected structures for each of the SFPLI mounting attachments. Based on the review, the staff found that the criteria established by the licensee appears to adequately account for the appropriate structural loading conditions, including seismic and hydrodynamic loads.

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

4.2.4 Design Features: Qualification

4.2.4.1 Augmented Quality Process

Appendix A-1 of the guidance in NEI 12-02 describes a quality assurance process for non-safety systems and equipment that are not already covered by existing quality assurance requirements. In JLD-ISG-2013, 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 augmented quality requirements, similar to those applied to fire protection, will be applied to this project.

The NRC staff concludes that, if implemented appropriately, this approach appears to be with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and appears to adequately address the requirements of the order.

4.2.4.2 Instrument Channel Reliability

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

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

- seismic effects on instrument channel components used during and following a potential seismic event for only installed components.

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

The NRC staff reviewed the Westinghouse SFP level instrumentation's qualification and testing during the vendor audit for temperature, humidity, radiation, shock and vibration, and seismic. The staff further reviewed the anticipated site's environmental conditions during the onsite audit.

4.2.4.2.1 Temperature, Humidity, and Radiation

In its OIP, the licensee stated that:

> Temperature, humidity and radiation levels consistent with conditions in the vicinity of the SFP and the area of use considering normal operational, event and post-event conditions for no fewer than seven days post-event or until off-site resources can be deployed by the mitigating strategies resulting from Order EA-12-049 will be addressed in the engineering and design phase. Examples of post-event (beyond-design-basis) conditions to be considered are:
>
> - radiological conditions for a normal refueling quantity of freshly discharged (100 hours) fuel with the SFP water level 3 as described in this order,
> - temperature of 212 degrees F and 100% relative humidity environment,
> - boiling water and/or steam environment, and
> - a concentrated borated water environment

In its letter dated June 20, 2016, the licensee also stated that the SFPLI instrumentation quality and expected reliability has been demonstrated by design, analysis, operating experience and testing with operating and environmental conditions applicable or bounding to the PTN fuel handling buildings following an extended loss of all AC power with concurrent loss of SFP cooling and ventilation.

In a letter dated August 11, 2016 (ADAMS Accession No. ML16243A041), the licensee also stated that for both Units 3 and 4, the primary and backup channel displays are located in the seismic Class I auxiliary building. This location is promptly accessible as the area is a normally assigned watch station, outside of the SFP floor and inside a structure providing protection against adverse weather and outside of any very high radiation areas or locked high radiation areas during normal operation. During a BDBEE, this location will not experience any significant change in radiation levels. As per engineering design package (EC 280301), this area is not expected to exceed 125°F, will remain between 0 to 95 percent humidity and radiation levels will not exceed 2.5 millirem (mrem)/hr as noted in the radiation survey calculation PTN-BSHM-09-004 for fire zones around the auxiliary building. The licensee also stated the transmitter electronic enclosures are located in the outdoor CCW heat exchanger room which has a missile barrier grating on its top surface. The transmitters are mounted at a height of 24 ft. 4 in. to the bottom of their NEMA 4X enclosures which is above all flooding levels for the current licensing basis and reevaluated levels for local intense precipitation and hurricane storm surge events. See staff's evaluation of transmitter environmental qualification in Section 4.2.5, Design Features: Independence.

During the onsite audit, the NRC staff noted that the licensee did not address the plant specific environmental qualification under beyond designed basis radiation for the probe cabling in the SFP area. The staff requested the licensee to demonstrate that the probe cabling connection are qualified for radiation level with the SFP water at Level 3 for a period of at least 7 days. In response to the staff's request, in a letter dated August 11, 2016, the licensee stated that a site-specific calculation was completed to establish the integrated dose at the probe locations. The calculation determined that the integrated dose is bounded by the capability of the instrument (Ref. NAI-1913-001, "Turkey Point Units 3&4 SFP Area Doses to Level Instrumentation"). The staff reviewed calculation NAI-1913-001 and concluded that it appears acceptable.

During the onsite audit, the NRC staff inquired about an assessment of potential susceptibilities of electromagnetic interferences (EMI) and radio-frequency interference (RFI) in the areas where the SFP instruments are located and how to mitigate those susceptibilities. By letter dated August 11, 2016 (ADAMS Accession No. ML16243A041), the licensee stated that to assure performance of the SFPIS at all times with respect to EMI/RFI, in situ testing was performed in addition to Westinghouse type testing. The testing, which include radio transmission and running equipment in the three areas where the equipment is located, demonstrated that the system is not adversely affected by EMI/RFI that could be experienced in the area. Based on this information, the NRC staff concludes that the licensee's response appears acceptable.

Based on the evaluation above, the NRC staff concludes 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 appears to adequately address the requirements of the order.

4.2.5 Design Features: Independence

In its OIP, the licensee stated that the primary instrument channel will be redundant to and independent of the backup instrument channel. The licensee also stated that independence will be obtained through separation of the sensors, indication, backup battery power supplies, associated cabling and channel power feeds.

By letter dated August 11, 2016 (ADAMS Accession No. ML16243A041), the licensee stated that two SFP level sensors are located in the Unit 3 SFP on the North end. For Unit 4, the two sensors are located on the South End. The two level sensors on each unit are separated to the extent practicable. The sensors are located on the side of the SFP opposite the transfer canal. Manipulator crane rails are on the East and West sides of the SFP and transfer canal and the conduits for the SFPIS do not cross the manipulator crane rails. The SFP buildings are designed to seismic Class 1 standards.

The Unit 3 instruments are physically located in the Northeast and Northwest corners of the SFP building and the Unit 4 instruments are located in the Southeast and Southwest corners. These locations provide inherent shielding from missiles and do not impair the SFP function. Inspections of the overhead areas within the SFP buildings determined that there are no structures or equipment that is not seismically designed or restrained that could affect both channels on either Turkey Point SFP.

During the onsite audit, the NRC staff performed a walkdown and noted that the coax cable from the probes to the transmitter and the transmitter itself are outside the SFP building (protected structure) and could be subject to external hazards. Also, the coax cables from the probe to the SFP building penetration at Units 3 and 4 are in flexible conduits on the deck of the SFP with no protection from tripping hazards and could make these circuits inoperable. The staff communicated these concerns to the licensee. Guidance document NEI 12-02 states that to the extent not otherwise covered in this guidance, the reasonable protection guidance outlined in NEI 12-06 to meet Order EA-12-049 should be used to provide protection for installed and portable channel from external hazards. The staff requested the licensee to provide technical justification of how conduits and transmitters located outside of the SFP are protected from all external hazards as defined in NEI 12-06.

By letter dated August 11, 2016 (ADAMS Accession No. ML16243A041), the licensee stated that the SFPIS probe to transmitter cable is a rugged coaxial cable mounted in 1.5 in. conduit. The 2 channels are run in conduits from the probes inside the building, penetrating the exterior wall. They then take paths around the SFP building to the east and west with at least 25 ft. of separation maintained throughout the runs outside the building. The review of the applicable NEI guidance and station tornado missile criteria determined that this routing meets the current licensing basis and therefore the NEI guidance with respect to tornado missile protection. In addition, the conduits that are routed along the west walls of the pools are substantially shielded from any windborne missiles by the containment structures and spent fuel pools. Once inside the CCW heat exchange and pumps rooms and the auxiliary building, the conduits are protected by surrounding structures. The transmitters are mounted at a height of 24 ft. 4 in. to the bottom of their NEMA 4X enclosures which is above all flooding levels for the current licensing basis and reevaluated level for local intense precipitation and hurricane storm surge events. The licensee further stated that the SFPIS level indicators are located in a room (Fire Zone 046) of the Class 1 auxiliary building in a mild indoor environment and above the floor level. The displays are physically separated and isolated form the SFPIS level transmitters. The two SFPIS channels are powered from separate 120 Vac feeds form non-safety sources on different unit step up transformers and each has a battery backup which has been tested to operate for greater than 72 hours.

The staff concludes that the arrangement of the SFPI cables were based on the configuration of the SFP (not connecting any protective structure such as auxiliary building) and the limitation of the coaxial cable length. The conduits are supported and attached to the Class 1E structure. As such, they are supported and should withstand the design basis wind and seismic loads. The separation between cables routing outside the SFP should provide reasonable separation and missile protection to meet the order. Based on this information, the staff concludes that the licensee's response appears acceptable and it resolved the staff's concern.

In addition, regarding the potential tripping hazard from the flexible conduits on the deck of the SFP, the licensee created action report (AR) 2068408. In this AR, the licensee states that it will evaluate the conduits associated with the SFPIS level probes on the SFP decks and determine what actions or protective measures (physical barriers, mechanical clamps) are necessary to protect the SFPIS circuits. Each SFPIS probe circuit will be evaluated independently and actions taken as necessary on an individual probe basis. The staff concludes that this action appears to have addressed the staff's concern of the potential tripping hazard.

The NRC staff concludes that the licensee appears to have adequately addressed the instrument channel independence, including the power sources. With the licensee's proposed power arrangement, the electrical functional performance of each level measurement channel would be considered independent of the other channel, and the loss of one power supply would not affect the operation of other independent channel under BDBEE conditions. The instrument channel physical separation is discussed in Section 4.2.2 of this SE.

Based on the evaluation above, the NRC staff concludes 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 appears to adequately address the requirements of the order.

4.2.6 Design Features: Power Supplies

In its OIP, the licensee stated that:

> Both channels will be powered from dedicated batteries and local battery chargers. The battery chargers for both channels will normally be powered from separate sources of 120 Vac power. Minimum battery life of 72 hours will be provided. The battery systems will include provision for battery replacement should the battery charger become unavailable following the event. Spare batteries will be readily available. In the event of a loss of normal power, the battery chargers could be connected to another suitable power source.

By letter dated August 11, 2016 (ADAMS Accession No. ML16243A041), the licensee stated that ac power sources for the primary channel of the SFP level indication is a lighting panel from a nearby distribution panel mounted in a Motor Control Center, which is powered from the Unit 3 non-vital ac system. This Unit 3 power system is connected through its load center and switchgear through a step-down transformer fed from the Turkey Point switchyard. The backup channel of the SFP level indication is powered from a similar power distribution system, but through a Unit 4 non-vital system. The Unit 4 system is connected through a separate step-down transformer which is fed from a separate bay in the Turkey Point switchyard. These two SFP level channels are powered from different sources. The licensee also stated that the battery backup duty cycle was calculated by Westinghouse and is documented in Westinghouse calculation WNA-CN-00300-GEN. For the level transmitter only configuration which is the Turkey Point SFP level transmitter configuration, a single 26 Amp-Hr. battery will last from full charge for 101.21 hours or 4.22 days. This capability is of sufficient duration to allow the SFPIS to operate until offsite resources can arrive onsite to replace batteries or connect a small ac generator to restore ac power to each of the channels. There will be a portable ac generator and spare batteries available in the FESB.

During the onsite audit, the staff reviewed drawings 5610-T-E-1591, "Operating Diagram Electrical Distribution," Revision 74; 5614-E-608, "Motor Control Center 4H (4B21)," Revision 3; 5610-E-855, "DP-321 (Component Cooling Water Area)," Revision 0; 5610-E-855, "DP-321 (Component Cooling Water Area)," Revision 0; 5610-E-608, "Motor Control Center 3H (93B21)," Revision 3; 5610-E-855, "DP-421 (Component Cooling Water Area)," Revision 0; and 5610-E-

855, "DP-421 (Component Cooling Water Area)," Revision 0. The staff concludes that the ac power sources to the primary and backup channels for Unit 3 and 4 are independent and loss of one power source will not result in a loss of both channel power supplies. The staff also conducted an audit at the Westinghouse facility and found the battery backup duty cycles acceptable. Guidance document NEI 12-02 specifies that electrical power for each channel be provided by different sources and that all channels have the capability of being connected to a source of power independent of the normal plant power systems. The NRC staff reviewed the SFPI power supply configuration and noted that upon a loss of normal power, the UPS arrangement would provide power for level indication until the power is restored by portable generators provided for Order EA-12-049.

The NRC staff concludes 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 appears to adequately address the requirements of the order.

4.2.7 Design Features: Accuracy

In its OIP, the licensee stated that:

> Instrument channels will be designed such that they will maintain their design accuracy following a power interruption or change in power source without recalibration. Accuracy will consider SFP conditions, e.g., saturated water, steam environment, or concentrated borated water. Additionally, instrument accuracy will be sufficient to allow trained personnel to determine when the actual level exceeds the specified lower level of each indicating range (level 1, 2 and 3) without conflicting or ambiguous indication. The accuracy will be within the resolution requirements of Figure 1 of NEI 12-02.

By letter dated August 11, 2016 (ADAMS Accession No. ML16243A041), the licensee stated that system accuracy was defined to be +/- 3 in. per Section 4.2.17 of Westinghouse SFPIS design specification WNA-DS-02957-GEN. This performance also recognizes the potential for boron deposits on the SFP level sensor cable of up to 4 in. long by ½ in. diameter as long as the system is maintained in accordance with the calibration and maintenance instructions contained in Westinghouse document WNA-TP-04709-GEN. This accuracy is to be maintained upon loss and restoration of power and will be maintained in all potential levels of SFP conditions.

The staff noted that the licensee appears to have adequately addressed instrument channel accuracy through a combination of statements in the OIP and subsequent letters. The 3 in. design accuracy is more conservative than the 1-foot accuracy specified by NEI 12-02 for SFP Level 2 and Level 3. With the licensee's proposed design and controls, the instrument channels should maintain their accuracy during both normal and BDBEE conditions.

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

4.2.8 Design Features: Testing

In its OIP, the licensee stated that:

> Instrument channel design will provide for routine testing and calibration consistent with Order EA-12-051 and the guidance in NEI 12-02.

By letter dated August 11, 2016 (ADAMS Accession No. ML16243A041), the licensee stated that:

> Westinghouse has provided a calibration procedure that utilizes two separate processes to meet the order (reference WNA-TP-04709-GEN rev 4). The functionality check (calibration verification) of the equipment requires the probe/bracket assembly to be unbolted and lifted approximately 1-foot above the SFP water line. Prior to lifting the probe/bracket, the level indicator reading is to be recorded. After lifting the probe bracket, record the physical change of the bracket from its original mounting elevation; also record the level indicator value. Subtract the raised level indicator value from the original level value and compare to the physical height the bracket was lifted. If within +/- 3 in. the calibration verification is acceptable. If not then calibration of the probe is required.
>
> Visual inspection of the probe cable with a camera along its length for fraying of the cable, corrosion, inspection of the weight at the end of the cable for damage, clearance to the SFP wall is within specification are all performed as a part of this calibration verification activity. Cleaning of any boric acid buildup on the cable at the water line is to be performed prior to performing this calibration verification activity.
>
> In addition visual inspection of the probe waveform characteristics is required in accordance with the Westinghouse procedure guidance. If these steps are not successful, then a full range calibration proof test is required. All of these steps will be incorporated into a plant maintenance procedure. Each SFP level probe will be checked individually.
>
> Operators will perform a daily check of the SFP level instrumentation to verify that the deviation between channels is within the specified limits and also that the indicated level is within +/- 3 inches of the normal SFP level indication. This will be incorporated into the operator daily log Form 419 to track this surveillance. Compensatory actions will be tracked under plant procedure 3/4-NOP-033.
>
> Calibration verification will be done on an 18 month interval as noted above. The probe lifespan is estimated to be 7.1 years; the replacement of the electronics will be based on the failure likelihood code in the Westinghouse FMEA analysis (ref. West WNA-AR-00377-GEN). Battery replacement is expected on a 3 year interval.

> All of these preventative maintenance (PM) tasks will be included in the plant PM program and will be based on the vendor recommendations (ref. West WNA-TP-04709-GEN).
>
> The planned maximum surveillance interval is daily and the preventative maintenance activities will be performed at 18 month intervals, unless the daily surveillance identifies a deficiency at which time the identified indicator will be entered into the corrective maintenance program. If a channel of SFP level indication is determined to be out of service it will be restored within 90 days. If both channels of SFP level indication become nonfunctional, then actions will be initiated within 24 hours to restore one of the channels of instrumentation and implement compensatory actions within 72 hours.

In accordance with the licensee's OIP and subsequent letters, the NRC staff noted that by comparing the levels in the instrument channels and the maximum level allowed deviation, the operators could determine if recalibration or troubleshooting is needed. The staff also noted that the licensee's proposed design has the ability to be tested and calibrated in-situ, which appears consistent with the provision of NEI 12-02.

The NRC staff concludes that the licensee's proposed SFP instrumentation design allows for testing, which appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and appears to adequately address the requirements of the order.

4.2.9 Design Features: Display

By letter dated August 11, 2016 (ADAMS Accession No. ML16243A041), the licensee stated that:

> For both Units 3 and 4, the primary and backup channel displays are located in auxiliary building room (Fire Zone 046) in the seismic Class I auxiliary building. This location is promptly accessible as the area is a normally assigned watch station, outside of the SFP floor and inside a structure providing protection against adverse weather and outside of any very high radiation areas or locked high radiation areas during normal operation.
>
> During a BDB event, this location will not experience any significant change in radiation levels. As per engineering design package (EC 280301), this area is not expected to exceed 125°F, will remain between 0 to 95% humidity and radiation levels will not exceed 2.5 mrem/hr. as noted in radiation survey calculation PTN-BSHM-09-004 for fire zones around the auxiliary building room (Fire Zone 046).
>
> In a BDB event, this location will not be continuously manned due to personnel assigned more time sensitive tasks. With a design basis heat load, the spent fuel pools would begin to boil 2.7 hours after the event. As noted in the OIP, uncover of the fuel has been calculated to occur after 33 hours. Monitoring of the level indicators will be directed by the Off Normal Procedure in effect during the event.

During the onsite audit, the staff walked down and verified that the SFPI display locations should be promptly accessible and should remain habitable. Guidance document NEI 12-02 specifies that the SFP level indication be displayed at an appropriate and accessible location. An appropriate and accessible location shall include: occupied or promptly accessible to the appropriate plant staff, outside of the area surrounding the SFP floor, inside a structure providing protection against adverse weather, and outside of any high radiation areas during normal operation. Since the licensee has installed the indicators in an appropriate and accessible location where they are able to be monitored by trained personnel, the staff concludes that the licensee's proposed display location appears to be acceptable.

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

4.3 Evaluation of Programmatic Controls

Order EA-12-051 specified that the SFP 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

In its OIP, the licensee stated that:

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

Guidance document NEI 12-02 specifies that the SAT process can be used to identify the population to be trained, and also to determine both the initial and continuing elements of the required training. Based on the licensee's OIP statement above, the NRC staff concludes that the licensee's plan to train personnel in 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, as endorsed by JLD-ISG-2012-03, and appears to adequately address the requirements of the order.

4.3.2 Programmatic Controls: Procedures

In its OIP, the licensee stated that:

> Procedures will be developed using guidelines and vendor instructions to address the maintenance, operation, and abnormal response issues associated with the new SFP instrumentation.

By letter dated August 11, 2016 (ADAMS Accession No. ML16243A041), the licensee stated that:

> Modification review process will be used to assure all necessary procedures are developed for maintaining and operating the spent fuel level instruments upon installation. These procedures will be developed in accordance with the FPL procedural control process.
>
> The objectives of each procedural area are described below, as well as reference to the applicable procedures:
>
> Inspection, Calibration and Testing – Guidance on the performance of periodic visual inspections, as well as calibration and testing, to ensure that each SFP instrument channel is operating and indicating level within its design accuracy.
>
> - Form F419, Inside SNPO Logs
> - 3-PMI-033.03A/B, Spent Fuel Pool Level Instrumentation LE/LIT-3-651A/B
> - 4-PMI-033.03A/B, Spent Fuel Pool Level Instrumentation LE/LIT-4-651A/B System Calibration Verification and Maintenance
>
> Preventative Maintenance – Guidance on scheduling of, and performing, appropriate preventative maintenance activities necessary to maintain the instruments in a reliable condition.
>
> - 3-PMI-033.03A/B, Spent Fuel Pool Level Instrumentation LE/LIT-3-651A/B System Calibration Verification and Maintenance
> - 4-PMI-033.03A/B, Spent Fuel Pool Level Instrumentation LE/LIT-4-651A/B System Calibration Verification and Maintenance
>
> Maintenance – To specify troubleshooting and repair activities necessary to address system malfunctions.
>
> - Form F419, Inside SNPO Logs
> - 0-ADM-213, Tech. Spec., Related Equipment and Risk Significant SSC OOS Log Book
> - 3-PMI-033.03A/B, Spent Fuel Pool Level Instrumentation LE/LIT-3-651A/B System Calibration Verification and Maintenance
> - 4-PMI-033.03A/B, Spent Fuel Pool Level Instrumentation LE/LIT-4-651A/B, System Calibration Verification and Maintenance
>
> Programmatic Controls – Guidance on actions to be taken if one or more channels is out of service.
>
> - 0-ADM-213, Tech. Spec., Related Equipment & Risk Significant SSC OOS Logbook

System Operations – To provide instructions for operation and use of the system by plant staff.

- 3/4-ONOP-033.1, SFP Cooling System Malfunctions

Response to Inadequate Levels – Action to be taken on observations of levels below normal level will be addressed on-site with off normal procedures and / or FSGs.

- 3/4-ONOP-033.1, SFP Cooling System Malfunctions

During the onsite audit, the NRC staff reviewed a sample of procedures and noted that they were developed using the guidelines and vendor instructions to address the testing, calibration, maintenance, operation and abnormal response, in accordance with the provisions of NEI 12-02.

The NRC staff concludes that the licensee's proposed procedure development appears to be consistent with NEI 12-02 guidance, as endorsed by JLDISG-2012-03, and appears to adequately address the requirements of the order.

4.3.3 Programmatic Controls: Testing and Calibration

In its OIP, the licensee stated that:

> Processes will 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. Testing and calibration of the instrumentation will be consistent with vendor recommendations and any other documented basis. Calibration will be specific to the mounted instrument and the monitor.

By letter dated August 11, 2016 (ADAMS Accession No. ML16243A041), the licensee stated that:

> SFPI channel/equipment maintenance/preventative maintenance and testing program requirements to ensure design and system readiness are established in accordance with FPL's processes and procedures. The design modification process took into consideration the vendor recommendations to ensure that appropriate regular testing, channel checks, functional tests, periodic calibration, and maintenance are performed.
>
> Performance checks, described in the Vendor's Operator's Manual, and the applicable information are contained in plant procedures. Operator performance tests will be performed periodically as recommended by the vendor.
>
> Channel functional tests with limits established in consideration of vendor equipment specifications are performed at appropriate frequencies.

> Channel calibration tests per maintenance procedures, with limits established in consideration of vendor equipment specifications, are performed at frequencies established in consideration of vendor recommendations.
>
> The primary and backup SFPI channels incorporate permanent installation (with no reliance on portable, post-event installation) of relatively simple and robust augmented quality equipment. Permanent installation coupled with stocking of adequate spare parts reasonably diminishes the likelihood that a single channel (and greatly diminishes the likelihood that both channels) is (are) out-of-service for an extended period of time. With one channel out of service, initiate actions to restore channel to functional status within 90 days. If channel restoration is not expect to be completed within 90 days, initiate compensatory. Initiate an evaluation in accordance with the corrective action program. The evaluation shall determine compensatory actions required if the second channel becomes inoperable. The evaluation shall include a planned schedule for restoring the instrument channel(s) to functional status. If two channels are out of service, initiate actions to restore at least one channel to functional status within 24 hours and initiate compensatory actions for monitoring spent fuel pool level within 72 hours. Initiate an evaluation in accordance with the corrective action program. The evaluation shall document compensatory actions taken or planned to be taken to implement an alternate method of monitoring and schedule required actions for restoring the instrument channel(s) to functional status.

The NRC staff concludes that the licensee has described maintenance, testing, channel checks, and functional tests. These maintenances and tests appears to be consistent with Westinghouse recommendations. The staff also concludes that the out of service (OOS) allowed outage time and compensatory measures that will be taken appear to be consistent with those recommended in NEI 12-02.

Guidance document NEI 12-02 contains provisions for the establishment of processes that will maintain the SFPLI at their design accuracy. It also contains provisions for the control of surveillance and OOS time for each channel. Based on the licensee's OIP and subsequent letters, the NRC staff concludes that the licensee's proposed testing and calibration processes appear to be consistent with vendor recommendations and the provisions of NEI 12-02. Further, the licensee's proposed restoration actions and compensatory measures for the instrument channel(s) out-of-service appear to be consistent with NEI 12-02.

Based on the evaluation above, the NRC staff concludes 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 appears to adequately address the requirements of the order.

4.4 Conclusions for Order EA-12-051

By letter dated January 6, 2016 (ADAMS Accession No. ML16028A143), 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 concludes that, if implemented appropriately, the licensee has conformed to the guidance in NEI 12-02, as endorsed by JLD-ISG-2012-03. In addition, the NRC staff concludes that if the SFP level instrumentation is installed at Turkey Point 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 August 2015 (ADAMS Accession No. ML15307A314). The licensee reached its final compliance date on June 20, 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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Date: October 28, 2016

with Order EA-12-051. These reports were required by the order, and are listed in the attached safety evaluation. By letters dated November 19, 2013 (ADAMS Accession No. ML13280A177), and November 12, 2015 (ADAMS Accession No. ML15307A314), the NRC staff issued an ISE and audit report, respectively, on the licensee's progress. By letter dated March 26, 2014 (ADAMS Accession No. ML14083A620), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-051 in accordance with NRC NRR Office Instruction LIC-111, similar to the process used for Order EA-12-049. By letter dated January 6, 2016 (ADAMS Accession No. ML16028A143), FPL submitted a compliance letter in response to Order EA-12-051. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-051.

The enclosed safety evaluation provides the results of the NRC staff's review of FPL's strategies for Turkey Point. The intent of the safety evaluation is to inform FPL on whether or not its integrated plans, if implemented as described, appear to adequately address the requirements of Orders EA-12-049 and EA-12-051. The staff will evaluate implementation of the plans through inspection, using Temporary Instruction 2515-191, "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 Jason Paige, Orders Management Branch, Turkey Point Project Manager, at Jason.Paige@nrc.gov.

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

Docket Nos.: 50-250 and 50-251
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