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

November 7, 2018

Mr. Kevin Cimorelli
Site Vice President
Susquehanna Nuclear, LLC
769 Salem Boulevard
NUCSB3
Berwick, PA 18603-0467

SUBJECT: SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2 – SAFETY EVALUATION REGARDING IMPLEMENTATION OF MITIGATION STRATEGIES AND RELIABLE SPENT FUEL POOL INSTRUMENTATION RELATED TO ORDERS EA-12-049 AND EA-12-051 (CAC NOS. MF0888, MF0889, MF0890, AND MF0891; EPID NOS. L-2013-JLD-0021 AND L-2013-JLD-0022)

Dear Mr. Cimorelli:

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

By letter dated February 28, 2013 (ADAMS Accession No. ML13060A357), PPL Susquehanna, LLC[1] (Susquehanna, the licensee) submitted its OIP for Susquehanna Steam Electric Station, (SSES), Units 1 and 2, 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 enclosed safety evaluation. By letter dated August 28, 2013 (ADAMS Accession No. ML13234A503), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" (ADAMS Accession No. ML082900195). By letters dated January 24, 2014 (ADAMS Accession No. ML13339A764), and April 13, 2015 (ADAMS Accession No. ML15089A123), the NRC issued an Interim Staff Evaluation (ISE) and an audit report, respectively, on the licensee's progress. By letter dated May 31, 2017 (ADAMS Accession No. ML17151A292), Susquehanna reported that SSES, Unit 2, was in full compliance with Order EA-12-049.

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1. By letter dated June 1, 2015 (ADAMS Accession No. ML15054A066) the NRC issued a conforming amendment for an indirect license transfer reflecting a change in name of the licensee for SSES, Units 1 and 2, from PPL Susquehanna, LLC, to Susquehanna Nuclear, LLC. This name change was associated with Talen Energy Corporation becoming a new majority parent owner of the SSES units.

By letter dated June 26, 2018 (ADAMS Accession No. ML18179A202), Susquehanna reported that SSES, Unit 1 was in full compliance with Order EA-12-049, and submitted a Final Integrated Plan for SSES, Units 1 and 2.

By letter dated February 28, 2013 (ADAMS Accession No. ML13064A276), the licensee submitted its OIP for SSES, Units 1 and 2, 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 enclosed safety evaluation. By letters dated November 6, 2013 (ADAMS Accession No. ML13295A606), and April 13, 2015 (ADAMS Accession No. ML15089A123), the NRC staff issued an ISE and an audit report, respectively, on the licensee's progress. By letter dated March 26, 2014 (ADAMS Accession No. ML14083A620), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-051 in accordance with NRR Office Instruction LIC-111, similar to the process used for Order EA-12-049. By letter dated July 2, 2015 (ADAMS Accession No. ML15211A378), the licensee submitted a compliance letter in response to Order EA-12-051. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-051 at SSES, Units 1 and 2.

The enclosed safety evaluation provides the results of the NRC staff's review of the licensee's strategies for SSES, Units 1 and 2. The intent of the safety evaluation is to inform the licensee on whether or not its integrated plans, if implemented as described, appear to adequately address the requirements of Orders EA-12-049 and EA-12-051. The staff will evaluate implementation of the plans through inspection, using Temporary Instruction 2515-191, "Inspection of the Implementation of Mitigation Strategies and Spent Fuel Pool Instrumentation Orders and Emergency Preparedness Communication/Staffing/Multi-Unit Dose Assessment Plans" (ADAMS Accession No. ML15257A188). This inspection will be conducted in accordance with the NRC's inspection schedule for the plant.

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

Sincerely,

Brett Titus

Brett A. Titus, Acting Chief
Beyond-Design-Basis Management Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket Nos.: 50-387 and 50-388

Enclosure:
Safety Evaluation

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

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

SUSQUEHANNA NUCLEAR, LLC

ALLEGHENY ELECTRIC COOPERATIVE, INC.

SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2

DOCKET NOS. 50-387 AND 50-388

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 [Reference 4], the NRC issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events". 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" [Reference 5]. This order directed licensees to install reliable SFP level instrumentation with a primary channel and a backup channel, and with independent power supplies that are independent of the plant alternating current (ac) and direct current (dc) power distribution systems. Order EA-12-051 applies to all power reactor licensees and all holders of construction permits for power reactors.

2.0 REGULATORY EVALUATION

Following the events at the Fukushima Dai-ichi nuclear power plant on March 11, 2011, the NRC established a senior-level agency task force referred to as the Near-Term Task Force

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

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

2.1 Order EA-12-049

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

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

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

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

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

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

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

2.2 Order EA-12-051

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3.0 TECHNICAL EVALUATION OF ORDER EA-12-049

By letter dated February 28, 2013 [Reference 10], PPL Susquehanna, LLC[1] (Susquehanna, the licensee) submitted its Overall Integrated Plan (OIP) for Susquehanna Steam Electric Station, (SSES), Units 1 and 2, in response to Order EA-12-049. By letters dated August 26, 2013 [Reference 11], February 28, 2014 [Reference 12], August 27, 2014 [Reference 13], February 25, 2015 [Reference 14], August 26, 2015 [Reference 15], February 18, 2016 [Reference 16], August 19, 2016 [Reference 17], February 9, 2017 [Reference 18], August 22, 2017 [Reference 19], and February 21, 2018 [Reference 20], the licensee submitted six-month updates to the OIP. By letter dated August 28, 2013 [Reference 21], the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" [Reference 22]. By letters dated January 24, 2014 [Reference 23], and April 13, 2015 [Reference 24], the NRC issued an Interim Staff Evaluation (ISE) and audit report, respectively, on the licensee's progress. By letter dated May 31, 2017 [Reference 25], Susquehanna reported that SSES, Unit 2, was in full compliance with Order EA-12-049. By letter dated June 26, 2018 [Reference 26], Susquehanna reported that SSES, Unit 1 was in full compliance with Order EA-12-049, and submitted a Final Integrated Plan (FIP) for SSES, Units 1 and 2.

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.

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1. By letter dated June 1, 2015 (ADAMS Accession No. ML15054A066) the NRC issued a conforming amendment for an indirect license transfer reflecting a change in name of the licensee for SSES, Units 1 and 2, from PPL Susquehanna, LLC, to Susquehanna Nuclear, LLC. This name change was associated with Talen Energy Corporation becoming a new majority parent owner of the SSES units.

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.

SSES Units 1 and 2 are General Electric (GE) boiling-water reactors (BWRs), Model 4, each with a Mark II containment. The licensee's three-phase approach to mitigate a postulated ELAP event, as described in the FIP, is summarized below.

At the onset of an ELAP both reactors are assumed to trip from full power. The main condenser is unavailable due to the loss of circulating water. At both units, decay heat is removed when the safety relief valves (SRVs) open on high pressure and dump steam from the reactor pressure vessel (RPV) to the suppression pool located in the primary containment. Makeup to the RPV is provided by the reactor core isolation cooling (RCIC) turbine-driven pump. Because the condensate storage tanks (CSTs) are not robust for all postulated external events, the licensee's mitigating strategy assumes that the RCIC pump suction realigns to the suppression pool. Within approximately 60 minutes, the operators take manual control of the SRVs and begin a controlled cooldown and depressurization of the RPV. The cooldown is stopped when reactor pressure reaches a control band of 150 pounds per square inch gauge (psig) to 300 psig to ensure sufficient steam pressure to operate the RCIC pump. At approximately 5 hours into the event, the hardened containment vent system (HCVS) is used to vent the containment atmosphere. This action mitigates the suppression pool temperature rise while still allowing the RCIC system to continue to function. The RPV makeup will continue to be provided from the RCIC system until the gradual reduction in RPV pressure resulting from diminishing decay heat requires a transition to Phase 2 methods. The RCIC injection source will be maintained for as long as possible, since it is a closed loop system using relatively clean suppression pool water. When the RCIC system is no longer available, the preferred RPV makeup supply in Phase 2 comes from a diesel-driven FLEX pump taking a suction from the spray pond. In the licensee's mitigating strategy, a single FLEX pump is able to supply adequate makeup flow for both units.

Both reactors have Mark II containments. The licensee performed a containment evaluation and determined that opening the suppression chamber vent to atmosphere will allow containment temperature and pressure to stay within acceptable levels. The vent will be used until supplemental Phase 3 actions are implemented to remove decay heat from the RPV and containment by other means.

The two SFPs at SSES are normally cross-connected, thus effectively making them one volume. The pools will initially heat up due to the unavailability of the normal cooling system. The licensee has calculated that, for a design basis heat load (one core fully offloaded), boiling could start at approximately 13.6 hours after the start of the ELAP. Assuming this heat load, the water level would drop to a level of 11 feet above the top of fuel in approximately 55 hours, unless water is added. The sequence of events in the licensee's FIP indicates that water addition to the SFP would begin by the time boiling conditions are reached. The pump used to provide makeup to the SFPs is the same diesel-driven FLEX pump as is used for RPV makeup once the RCIC pump is secured.

The licensee is able to provide SFP makeup by diverse methods that use different combinations of installed piping and hoses to establish the flow path. The licensee's plan includes the capability to provide SFP makeup by spray.

The operators will perform dc bus load stripping to ensure safety-related battery life is extended to allow time for the deployment of two FLEX combustion turbine generators (CTGs) that will provide power for both units in Phase 2. The load stripping is completed within approximately 45 minutes of the event and has been shown by analysis to extend battery life to approximately 8 hours. At approximately 6 hours, two 4160 volt alternating current (Vac) CTGs will be deployed. These CTGs will be used to repower essential battery chargers and other necessary loads.

In addition, a National SAFER [Strategic Alliance for FLEX Emergency Response] Response Center (NSRC) will provide high capacity pumps and large CTGs which could be used to provide spares or backups to the Phase 2 equipment and to restore selected plant systems.

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

3.2 Reactor Core Cooling Strategies

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

As reviewed in this section, the licensee's core cooling analysis for the event presumes that, per endorsed guidance from NEI 12-06, both units would have been operating at full power prior to the event. Therefore, each unit's suppression pool would be available and may be credited as the heat sink for core cooling. Maintenance of sufficient RPV inventory, while accounting for steam release from the SRVs and ongoing system leakage expected under ELAP conditions, is accomplished through a combination of installed systems and FLEX equipment. The licensee's strategy for ensuring compliance with Order EA-12-049 for conditions where one or more units are shut down or being refueled is reviewed separately in Section 3.11 of this safety evaluation.

3.2.1 Core Cooling Strategy and RPV Makeup

3.2.1.1 Phase 1

According to the licensee's FIP, the initial injection of cooling water into the RPV will be accomplished through the use of the RCIC system. Because the turbine for the RCIC pump is driven by steam from the RPV, operation of the RCIC system further assists the SRVs with RPV pressure control. The RCIC system suction is initially lined up to each unit's CST and will pump water from the CST if it is available. The CSTs are not a fully protected source of water for the ELAP event. In the event that the CSTs are not available, the RCIC pumps will take suction from the suppression pool. The Susquehanna strategy assumes that only the water from the suppression pool is available.

Pressure control of the RPV is accomplished using the SRVs. The SRVs require dc control power and pneumatic pressure to operate. Within 1 hour after the initiation of the event, operators will utilize the SRVs to depressurize at a rate of less than 100 degrees Fahrenheit (°F) per hour. The RPV pressure will be lowered and then maintained between 150 and 300 psig to allow for continued operation of the RCIC system. Initially, all of the SRVs have a limited amount of backup pneumatic pressure available after the loss of power. In addition, there is a pressurized gas bottle bank system in place that automatically aligns to the automatic depressurization system (ADS) SRVs (6 out of 16 SRVs are ADS SRVs on each unit) to supply pneumatic motive force for at least 72 hours of valve operation. The licensee's coping strategy contains provisions to connect supplemental nitrogen bottles to allow for continued operation beyond 72 hours.

According to the licensee's FIP, station batteries and the Class 1E dc distribution system provide power for the RCIC system and the necessary instrumentation. Load shedding is performed to extend the battery capacity to power the Phase I systems and instrumentation until the FLEX CTGs are deployed to provide long term electrical power.

3.2.1.2 Phase 2

The licensee's FIP states that the RCIC system will be used as long as possible for RPV makeup. Eventually a transition to a FLEX pump for RPV makeup will occur. The FLEX pump is designed to be able to supply water to both units and will be located near the spray pond, which is the SSES UHS. The FLEX pump will take suction from the spray pond and discharge into the residual heat removal service water (RHRSW) system via connections made in the Engineering Safeguards Service Water Pump House (ESSWPH). The licensee can use either Division II (preferred) or Division I (alternate) connections for the FLEX pump discharge locations. Both RHRSW divisions are cross-connected to the respective division of the residual heat removal (RHR) system on each unit and thus the licensee can supply both units' RPVs by redundant methods. The FLEX pump is sized to supply both units simultaneously. In sizing the FLEX pump, the licensee assumed that each RPV would require 415 gallons per minute (gpm) of makeup flow and each SFP would require up to 250 gpm (if using spray).

The licensee plans to utilize the HCVS to maintain containment parameters within limits that will support maintenance of the containment capability function and also support operation of the RCIC system. According to the licensee's FIP timeline, the vent would be opened at approximately 5 hours after the event begins.

3.2.1.3 Phase 3

According to the licensee's FIP, the Phase 3 strategy would be to maintain and supplement/replace the Phase 2 strategy with NSRC-supplied equipment. The Phase 3 equipment begins to arrive within 24 hours of the NSRC notification. It would then be available to replace or supplement Phase 2 components. The additional capability provided by the NSRC equipment could support transitioning to shutdown cooling or suppression pool cooling modes of RHR operation.

3.2.2 Variations to Core Cooling Strategy for Flooding Event

The licensee's FIP does not identify any variations to the FLEX strategy to respond to a flooding event.

3.2.3 Staff Evaluations

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

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

3.2.3.1.1 Plant SSCs

Phase 1

The licensee's FIP states that the primary strategy for core cooling and RPV level control is to supply water via the RCIC system. The RCIC system consists of a steam-driven turbine pump that gets motive steam from the RPV and is capable of taking suction from either the CST or from the suppression pool. Since the CST is not seismically robust or protected from tornado/high wind hazards, the licensee's strategy includes provisions for RCIC suction to be aligned to the suppression pool, either automatically or manually. According to the licensee's FIP, the suppression pool is a safety-related, seismically qualified structure which is protected from the postulated external hazards. The FIP also describes the RCIC pump discharge motor-operated isolation and flow control valves as controllable from either the main control room (MCR) or local panels, using dc power initially supplied by safety-related batteries. Additionally, the valves can be operated locally if dc power is lost. The RCIC system is located in the Reactor Building. According to the SSES Updated Final Safety Analysis Report (UFSAR) [Reference 52], Section 3.8.4, the Reactor Building is a Seismic Category I structure. In addition, the UFSAR, Section 3.5, describes Seismic Category I buildings as being designed to withstand internal and external missiles, including tornado missiles. In the UFSAR, Table 3.3-2 describes the Reactor Building as a tornado resistant enclosure; however, the UFSAR also acknowledges that certain components on the top (refuel) floor of the Reactor Building could be exposed to tornado missiles. The SSES UFSAR indicates that all potentially exposed safety-related components in the refuel floor area have been reviewed and justified. None of these refuel floor components described in the UFSAR relate to the RCIC system. In addition, the RCIC system is designed as Seismic Category I equipment, as described in UFSAR Section 5.4.6.2.3. Based on the UFSAR and FIP descriptions, the NRC staff finds the RCIC system, including the steam-driven turbine pump, associated piping, and the suppression pool, is robust and would be expected to be available at the start of an ELAP event consistent with NEI 12-06, Section 3.2.1.3.

The primary strategy for RPV pressure control is by operation of the SRVs. These valves require dc control power from the station's batteries and pneumatic pressure for operation. The FIP, Section 2.4.1, states that 6 of the 16 total SRVs are used for the ADS. These ADS valves are equipped with a backup nitrogen bottle bank to ensure the valves will operate following the loss of the normal air supply. The licensee's plan also has provisions to supply nitrogen via additional backup bottles for long term operation. The SRVs are located in the drywell, within the Reactor Building, which is robust to all applicable hazards. As described in Table 3.2-1 of the SSES UFSAR, the SRVs and the pneumatic supply system are Seismic Category I and therefore would be expected to be available following a seismic event. Based on the licensee's FIP and UFSAR descriptions, the NRC staff concludes the ADS SRVs are robust and would be expected to be available at the start of an ELAP event consistent with NEI 12-06, Section 3.2.1.3.

Phase 2

The licensee's Phase 2 strategy continues to use the suppression pool as the heat sink for SRV discharges and RCIC turbine steam exhaust. The RCIC system will continue to be used for RPV makeup with suction from the suppression pool as long as possible. The suppression chamber will be vented to atmosphere to remove heat from the suppression pool. According to the licensee's FIP, the vent has been designed to meet the requirements of NRC Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions," which includes provisions for reliable and rugged performance to ensure that the vent remains functional following postulated external events.

The RPV and suppression pool makeup strategy for Phase 2 transitions from the RCIC system to the FLEX pump. Operators are directed by FLEX support guidelines (FSGs) to align the suction of the FLEX pumps to the spray pond, which contains approximately 20 million gallons of water. The discharge of the FLEX pumps is aligned to the RHRSW system. The RHRSW system is safety-related and designed to normally supply cooling water to the RHR heat exchangers on each unit. The system has two loops ("A" and "B") per unit with cross-connects between the two units available on each loop. The RHRSW system can be cross-connected to the RHR system through existing piping on each RHR loop of both units. Each RHR loop is capable of providing water makeup to the RPV or to the suppression pool. In the SSES UFSAR, Table 3.2-1 describes the RHRSW system, RHR system, and the spray pond as Seismic Category I. Table 3.3-2 in the UFSAR lists the RHRSW and RHR systems as protected from tornado missiles. Based on the FIP and UFSAR descriptions, the NRC staff concludes that the RHRSW system, RHR system, and the spray pond are robust and should be available during the postulated ELAP event, consistent with NEI 12-06, Section 3.2.1.3.

Phase 3

The licensee's Phase 3 core cooling strategy initially relies on Phase 2 strategies with the NSRC equipment providing backup equipment.

3.2.3.1.2 Plant Instrumentation

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

As described in the FIP, the available instrumentation to support FLEX core cooling and inventory control strategy includes the following:

- RPV level (wide range)
- RPV pressure
- RCIC parameters (steam supply/exhaust pressures, pump suction/discharge pressure, pump flow, turbine speed)
- Drywell pressure
- Drywell temperature
- Suppression pool level
- Suppression pool temperature

These instruments can be monitored from the MCR. According to the licensee's FIP, many local indications will remain available, even without power, to provide indications of the key reactor parameters.

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

According to the licensee's FIP, contingencies for alternate instrumentation monitoring are available via procedural guidance for essential instrumentation. The staff concludes that this plan provision meets the guidance contained in NEI 12-06, Section 5.3.3.1, and is therefore acceptable.

3.2.3.2 Thermal-Hydraulic Analyses

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

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

To provide analytical justification for their mitigating strategies in response to Order EA-12-049, a number of licensees for BWRs and pressurized-water reactors (PWRs) completed analyses of the ELAP event using Version 4 of the MAAP code (MAAP4). Although MAAP4 and predecessor code versions have been used by the industry for a range of applications, such as the analysis of severe accident scenarios and probabilistic risk analysis (PRA) evaluations, the NRC staff had not previously examined the code's technical adequacy for performing best-estimate simulations of the ELAP event. In particular, due to the breadth and complexity of the physical phenomena within the code's calculation domain, as well as its intended capability for rapidly simulating a variety of accident scenarios to support PRA evaluations, the NRC staff observed that the MAAP code makes use of a number of simplified correlations and approximations that should be evaluated for their applicability to the ELAP event. Therefore, in support of the reviews of licensees' strategies for ELAP mitigation, the NRC staff audited the capability of the MAAP4 code for performing thermal-hydraulic analysis of the ELAP event for both BWRs and PWRs. The NRC staff's audit review involved a limited review of key code models, as well as confirmatory analysis with the TRACE[2] code to obtain an independent assessment of the predictions of the MAAP4 code.

To support the NRC staff's review of the use of MAAP4 for ELAP analyses, in June 2013, EPRI issued a technical report entitled "Use of Modular Accident Analysis Program (MAAP) in Support of Post-Fukushima Applications" [Reference 47]. The document provided general information concerning the code and its development, as well as an overview of its physical models, modeling guidelines, validation, and quality assurance procedures.

Based on the NRC staff's review of EPRI's June 2013 technical report, as supplemented by further discussion with the code vendor, audit review of key sections of the MAAP code documentation, and confirmation of acceptable agreement with NRC staff simulations using the TRACE code, the NRC staff concluded that, under certain conditions, the MAAP4 code may be used for best-estimate prediction of the ELAP event sequence for BWRs. The NRC staff issued an endorsement letter dated October 3, 2013 [Reference 48], which documented these conclusions and identified specific limitations that BWR licensees should address to justify the applicability of simulations using the MAAP4 code for demonstrating that the requirements of Order EA-12-049 have been satisfied.

During the audit process, the NRC staff verified that the licensee's MAAP4 calculation, along with an associated addendum, addressed the limitations from the NRC staff's endorsement letter. The licensee utilized the generic roadmap and response template that had been

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2. TRACE stands for TRAC/RELAP [Transient Reactor Analysis Code/Reactor Excursion and Leak Analysis Program] Advanced Computational Engine. TRACE is the latest in a series of advanced, best-estimate reactor systems codes developed by the U.S. Nuclear Regulatory Commission for analyzing transient and steady-state neutronic-thermal-hydraulic behavior in light water reactors.

developed by EPRI to support consistency in individual licensee's responses to the limitations from the endorsement letter. In particular, based upon review of the MAAP4 calculation documentation, the staff concluded that appropriate inputs and modeling options had been selected for the code parameters expected to have a dominant influence for the ELAP event. The NRC staff further observed that the limitations imposed in the endorsement letter, particularly those concerning the RPV collapsed liquid level being maintained above the reactor core and the primary system cooldown rate being maintained within Technical Specification limits, were satisfied. Specifically, the licensee's analysis calculated that the licensee would maintain the collapsed liquid level in the RPV above the top of the active fuel region throughout the analyzed ELAP event. By maintaining the reactor core fully covered with water, adequate core cooling is assured for this event. Additionally, the licensee's fulfillment of the endorsement letter condition regarding the primary system cooldown rate signifies that thermally induced volumetric contraction and other changes in primary system thermal-hydraulic conditions should proceed relatively slowly with time, which supports the NRC staff's confidence in the predictions of the MAAP4 code. Furthermore, the licensee's analysis calculated that the reactor core remains submerged throughout the ELAP event; this is consistent with the staff's expectation that the flow capacity for primary makeup (i.e., installed RCIC pump and, subsequently, FLEX pumps) should be sufficient to support adequate heat removal from the reactor core during the analyzed ELAP event, including potential losses due to expected primary leakage.

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

3.2.3.3 Recirculation Pump Seals

An ELAP event would result in the interruption of cooling to the recirculation pump seals, potentially resulting in increased leakage due to the distortion or failure of the seals, elastomeric O-rings, or other components. Sufficient primary makeup must be provided to offset recirculation pump seal leakage and other expected sources of primary leakage, in addition to removing decay heat from the reactor core. During the audit process, the NRC staff discussed recirculation pump seal leakage with the licensee and requested that the licensee justify the applicability of the assumed leakage rate to the ELAP event.

The licensee's calculations for SSES assumed a seal leakage rate of 100 gpm (50 gpm per pump) at full reactor pressure. This leakage rate is meant to bound the 18 gpm per recirculation pump seal postulated in accordance with NRC Generic Letter 91-07, "GI-23, 'Reactor Coolant Pump Seal Failures' and its Possible Effect on Station Blackout" [Reference 49], which assumes that no gross seal failure occurs. This leakage rate will decrease as the system pressure decreases while the RPV is cooling down. The RCIC pump capability on each unit can accommodate this leak rate, plus steaming decay heat removal, with margin. The FLEX pump's capability of 2250 gpm at 165 psig allows for makeup to both units' RPVs, as well as the SFPs, and provides margin to the assumed leakage rates during the event.

In the MAAP analysis, the licensee discussed system response to the variation of seal leakage rate as a function of RPV pressure in the thermal hydraulic simulation. The initial seal leakage rate was assumed to be 100 gpm. As the RPV was depressurized the seal leakage rate was reduced. The licensee concluded that the RPV water level continued to be above the top of the active fuel throughout the simulation period.

Considering the above factors, the NRC staff concludes that the leakage rate assumed by Susquehanna is reasonable. The staff further notes that gross seal failures are not anticipated to occur during the postulated ELAP event. As is typical of the majority of U.S. BWRs, SSES has an installed steam-driven pump (i.e., RCIC) capable of injecting into the primary system at a flow rate well in excess of the primary system leakage rate expected during an ELAP, and the other pumps used for core cooling in its FLEX strategy have a similar functional capability and margin well above the expected leakage rate.

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

3.2.3.4 Shutdown Margin Analyses

As described in SSES UFSAR, Section 4.3.2.4, the safety design basis requires that the core, in its maximum reactivity condition, will be subcritical with all control rods inserted except with the highest worth rod completely withdrawn. Thus, the control rods provide adequate shutdown margin under all anticipated plant conditions, with the assumption that the highest-worth control rod remains fully withdrawn. SSES Technical Specification Section 1.1 further clarifies that shutdown margin is to be calculated for a cold, xenon-free condition to ensure that the most reactive core conditions are bounded.

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

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

3.2.3.5 FLEX Pumps and Water Supplies

The licensee relies on a single FLEX pump during Phase 2 to supply both units. When RCIC is no longer available, the FLEX pump is used to inject water into the RPV from the UHS. As described in the licensee's FIP, the pump takes suction from the UHS. The FLEX pump can provide flow at 2250 gpm with a 165 psig discharge head (and 1400 gpm at 200 psig). As described in the FIP, the FLEX pump is sized based on the strategies' flow requirements. To evaluate the pump capacity, the licensee performed hydraulic calculations EC-013-1896, "Performance Requirements for Portable Diesel Driven Pump in Support of FLEX Mitigation Strategies (NRC Order EA-12-049)," Revision 0, and EC-016-1043, "Flow Model of UHS Cooling Water to Support Phase II and III FLEX Mitigation Strategy," Revision 4, to verify the volumetric flow rate and head needed to remove decay heat following a BDBEE. During the audit process the staff reviewed these calculations and confirmed that one FLEX pump has sufficient capacity to supply the required flow, as described by the hydraulic analysis. During the onsite audit, the staff conducted a walk down of the hose deployment routes for the FLEX pump to confirm the consistency of the pump staging locations, hose distance runs, and connection points between the hydraulic analysis and the plan description.

Because one pump can supply adequate flow to both units, the licensee's strategy has provisions to provide two FLEX pumps, satisfying the "N+1" provision of NEI 12-06 for spare equipment. The FLEX pump capability described in this section also accounts for SFP makeup and thus this flow is incorporated into the hydraulic analysis. According to Section 2.8 of the licensee's FIP, both of the FLEX pumps are stored in a fully protected FLEX storage building.

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

3.2.3.6 Electrical Analyses

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

According to the licensee's FIP, operators would declare an ELAP following a loss of offsite power and the inability to start the emergency diesel generators (EDGs) or restore offsite power. 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 an ELAP event, the licensee would rely on the safety-related Class 1E batteries (125 Volts-dc (Vdc) and 250 Vdc) to provide power to key instrumentation and applicable dc components. The SSES Class 1E station batteries and associated dc distribution systems are located within safety-related structures designed to meet applicable design-basis external hazards. The batteries were manufactured by C&D Technologies. The 125 Vdc batteries are model KCR-25 with an 825 ampere-hours (AH) rating and the 250 Vdc batteries are model LCR-25 with an 1800 AH rating. The licensee's procedures direct operators to conserve dc power during the event by stripping non-essential loads. Operators will strip or shed unnecessary loads to extend battery life so that dc power is maintained until backup power is available (Phase 2). The plant operators are expected to complete load shedding within 45 minutes from the onset of the event. In its FIP, the licensee stated the station batteries could cope for at least 8 hours if the load shed is completed within 45 minutes.

During the audit process, the NRC staff reviewed the licensee's dc coping calculations EC-SBOR-0501, "Coping Assessment for the SSES Station Blackout," Revision 8, EC-088-0524, "250 VDC Battery 2D650 Station Blackout Discharge Calculation," Revision 1, and EC-FLEX-0001 through EC-FLEX-0012, "Fukushima-Battery (1D620 through 2D660, respectively) Coping Time for ELAP (Extended Loss of AC Power)" (various revisions), which verified the capability of the dc system to supply power to the required loads during the first phase of the licensee's FLEX mitigation strategy. The licensee's calculations identified the required loads and their associated ratings (ampere and minimum required voltage) and the non-essential loads that would be shed within 45 minutes to ensure battery operation for at least 8 hours. Based on its review of the licensee's analyses and procedures, and the battery vendor's capacity and discharge rates for the Class 1E station batteries, the NRC staff finds that the SSES dc systems have adequate capacity and capability to power the loads required to mitigate the consequences during Phase 1 of an ELAP, provided that necessary load shedding is completed within the times assumed in the licensee's analyses.

The licensee's Phase 2 strategy is to deploy two 4160 Vac FLEX combustion turbine generators (CTGs) to supply the 4160 Vac buses providing the ability to power the battery chargers and dc loads. The 4160 Vac CTGs are rated for 1 megawatt (MW) and are sized to power all the 125 and 250 Vdc battery chargers, RCIC controls, MCR lighting, RHR motor operated valves (MOVs), and other selected loads (including HCVS and SFP level instrumentation). While two CTGs are required to supply the power necessary to complete the licensee's FLEX strategies at both units combined, three CTGs are available, thus satisfying the "N+1" equipment provision of NEI-12-06. The licensee plans to repower the required equipment approximately 6 hours into the event.

During the audit process, the NRC staff reviewed licensee calculation EC-FLEX-0015, "Fukushima FLEX Generators - Phase 2 Load Flow Analysis," Revision 2, conceptual single line diagrams, and the separation and isolation of the FLEX CTGs from the EDGs. Based on the NRC staff's review of EC-FLEX-0015, under the licensee's basic power supply arrangement, the FLEX CTGs would be loaded to approximately 86 percent of their 1250 kilo-Volt-Ampere (KVA) rating during the initial Phase 2 timeline. However, this loading is expected to be reduced once the batteries are fully charged. For alternative connections where the loading may not be equally shared between the two CTGs, the licensee showed that the maximum loading on one of the CTGs would be approximately 94.5 percent of their 1250 KVA rating.

The staff notes that the licensee took the FLEX cable lengths into consideration when sizing the FLEX CTGs (i.e., ensured that the voltage drop did not result in violating the minimum required voltage required at the limiting component). Based on its review of the licensee's calculations, the NRC staff finds that two 4160 Vac FLEX CTGs are adequate to support the electrical loads required for the licensee's Phase 2 strategies. The NRC staff confirmed that licensee guidelines DC-FLEX-003, "Deployment for FLEX Strategies," Revision 4, and DC-FLEX-010, "4160 Vac Connection to E DG and ESS Busses," Revision 2, provide direction for staging and connecting the FLEX CTGs to energize the electrical buses within the required timeframes.

For Phase 3, the licensee plans to continue the Phase 2 coping strategy with additional assistance provided from offsite equipment/resources. The offsite electrical equipment that will be provided by the NSRC includes four 1-MW 4160 Vac CTGs, two 1-MW 480 Vac CTGs, and distribution centers (including cables and connectors). Based on being the same make, model, and size as the Phase 2 FLEX CTGs, the NRC staff finds that the 4160 Vac CTGs being supplied from the NSRCs have sufficient capacity and capability to supply the required loads during Phase 3, if necessary. The licensee would stage the CTGs in the vicinity of the Phase 2 FLEX CTGs. The licensee would rely on emergency response organization (ERO) personnel to connect and utilize the NSRC equipment for long-term coping or recovery.

Based on its review, the NRC staff finds that the Class 1E station batteries should have sufficient capacity to support the licensee's strategy, and that the FLEX CTGs and NSRC-supplied CTGs should have sufficient capacity and capability to supply the necessary loads during an ELAP event while maintaining adequate electrical separation and isolation of the FLEX CTGs from the EDGs.

3.2.4 Conclusions

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

3.3 Spent Fuel Pool Cooling Strategies

In NEI 12-06, Table 3-1 and Appendix C summarize an acceptable approach consisting of three separate capabilities for the SFP cooling strategies. This approach uses a portable injection source to provide the capability for: (1) makeup via hoses on the refueling floor capable of exceeding the boil-off rate for the design basis heat load; (2) makeup via connection to spent fuel pool cooling piping or other alternate location capable of exceeding the boil-off rate for the design basis heat load; and (3) spray via portable monitor nozzles from the refueling floor using a portable pump capable of providing a minimum of 200 gpm per unit (250 gpm if overspray occurs). During the event, the licensee selects the SFP makeup method to use based on plant conditions. This approach also requires a strategy to mitigate the effects of steam from the SFP, such as venting. The licensee's FIP, Section 2.5.2, describes the SSES Unit 1 and Unit 2 SFPs are being normally cross-connected.

As described in NEI 12-06, Section 3.2.1.7, and JLD-ISG-2012-01, Section 2.1, strategies that must be completed within a certain period of time should be identified and a basis that the time can be reasonably met should be provided. In NEI 12-06, Section 3 provides the performance attributes, general criteria, and baseline assumptions to be used in developing the technical basis for the time constraints. Since the event is beyond design basis, the analysis used to provide the technical basis for time constraints for the mitigation strategies may use nominal initial values (without uncertainties) for plant parameters, and best-estimate physics data. All equipment used for consequence mitigation may be assumed to operate at nominal setpoints and capacities. In NEI 12-06, Section 3.2.1.2 describes the initial plant conditions for the at-power mode of operation; Section 3.2.1.3 describes the initial conditions; and Section 3.2.1.6 describes SFP initial conditions. In NEI 12-06, Section 3.2.1.1 provides the acceptance criterion for the analyses serving as the technical basis for establishing the time constraints for the baseline coping capabilities to maintain SFP cooling. This criterion is keeping the fuel in the SFP covered with water.

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

3.3.1 Phase 1

The licensee stated in its FIP that no actions are required during ELAP Phase 1 for SFP makeup because the time to boil is sufficient to enable deployment of Phase 2 equipment. According to the licensee, adequate SFP inventory exists to provide radiation shielding for personnel well beyond the time of boiling. The licensee will monitor SFP water level using reliable SFP level instrumentation installed per Order EA-12-051.

3.3.2 Phase 2

During Phase 2, the FIP, Section 2.5.2, states that operators will deploy a FLEX pump to supply water from the UHS to the SFP. The FLEX pump discharge is connected to the RHRSW system as described in Sections 3.2.1.2 and 3.2.3.1.1 of this safety evaluation. A hose is then connected between the RHRSW piping and a permanently installed standpipe which directs flow up to the refueling floor. Then hoses are routed from the top of the standpipe directly into the SFPs, or to spray nozzles, if desired. The SFP makeup can also be established without refueling floor access. This capability is accomplished by cross-connecting the RHRSW system to the RHR system as described for the RPV makeup strategy. From this point the RHR divisions can be cross-tied and makeup flow provided by opening the RHR to SFP cooling assist valves to provide a makeup flow path to the SFP. This approach uses installed piping other than the hose(s) connecting the FLEX pump to the RHRSW system.

3.3.3 Phase 3

The licensee's FIP states that SFP cooling can be maintained indefinitely using the makeup strategies described in Phase 2 above. The NSRC equipment available for Phase 3 provides backup capability to the Phase 2 FLEX equipment. The licensee's FIP recognizes that a transition from Phase 2 methods may eventually be desired after receipt of the NSRC equipment. This activity is not time sensitive and thus can be planned and sequenced as manpower and plant conditions allow.

3.3.4 Staff Evaluations

3.3.4.1 Availability of Structures, Systems, and Components

3.3.4.1.1 Plant SSCs

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

The licensee's FIP indicates that boiling begins at approximately 13.6 hours under ELAP conditions with a full core offload from one of the SSES units. The staff notes that the licensee's sequence of events timeline in the FIP indicates that operators will begin SFP makeup by this time to ensure the SFP area remains habitable for personnel entry.

As described in the licensee's FIP, the licensee's Phase 1 SFP cooling strategy does not require any operator actions. However, the licensee does establish a ventilation path prior to reaching boiling conditions in the SFPs to cope with temperature, humidity and condensation from evaporation and/or boiling of the SFP. The operators are directed to open various hatches and doors as directed by procedural guidance to establish a ventilation flow path.

The licensee's Phase 2 and Phase 3 SFP cooling strategy involves the use of the FLEX pump (or NSRC-supplied pump for Phase 3) to supply water to the SFP with suction from the UHS. The staff's evaluation of the robustness and availability of the connection points for the FLEX pump is discussed in Section 3.7.3.1 of this safety evaluation and the evaluation of the robustness and availability of the UHS is discussed in Section 3.10.1. The licensee's strategy uses the RHRSW system, RHR system, and SFP assist piping for aspects of the SFP makeup strategy. The robustness of the RHRSW and RHR systems is discussed in Section 3.2.3.1.1 of this safety evaluation. The licensee's FIP states that the flow through the SFP assist piping uses seismically qualified piping. Since this piping is located in a protected structure (Reactor Building) and the piping is seismically qualified, the staff concludes that the SFP makeup strategy uses robust components in accordance with the provisions of NEI 12-06.

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 dedicated battery power with the capability to have longer term power supplied by FLEX generators. The NRC staff's review of the SFP level instrumentation is discussed in Section 4 of this safety evaluation.

3.3.4.2 Thermal-Hydraulic Analyses

As described in Section 2.5.6 of the FIP, for the maximum heat load, the SFP will boil sometime after 13.6 hours. According to the licensee's FIP, the licensee determined that an SFP boil off rate of approximately 93 gpm corresponds to the design basis heat load. Makeup requirements for a typical reload, which would more closely represent an initial condition with both units operating, would be 31 gpm. Since the FLEX pump can provide up to 250 gpm of makeup to each SFP, the staff concludes that the licensee should be able to maintain adequate SFP level makeup for water inventory lost to evaporation and boiling and maintain water level above the fuel for an ELAP event. Consistent with the guidance in NEI 12-06, Section 3.2.1.6, the staff also concludes that the licensee has considered the maximum design-basis SFP heat load.

3.3.4.3 FLEX Pumps and Water Supplies

As described in the FIP, the SFP cooling strategy relies on a FLEX pump to provide SFP makeup during Phase 2. In the FIP, Section 2.4.10.1 describes the hydraulic performance criteria (e.g., flow rate, discharge pressure) for the FLEX pump. The staff's review of the FLEX pump capability, including provisions for SFP makeup, is documented in Section 3.2.3.5 of this safety evaluation.

The staff noted that the performance criteria of a FLEX pump supplied from an NSRC for Phase 3 would allow the NSRC pump to fulfill the mission of the onsite FLEX pump, if necessary.

3.3.4.4 Electrical Analyses

The licensee's mitigating strategy for SFP cooling does not rely on electrical power, except for power to SFP level instrumentation. The SFP water level is monitored by the instrumentation that was installed in response to Order EA-12-051, "Reliable Spent Fuel Pool Level Instrumentation." The capability of the SFP level instrumentation is described in Section 4 of this safety evaluation.

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

3.3.5 Conclusions

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

3.4 Containment Function Strategies

The industry guidance document, NEI 12-06, Table 3-1, provides some examples of acceptable approaches for demonstrating the baseline capability of the containment strategies to effectively maintain containment functions during all phases of an ELAP event. One such approach is for a licensee to perform an analysis demonstrating that containment pressure control is not challenged.

According to the licensee's FIP, the HCVS installed in response to Order EA-13-109 will be used to provide long-term core cooling capability through RCIC and to maintain containment parameters within limits. The FIP describes a MAAP analysis that was used to evaluate the containment parameters, including the venting operation. During the audit process the staff reviewed the containment evaluation documented in LTR-AEO-12-0004, "Susquehanna Steam Electric Station FLEX Coping Time Evaluation," Revision 2. The staff observed that this calculation was based on the boundary conditions described in Section 2 of NEI 12-06. The calculation analyzed the strategy of monitoring key parameters and venting the suppression chamber through the HCVS approximately 5 hours into the event. The evaluation concluded that, with the exception of the suppression chamber temperature, the containment parameters of pressure and temperature remain well below the design limits specified in UFSAR Table 6.2-1. The pressure limit is 53 psig for both the drywell and suppression chamber, and the temperature limits are 340°F for the drywell and 220°F for the suppression chamber. In its FIP, the licensee stated that a small variance (228°F calculated vs. 220°F design value) for the suppression chamber temperature under ELAP conditions was evaluated and it was determined that no containment structural limits would be violated. From its review of the FIP, the NRC staff concludes that the required actions to maintain containment capability and required instrumentation functions have been developed by the licensee, and are summarized below.

3.4.1 Phase 1

The licensee's FIP states that during Phase 1, containment integrity is maintained through normal design features of the containment, such as the containment isolation valves and by operation of the HCVS. The FIP timeline indicates that the operators will initiate containment venting at approximately 5 hours. Otherwise, during Phase 1, the containment strategy involves monitoring of critical containment parameters such as drywell pressure, drywell temperature, suppression pool water level, and suppression pool water temperature. The instrumentation providing this monitoring capability is powered by safety-related batteries.

During the audit process the NRC staff confirmed that procedure EO-100-030 (EO-200-030 for Unit 2), "Unit 1 Response to Station Blackout," Revision 38 (Revision 34 for Unit 2), directs operators to verify containment integrity by verifying that the primary containment isolates. The staff also noted that procedure EO-100(200)-030 also directs operators to use the HCVS to preserve RCIC capability and to control the containment pressure (and indirectly, temperature). According to the licensee, procedures ES-173-007 (Unit 1) and ES-273-007 (Unit 2), "Venting Suppression Chamber through the HCVS," provide guidance for the venting operation.

3.4.2 Phase 2

The Phase 2 strategy is to maintain Phase 1 actions of venting and monitoring containment parameters. The licensee's FIP timeline indicates that suppression pool makeup from the FLEX pump will be initiated at approximately 6 hours into the event. This helps to lower the peak suppression pool temperature to support RCIC system operation. In addition, the FLEX CTGs will be aligned to support continued powering of instrumentation monitoring containment parameters.

The RCIC system operation will continue as long as possible, but eventually the FLEX pump will be used for RPV injection as described in Section 3.2.1.2 of this safety evaluation. Containment venting and monitoring of the applicable parameters will continue after this transition.

3.4.3 Phase 3

In Phase 3, offsite resources (NSRC equipment) will be available for use to maintain Phase 2 actions of monitoring containment parameters, venting the suppression pool through the HCVS, and providing makeup to the RPV and suppression pool.

The licensee's FIP also states that additional capability provided by the NSRC equipment can be used to place one loop of the RHR system into the shutdown cooling or suppression pool cooling modes of operation. According to the licensee, instructions for connection and utilization of NSRC equipment for long term coping or recovery will be provided by Technical Support Center personnel after they have assessed the condition of the plant and infrastructure, plant accessibility, and additional available off-site resources (both equipment and personnel) following the BDBEE.

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 NRC staff's evaluations for the availability of SSCs for maintaining containment functions during an ELAP.

3.4.4.1.1 Plant SSCs

Containment/Suppression Chamber

The primary containment structure consists of the drywell, the pressure suppression chamber, and the drywell floor, which separates the drywell and suppression chamber. The drywell is a steel-lined reinforced concrete vessel in the shape of a frustum of a cone, closed by a dome with a torispherical head. The pressure suppression chamber is a cylindrical stainless steel clad, steel-lined, reinforced concrete vessel located below the drywell. The pressure suppression chamber stores a large volume of water (a minimum of 122,410 cubic feet, or approximately 920,000 gallons). The primary containment structure houses the RPV and other SSCs comprising portions of the reactor coolant pressure boundary. The primary containment is a safety-related structure protected from all postulated external events.

Since the water in the suppression pool is predicted to slightly exceed the design temperature of the suppression chamber (peak temperature of 228°F), the licensee's FIP states that the small variance was evaluated and it was determined that no containment structural limits were violated. During the audit process, the NRC staff reviewed the licensee's evaluation contained in action request AR-2014-00520 and agrees that exceeding the suppression chamber design temperature by a small amount should not prevent maintaining containment capability during an ELAP event. The staff concludes that the primary containment, including the suppression chamber, is robust and should be available to support the licensee's strategy for Order EA-12-049 compliance.

Hardened Containment Vent System

The FIP describes the HCVS as a reliable, severe accident capable, wetwell venting system that complies with the requirements of NRC Order EA-13-109, with components designed for reliable and rugged performance. During the postulated event, the HCVS provides a means of relieving containment pressure directly to the environment via a dedicated vent pipe with a release point above the Reactor Building roof. The two primary containment isolation valves within the HCVS are provided with a dedicated air supply (adequate for at least 7 days) and a dedicated electrical power system (dedicated batteries that can be recharged by the FLEX generators). The HCVS is normally operated from the MCR and can also be operated from the remote operating station. Based on the FIP description, the NRC staff concludes that the venting system should support the licensee's strategy for Order EA-12-049 compliance.

3.4.4.1.2 Plant Instrumentation

In NEI 12-06, Table 3-1 specifies that containment pressure, suppression pool level, and suppression pool temperature are key containment parameters which should be monitored by repowering the appropriate instruments. The licensee's FIP states that critical instrumentation would be available by relying on the station batteries in Phase 1, or the portable CTGs deployed in Phase 2. If no ac or dc power were available, the FIP states that key credited plant parameters, including these containment parameters, would be available using alternate methods.

The licensee's FIP details the availability of the following containment-related instrumentation:

- Suppression pool temperature
- Suppression pool level
- Suppression chamber pressure
- Drywell ambient temperature
- Drywell pressure

Based on the description in the licensee's FIP, the NRC staff concludes that the licensee's available containment instrumentation meets the provisions of NEI 12-06.

3.4.4.2 Thermal-Hydraulic Analyses

As described in Section 3.2.3.2 of this safety evaluation, the licensee performed a MAAP analysis that models the containment features in a coupled calculation with the reactor core analysis. During the audit process, the NRC staff reviewed the licensee's calculation, LTR-AEO-12-0004, "Susquehanna Steam Electric Station FLEX Coping Time Evaluation," Revision 2. The calculation describes the various cases developed by the licensee to evaluate the strategy for responding to the postulated event. The SSES mitigating strategy is based on Case SSES_005 of this calculation. The key assumptions integrated into this case are: 100 gpm seal leakage from the recirculation pumps, no credit for CST water, minimum FLEX water flow is 175 gpm for both suppression pool makeup and RPV makeup, suppression chamber venting begins at 5 hours, injection of FLEX water to the suppression pool begins at 5 hours, and the RCIC pump fails at approximately 37 hours. Based on these parameters, the peak suppression chamber pressure of 22 pounds per square inch absolute (approximately 7 psig) is reached at 5 hours and again at 36 hours. The peak suppression chamber temperature of 228°F is reached at approximately 37 hours. The NRC staff review of the calculation confirmed that the analysis is consistent with the FIP description of the event. Based on the containment parameters staying with within their design parameters, except as evaluated in Section 3.4.4.1.1 of this safety evaluation, the staff concludes that the containment safety function should be met during the postulated BDBEE.

3.4.4.3 FLEX Pumps and Water Supplies

The FLEX pump is deployed and ready for operation at approximately 5 hours into the event. The suction for this pump is from the spray pond (UHS). The discharge of the FLEX pump will be connected to the RHRSW system and will serve both units. As described in Section 3.2.3.5 of this safety evaluation, the NRC staff evaluated the licensee's FLEX hydraulic calculation and notes that the FLEX pump is sized based on the strategies' flow requirements (315 gpm per

RPV plus 100 gpm for recirculation pump seal leakage per unit – 830 gpm total, 500 gpm for the spent fuel pools – 250 gpm per unit). This corresponds to a minimum flow rate of a 1,330 gpm (665 gpm to each unit) at ~210 pounds per square inch differential (psid), which is a discharge pressure sufficient to feed the RPV. The staff notes that the 315 gpm flow to each RPV in the hydraulic analysis is greater than the minimum of 175 gpm assumed in the core cooling analysis and is therefore conservative.

3.4.4.4 Electrical Analyses

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

Each unit's HCVS contains its own battery, which provides power to the HCVS solenoids. The HCVS batteries are sized to provide a minimum of 24 hours of power to HCVS-related equipment. During the audit process, the NRC staff reviewed licensee calculation EC-002-1081, "Hardened Containment Vent System Battery Sizing," Revision 0, which evaluated the battery/battery charger sizing and device terminal voltages for the HCVS dc system. The results of the calculation showed that each HCVS battery, which is comprised of two strings of Enersys G70EP batteries (140 AH total), is adequately sized to supply power to the HCVS for at least 24 hours (129.6 AH) following an ELAP.

The licensee's Phase 2 coping strategy is to continue monitoring containment pressure and temperature using installed instrumentation. The licensee's strategy to repower instrumentation using the FLEX CTGs is identical to what was described in Section 3.2.3.6 of this safety evaluation and is adequate to ensure continued containment monitoring. The licensee also plans to recharge the HCVS batteries utilizing the FLEX CTGs. Based on its review of licensee calculation EC-002-1081, the NRC staff finds that the FLEX CTGs can support the addition of the HCVS battery chargers (each rated at 2 kilowatts). The licensee would transition to Phase 2 prior to depleting the HCVS batteries (i.e., within 24 hours). The staff confirmed that procedure DC-FLEX-010 provides guidance to energize the HCVS battery chargers from the FLEX CTGs.

The licensee's Phase 3 strategy is to continue its Phase 2 strategy throughout the event. Susquehanna will receive offsite resources and equipment, including CTGs, from an NSRC. Given the capacity of these CTGs, the NRC staff finds that it is reasonable to expect that the licensee could utilize these resources to supply power to the HCVS components to maintain the containment function indefinitely. The licensee would stage the CTGs in the vicinity of the Phase 2 FLEX CTGs and would rely on emergency response personnel to connect and utilize the NSRC equipment for long-term coping or recovery.

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

3.4.5 Conclusions

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

3.5 Characterization of External Hazards

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

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

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

References to external hazards within the licensee's mitigating strategies and this safety evaluation are consistent with the guidance in NEI-12-06 and the related NRC endorsement of NEI 12-06 in JLD-ISG-2012-01. Guidance document NEI 12-06 directed licensees to proceed with evaluating external hazards based on currently available information. For most licensees, this meant that the OIP used the current design basis information for hazard evaluation. Coincident with the issuance of Order EA-12-049, on March 12, 2012, the NRC staff issued a Request for Information under Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) [Reference 27] (hereafter referred to as the 50.54(f) letter), which requested that licensees reevaluate the seismic and flooding hazards at their sites using updated hazard information and current regulatory guidance and methodologies. Due to the time needed to reevaluate the hazards, and for the NRC to review and approve them, the reevaluated hazards were generally not available until after the mitigation strategies had been developed. The NRC staff has developed a draft final rule, titled "Mitigation of Beyond-Design-Basis Events," hereafter called the MBDBE rule, which was provided to the Commission for approval on December 15, 2016 [Reference 51]. The MBDBE rule would make the intent of Orders EA-12-049 and EA-12-051 generically applicable to all present and future power reactor licensees, while also requiring that licensees consider the reevaluated hazard information developed in response to the 50.54(f) letter.

The NRC staff requested Commission guidance related to the relationship between the reevaluated flooding hazards provided in response to the 50.54(f) letter and the requirements for Order EA-12-049 and the MBDBE rulemaking (see COMSECY-14-0037, Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards" [Reference 50]. The Commission provided guidance in an SRM to COMSECY-14-0037 [Reference 28]. In a letter to licensees dated September 1, 2015

[Reference 40], the NRC staff informed the licensees that the implementation of mitigation strategies should continue as described in licensee's OIPs, and that the NRC safety evaluations and inspections related to Order EA-12-049 will rely on the guidance provided in JLD-ISG-2012-01, and the related industry guidance in NEI 12-06. 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, or have reevaluated, 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 use this information to perform flood and seismic mitigating strategies assessments (MSAs) per the guidance in NEI 12-06, Revision 2, Appendices G and H [Reference 53]. The NRC staff endorsed Revision 2 of NEI 12-06 in JLD-ISG-2012-01, Revision 1 [Reference 54]. The licensee's MSAs evaluate the mitigating strategies described in this safety evaluation using the revised seismic and flooding hazard information and, if necessary, make changes to the strategies or equipment. For SSES, the licensee has submitted MSAs for the reevaluated seismic and flooding hazards [References 55 and 57 for seismic and flooding, respectively]. The licensee's MSAs concluded that the FLEX strategies do not require changes to accommodate the reevaluated hazards. The NRC assessments of the SSES MSAs [References 56 and 58] have confirmed this conclusion.

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

3.5.1 Seismic

In its FIP, the licensee described the current design-basis seismic hazard, including descriptions of the operating basis earthquake (OBE) and the safe shutdown earthquake (SSE). As described in UFSAR, the SSE seismic criteria for the site is one tenth of the acceleration due to gravity (0.10g) peak horizontal ground acceleration, with the peak horizontal ground acceleration for the OBE specified as 0.05g. 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.

In order to assess the reevaluated seismic hazard, the licensee submitted an MSA to the NRC [Reference 55]. For SSES, the reevaluated hazard was not bounded by the design-basis SSE. The licensee's MSA used an Alternate Mitigation Strategy (AMS) based on the Individual Plant Examination of External Events (IPEEE) to address the impacts of the reevaluated seismic hazard. The IPEEE-based assessment uses an earthquake spectrum that is higher than the reevaluated hazard in the frequency range of 1 to 10 Hertz. The spectrum used for the IPEEE-based assessment was below the reevaluated hazard for a portion of the frequency range above 10 Hertz. In addition to the IPEEE assessment, the licensee performed supplemental evaluations addressing indefinite coping, SFP cooling capability, and high frequency exceedances above 10 Hertz to demonstrate a capability to respond to a seismic event at the magnitude of the reevaluated hazard. By letter dated April 13, 2017 [Reference 56], the NRC staff concluded that the licensee's seismic hazard MSA was performed consistent with the guidance in Appendix H.4.3 of NEI 12-06, Revision 2, as endorsed by

JLD-ISG-2012-01, Revision 1. The staff also concluded that the licensee's AMS evaluation demonstrates that SSCs relied on for mitigation strategies have seismic capacity to levels higher than the reevaluated hazard and that safe shutdown of the plant can be accomplished with any consequences appropriately mitigated. The staff's review of the licensee's MSA evaluation acknowledges that the AMS does not necessarily rely on the FLEX equipment for mitigation, with the exception of SFP cooling, but it does note the following: (1) the FLEX storage building and SFP standpipe are designed to withstand a seismic event at a level of twice the SSE; (2) the soil liquefaction analysis considered in the IPEEE assessment concluded that liquefaction is not a concern at the site, thus allowing deployment of FLEX equipment after a seismic event; (3) the SFP level instrumentation installed for Order EA-12-051 was also designed to withstand a seismic event at twice the SSE level; and (4) the RHRSW piping supporting the FLEX strategy was included in the IPEEE review.

Based on the FIP description and the MSA review, the NRC staff concludes that 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 location of the site as over 150 feet above the normal elevation of the adjacent Susquehanna River. According to the licensee's FIP, the site is considered to be a "dry site" as stipulated in NEI 12-06 with respect to river flooding, upstream dam failures, high tides, or tsunami events. The NRC staff observes that this is consistent with the description of the site in the SSES UFSAR, Section 2.4.2. According to the licensee's FIP, the most significant long-term external flooding event (24 hours or greater) is the Probable Maximum Precipitation (PMP) flooding event. This postulated external flooding event results in approximately 30 inches of rain in a 24-hour period. This external flooding event results in some local ponding around safety-related buildings or structures, with no significant water accumulation against any safety-related buildings. This PMP flooding event bounds any postulated severe weather external flooding event at the station, such as from a hurricane. As a result, the licensee concludes that no external flood mitigating actions are required in response to these external flooding events.

The licensee's FIP also acknowledges that SSES could be subject to short-term external flooding from postulated external flooding events such as a cooling tower basin rupture or a site storage tank rupture. The licensee indicates that these external flooding events could result in a short duration buildup of water around safety-related buildings. Due to the short duration of these external flooding events, no mitigating actions could be initiated in response to these events. In addition, the licensee concludes that no mitigating actions are required in response to these short-term external flooding events and it is not anticipated that deployment of FLEX equipment would be required during these short term external flooding events.

The licensee's FIP does not contain provisions for any groundwater in-leakage mitigation within the FLEX strategy.

In order to assess the reevaluated flooding hazard the licensee submitted an MSA to the NRC [Reference 57]. The purpose of the MSA was to review the FLEX strategies against flooding mechanisms that were not bounded by the design basis. For SSES, the reevaluated hazard, for all flood-causing mechanisms, was bounded by the plant design basis. Thus, the licensee's

MSA concluded that no further action was required to address the reevaluated hazard within its BDB mitigating strategies. By letter dated January 19, 2017 [Reference 58], the NRC staff concluded that the licensee had demonstrated that the mitigation strategies are reasonably protected from the reevaluated hazards and noted that it was appropriate to evaluate the mitigating strategies against the current design-basis flooding hazard. Based on the FIP description, supplemented by the MSA review, the staff concludes that the licensee has appropriately reviewed 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 tornados. The screening for high wind hazards associated with hurricanes should be accomplished by comparing the site location to NEI 12-06, Figure 7-1 (Figure 3-1 of U.S. NRC, "Technical Basis for Regulatory Guidance on Design Basis Hurricane Wind Speeds for Nuclear Power Plants" NUREG/CR-7005, December, 2009); if the resulting frequency of recurrence of hurricanes with wind speeds in excess of 130 miles per hour (mph) exceeds 1E-6 per year, the site should address hazards due to extreme high winds associated with hurricanes using the current licensing basis for hurricanes.

The screening for high wind hazard associated with tornados 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 tornados using the current licensing basis for tornados or Regulatory Guide 1.76, Revision 1.

According to the SSES UFSAR, Section 2.1.1.1, the site location is at 41° 05' 30" north latitude and 76° 08' 55" west longitude. Based on that location, NEI 12-06, Figure 7-1, shows that SSES is susceptible to hurricanes due to location, though it is very close to screening the site out. In addition, NEI 12-06 Figure 7-2, indicates the site is in a region where the tornado design wind speed exceeds 130 mph. Therefore, the plant screens in for an assessment for high winds due to hurricanes and tornados, including missiles produced by these events. In the SSES UFSAR, Section 3.3.2.1 lists the following tornado design parameters (with some differences for the "E" DG Building): (1) tangential wind speed - 300 mph; (2) translational wind speed - 60 mph; (3) pressure drop - 3 psi; and (4) rate of pressure drop - 1 psi per second. The SSES UFSAR, Section 2.3.1.2.1, discusses the hurricane susceptibility of the site and notes that hurricane winds seldom affect the area because of the rough terrain and the distance of the region from the ocean. In general, for inland sites such as SSES, the primary impact from hurricanes is rain, which is evaluated in the flooding section of this safety evaluation.

In terms of tornado missiles, the SSES UFSAR, Table 3.5-4, lists the applicable missile parameters, partially summarized as follows:

Missile	Physical Properties	Horizontal Impact Velocity (mph)
Wood Plank	4 inch x 12 inch x 12 feet	300
Steel pipe	3 inch diameter, 10 feet long, schedule 40	100
Automobile	4000 pounds	50
Steel Rod	1 inch outside diameter, 3 feet long, 8 pounds	216
Utility Pole	13-½ inch outside diameter, 35 feet long, 1490 pounds	144

Therefore, hurricane and tornado-based high-wind hazards are applicable to the plant site. The staff concludes that the licensee's use of the design-basis tornado wind and missile criteria for the high wind evaluation is appropriate for SSES. 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.

According to the SSES UFSAR, the site location is at 41° 05' 30" north latitude and 76° 08' 55" west longitude. In addition, the site is located within the region characterized by NEI 12-06, Figure 8-2, as ice severity level 3. Consequently, the site is subject to considerable amounts of ice that could cause low to medium damage to electrical transmission lines. The SSES UFSAR, Section 2.3.1.1, indicates that the low temperature for the site is -21°F. The licensee concludes that the plant screens in for an assessment for snow, ice, and extreme cold hazard.

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

3.5.5 Extreme Heat

The licensee's FIP notes that, as per NEI 12-06 Section 9.2, all sites are required to consider the impact of extreme high temperatures. The licensee's FIP notes that according to the SSES UFSAR, Section 2.3.1.1, the maximum air temperature is 101°F.

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

3.5.6 Conclusions

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

3.6 Planned Protection of FLEX Equipment

3.6.1 Protection from External Hazards

The licensee's FLEX storage strategy utilizes a single reinforced concrete FLEX storage building located within the protected area of the site. The building location was chosen to be near the highest point on-site to assist in protection from flooding events. The licensee's FIP states that the building protects the equipment against all the BDBEE hazards that are applicable to the site. The building is designed to protect against a seismic event at twice the site SSE level and also provides protection against the applicable high winds and tornado missiles.

According to the licensee's FIP, debris removal equipment is also stored inside the FLEX storage building to reasonably protect it from the applicable external events such that the equipment remains functional and deployable to clear obstructions from the pathway between the FLEX equipment's storage location and its deployment location(s).

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

3.6.1.1 Seismic

According to NEI 12-06, Revision 0, a robust structure means that the design either meets the current plant design basis for the applicable external hazard(s); or has been shown by analysis or test to meet or exceed the current design basis. Therefore, the licensee's FLEX storage building must protect the equipment stored within from an earthquake at a minimum of the design basis (SSE) level such that the equipment survives the event and is subsequently deployable. According to the licensee's FIP, the SSES FLEX storage building is designed to resist a seismic event at twice the SSE level. Based on the FIP description, the NRC staff concludes that the FLEX storage building is seismically robust.

According to the licensee's FIP, large portable FLEX equipment such as the FLEX pumps and FLEX generators are positioned inside the FLEX storage building to protect them during a seismic event. Additionally, fire suppression piping and ventilation ductwork were designed and installed to meet the FLEX storage building specifications (e.g., seismic, wind, etc.). The lighting, conduits, electrical, and fire detection/suppression components were seismically installed to ensure they remain functional before, during, and after a BDBEE and to preclude damage to the FLEX equipment.

Based on the licensee's FIP description, the NRC staff concludes that the licensee's storage plan for the FLEX equipment provides reasonable protection against postulated seismic events.

3.6.1.2 Flooding

As previously discussed in this safety evaluation, SSES is considered to be a "dry site" and therefore, there are no specific provisions regarding protection and deployment of FLEX equipment necessary to respond to postulated river flooding conditions. For local intense precipitation considerations, the licensee's FIP notes that the FLEX storage building is built upon high ground for the site, ensuring that it would be protected against this potential flooding mechanism. Based on the FIP description, the staff concludes that the licensee's storage plan for the FLEX equipment provides reasonable protection against postulated flooding events.

3.6.1.3 High Winds

According to NEI 12-06, a robust structure means that the design either meets the current plant design basis for the applicable external hazard(s); or has been shown by analysis or test to meet or exceed the current design basis. Therefore, the licensee's FLEX storage building must protect the equipment stored within from tornado wind and missile loads at the design basis level such that the equipment survives the event and is subsequently deployable. According to the licensee's FIP, the FLEX storage building provides tornado-missile protection and was designed and constructed to withstand all the site's applicable hazards, including high winds. The FIP also indicates that personnel and equipment doors are designed to survive the design basis tornado and wind loading, and will remain operational after those design loading conditions are applied. Based on the licensee's FIP description, the NRC staff concludes that the licensee's storage plan for the FLEX equipment provides reasonable protection against postulated high wind events.

3.6.1.4 Snow, Ice, Extreme Cold, and Extreme Heat

According to NEI 12-06, a robust structure means that the design either meets the current plant design basis for the applicable external hazard(s); or has been shown by analysis or test to meet or exceed the current design basis. Therefore, the licensee's FLEX storage building must provide protection from snow, ice, cold, and heat consistent with the design basis. According to the licensee's FIP, the FLEX storage structures have been designed to protect against all applicable hazards, which includes extreme snow, ice, extreme heat and cold temperature conditions. The FIP also describes the installed ventilation system in the FLEX storage building. Heating is designed to maintain a minimum indoor temperature of 50°F, and the building ventilation will maintain a maximum indoor temperature of 100°F. Thus, prior to deployment, the FLEX equipment should be stored at an appropriate temperature that will support functionality. Based on the licensee's FIP description, the staff concludes that that the licensee's storage plan for the FLEX equipment provides reasonable protection against snow, ice, extreme cold, and extreme heat.

3.6.1.5 Conclusions

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

3.6.2 Availability of FLEX Equipment

Section 3.2.2.16 of NEI 12-06 states, in part, that in order to assure reliability and availability of the FLEX equipment, the site should have sufficient equipment to address all functions at all units on-site, plus one additional spare (i.e., an "N+1" capability, where "N" is the number of units on site). It is also acceptable to have a single resource that is sized to support the required functions for multiple units at a site (e.g., a single pump capable of all water supply functions for a dual unit site). In this case, the "N+1" could simply involve a second pump of equivalent capability. In addition, it is also acceptable to have multiple strategies to accomplish a function, in which case the equipment associated with each strategy does not require an additional spare.

The major components of the licensee's FLEX strategy subject to the "N+1" provision of NEI 12-06 are the FLEX CTGs, the FLEX pumps, and the associated hoses and cables. For the FLEX CTGs, the licensee's strategy uses two CTGs for the two units, with a third CTG available as a spare to meet the "N+1" provision. All three CTGs are stored in the FLEX storage building. Since all three CTGs are stored in a robust structure, this meets the provisions of NEI 12-06, Revision 0. Regarding the FLEX pumps, one pump is sufficient to meet the flow needs of both units. Thus, having two pumps meets the "N+1" provision of NEI 12-06. Both pumps are stored in the FLEX storage building in order to provide the necessary protection. For hoses and cables, the licensee has chosen an alternate approach to the provisions of NEI 12-06, Revision 0. This is discussed further in Section 3.14.1 of this safety evaluation.

Based on the number of portable FLEX pumps and CTGs identified in the FIP, and considering the hoses and cables alternative approach described in Section 3.14.1 of this safety evaluation, the NRC staff finds that, if implemented appropriately, the licensee's FLEX strategies include sufficient portable equipment provisions for RPV makeup and core cooling, SFP makeup, and maintaining containment consistent with the "N+1" provision in Section 3.2.2 of NEI 12-06.

3.7 Planned Deployment of FLEX Equipment

The major pieces of FLEX equipment that must be deployed to support the licensee's strategy are the two FLEX CTGs and the FLEX pump. According to the licensee's FIP, equipment being transported for the Phase 2 strategies will be towed by heavy duty pickup trucks. The FLEX pump is actually a pumper truck that can be driven to the deployment location from the FLEX storage building. The pumper truck also has the capability to tow equipment, and, if needed, the "N+1" pumper truck could be used to support deployment of equipment.

3.7.1 Means of Deployment

According to the licensee's FIP, there are two pickup trucks available to support large FLEX equipment deployment. Both are stored in the robust FLEX storage building. These vehicles are also designated for debris removal and are outfitted with plows. The FIP also states that debris removal equipment is stored inside the FLEX storage building in order to be reasonably protected from the applicable external events such that the equipment is likely to remain functional and deployable to clear obstructions from the pathway between the equipment's storage location and its deployment location. This equipment includes a front-end loader/backhoe and various hand tools for debris removal to support deployment. Also, according to the license's FIP, deployment of the FLEX debris removal equipment from the storage locations is not dependent on electrical power. The FLEX storage building has an internal permanently installed dedicated diesel generator to provide power if off-site power is lost (automatic start on loss of external power with a 24-hour capacity fuel tank). In addition, the personnel access and main access doors can be opened manually. Based on the FIP description, the staff concludes that the licensee's means of deployment meets the provisions of NEI 12-06 regarding protection, debris removal capability, and accessibility.

3.7.2 Deployment Strategies

The licensee has pre-determined staging locations and deployment routes for the major pieces of FLEX equipment. The licensee's plan recognizes that snow/ice removal may be required to deploy FLEX equipment. Path-clearing equipment is available to support deployment of FLEX equipment. Also, the FIP states that since the UHS may be affected by extreme low temperatures due to ice buildup, the FLEX strategy includes provisions for creating access to the UHS water, or minimizing ice buildup in the UHS, when sufficiently cold weather conditions are forecast.

According to the licensee's FIP, the appropriate haul routes have been evaluated for access including liquefaction assessment. The FIP further describes that based on the results of a liquefaction potential assessment, the overall liquefaction potential at the FLEX storage building and across the designated travel paths is deemed to be low for the postulated seismic ground motions. The risk of surface displacement due to faulting or lateral spreading is also deemed to be low. Additionally, the FIP references the SSES UFSAR, which describes that adequate safety margin against liquefaction is present.

Based on the licensee's FIP description, the NRC staff concludes that the licensee's deployment strategies meet the provisions of NEI 12-06.

3.7.3 FLEX Connection Points

3.7.3.1 Mechanical Connection Points

Core Cooling

In the FIP, Section 2.4.5.1 describes the primary and alternate core cooling connection points for the FLEX pump. The FLEX pump will supply water to the connection points via portable hose from the discharge of the pump. The hose will be routed into the ESSWPH. Within the ESSWPH, the hoses are connected to either division of RHRSW. The RHRSW system can be cross-connected to the RHR system to accomplish RPV injection through either division of the RHR low pressure coolant injection flow path. The RHR and RHRSW systems are listed as Seismic Category I in the SSES UFSAR, Table 3.2-1. The connections are located in the ESSWPH, which is a Seismic Category I and missile-protected structure. Based on the licensee's FIP description and the SSES UFSAR, the staff concludes that the mechanical connection points for the FLEX pumps are robust and should be available following a BDBEE.

SFP Cooling

In the FIP, Section 2.5.4.1 discusses the SFP connections. The SFP makeup connections will be the same as the core cooling connections, except portable hoses will be used to connect from either division of the RHRSW piping to a seismically robust installed standpipe in the Unit 2 Reactor Building northeast stairwell. From the top of the standpipe, hoses will be routed directly to the pool(s), or to monitor nozzles that provide spray makeup. A separate strategy utilizes the cross-connect of the RHRSW and RHR systems and then aligns to the SFP cooling assist line to establish a makeup path to the SFP. The staff notes that the licensee's FIP states that the RHR to SFP cooling assist line is Seismic Category I, and the licensee's FIP also states that the SFP makeup standpipe is seismically robust.

Given the design and location of the primary and alternate strategies, as described in the FIP and UFSAR, the staff concludes that makeup should be available to support core and SFP cooling via a portable pump during an ELAP caused by an external event, consistent with NEI 12-06, Section 3.2.2. The staff also notes that the licensee has the ability to provide SFP makeup without accessing the refueling floor, if needed.

3.7.3.2 Electrical Connection Points

During Phase 2, the licensee's FLEX strategy to re-power essential equipment requires deployment of two 4160 Vac CTGs. The primary staging area for the CTGs is outside the "E" Diesel Generator (DG) Building. The alternate strategy consists of powering the four individual 4160 Vac buses directly from the FLEX CTGs, via temporary cables, to FLEX connections in each of the "A" through "D" DG Buildings.

For the primary strategy, cables would run from the CTGs to a connection point on the exterior of the "E" DG Building. These connections are in a connection box that is protected from BDBEEs. For the alternate strategy, cables from the CTGs would run to connection points in the interior of the "A" through "D" DG Buildings. These connections are located in buildings that provide protection from BDBEEs. The connections are color-coded to help facilitate correct, smooth, safe, and quick connections. The 4160 Vac FLEX CTGs would then be cross-connected to the eight Engineered Safeguard System (ESS) 4160 Vac buses, which supply the eight ESS load centers, which are located in the Reactor Building. This electrical alignment will re-power all selected ESS 480 Vac loads which, after load shedding and re-powering selected loads to both units, will support essential ac and dc loads such as 125 Vdc battery chargers, 250 Vdc battery chargers, SRV and ADS power, vital instruments, MCR lighting/cooling, and selected valves in the RHR, RHRSW, reactor recirculation, and core spray systems.

During the audit process, the NRC staff confirmed that licensee guidelines, DC-FLEX-003 and DC-FLEX-010, provide direction for staging and connecting the FLEX CTGs to energize the electrical buses to supply required loads within the required timeframes. In addition to the color-coded cables and connections, the NRC staff confirmed via the audit process that the Phase 2 FLEX CTGs were phase-checked during the modification engineering process.

For Phase 3, the licensee plans to continue the Phase 2 coping strategy with additional assistance provided from offsite equipment/resources. The offsite electrical equipment that will be provided by the NSRC includes four 1-MW 4160 Vac CTGs, two 1-MW 480 Vac CTGs, and distribution centers (including cables and connectors). The licensee would stage the CTGs in the vicinity of the Phase 2 FLEX CTGs. The licensee would rely on ERO personnel to connect and utilize the NSRC equipment for long-term coping or recovery. During the audit process, the NRC staff questioned how the licensee planned to ensure the proper phase rotation of the Phase 3 CTGs. The licensee initiated action request DI-2018-12586 to update licensee guideline DC-FLEX-010 to include a cautionary note that informs of the difference in the phase rotation of the NSRC supplied CTGs versus the plant's electrical configuration. Assuming that it is properly incorporated, the NRC staff concludes that such a note would be adequate to ensure that proper phase rotation will be verified prior to energizing the SSES electrical buses with an NSRC-supplied CTG.

3.7.4 Accessibility and Lighting

According to the licensee's FIP, the SSES emergency lighting system is comprised of two subsystems. The first subsystem is the 125 Vdc station battery lighting system. This subsystem provides emergency lighting throughout the plant. However, in remote areas not served by the station battery subsystem, emergency lighting is provided by various types of self-contained battery powered units. The licensee's FIP indicates that emergency lighting units exist in the MCR, operating areas of the Reactor Building, Turbine Building, Diesel Generator Buildings, Control Structure, and ESSWPH, stairways and major walkways, at building exits, and in the Technical Support Center.

During Phase 2, the FLEX CTGs will be used to repower the MCR lighting and selected Reactor Building lighting equipment. The FLEX vehicles (two pickup trucks, two fuel trucks, two FLEX pumper trucks, and the front end loader/backhoe) all have lights that can be used to provide general area lighting where people are working. Additional general area outdoor lighting may be available from the security lighting system. In addition, members of the operating staff are equipped with flashlights. The licensee's FIP also notes that six portable lighting towers will be provided by the NSRC during Phase 3 that can be used around the plant site.

Based on the licensee's FIP description, the NRC staff concludes that the licensee has established lighting strategies sufficient to meet the provisions of NEI 12-06, Section 3.2.2.

3.7.5 Access to Protected and Vital Areas

During the audit process, the licensee provided information describing how access to protected areas will not be hindered under the postulated conditions. The staff confirmed that provisions are in place to control site access upon a loss of power. The staff also confirmed that the licensee has contingencies in place to provide access to the areas necessary for the ELAP response, assuming the normal access control systems are without power.

3.7.6 Fueling of FLEX Equipment

In its FIP, Section 2.10.4, the licensee states that the preferred source for refueling of the FLEX equipment uses the "E" fuel oil storage tank which contains 80,000 gallons of ultra-low sulfur diesel fuel oil. Operators can also access fuel oil from the "A", "B", "C", and "D" storage tanks that each contain 50,000 gallons of low sulfur fuel, but these tanks are not preferred. In the SSES UFSAR, Table 3.2-1 classifies the EDG storage tanks as Seismic Category I and the FIP states that all five tanks are seismically designed and protected from all the BDBEE hazards.

The volume of the "E" fuel oil storage tank will supply the FLEX equipment for greater than 72 hours.

The licensee will deploy two tanker trucks that are stored in the FLEX storage building as part of the equipment fueling strategy. One of the tanker trucks will be stationary and provide fuel for the CTGs and one will be mobile and used to fuel the other FLEX equipment. Except for the CTGs, all major FLEX equipment will be stored fueled. Based on the design and location of the available fuel oil tanks and their protection from hazards, the staff finds the five designated fuel oil storage tanks are robust and the fuel oil contents should be available to support the licensee's FLEX strategies during and after the postulated BDBEE.

As described above, the EDG fuel oil tanks have a total capacity of more than 250,000 gallons. In order to confirm that the licensee's fuel strategy will support the FLEX equipment as described in the FIP, the NRC staff reviewed the licensee's procedure, DC-FLEX-011, "Fuel Oil Deployment Strategy," Revision 4, during the audit process. This review found that the total FLEX equipment consumption for the first 96 hours is around 98,000 gallons. Given this fuel demand and the large amount of available fuel, the staff concludes Susquehanna has a sufficient inventory of fuel for diesel-powered equipment required for the FLEX strategy, including the potential additional consumption by the Phase 3 equipment, until additional fuel arrives from off-site. Furthermore, the staff finds that the licensee has adequate plans to refuel the diesel-powered FLEX equipment to ensure uninterrupted operation to support the licensee's FLEX strategies.

3.7.7 Conclusions

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

3.8 Considerations in Using Offsite Resources

3.8.1 SSES SAFER Plan

The industry has collectively established the needed off-site capabilities to support FLEX Phase 3 equipment needs via the SAFER team. The SAFER team consists of the Pooled Equipment Inventory Company (PEICo) and AREVA Inc. (Framatome) 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 National SAFER Response Centers (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 [Reference 29], 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 staff subsequently updated the staff assessment of the NSRCs to account for provisions relating to certain non-nuclear emergencies [Reference 60].

During the audit process, the NRC staff noted that the licensee's SAFER Response Plan includes: (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 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. The SSES SAFER plan does not have provisions for Alternate Staging Area "D". Staging Area "C" is the Wilkes-Barre/Scranton International airport, located northeast of the SSES site (travel distance approximately 35 miles, 27 miles direct path). Staging Area "B" is the south gate house parking lot at SSES with a helicopter pad located next to the main site access road. Staging Area "A" corresponds to the various deployment locations for the FLEX equipment in the vicinity of the applicable plant buildings. Use of helicopters to transport equipment from Staging Area "C" to Staging Area "B" is is provided for within the licensee's SAFER plan.

3.8.3 Conclusions

Based on the FIP description, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should allow utilization of offsite resources following a BDBEE consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.9 Habitability and Operations

3.9.1 Equipment Operating Conditions

3.9.1.1 Loss of Ventilation and Cooling

Following a BDBEE and subsequent ELAP event, ventilation that provides cooling to occupied areas and areas containing required equipment will be lost. Per the guidance given in NEI 12-06, FLEX strategies must be capable of execution under the adverse conditions (i.e., unavailability of installed plant lighting, ventilation, etc.) expected following a BDBEE resulting in an ELAP. In addition, NEI 12-06 states that a basis should be provided for the capability of the

FLEX equipment to continue to function regarding the extreme environments that may be posed.

The primary concern with regard to ventilation is the heat buildup, which occurs with the loss of forced ventilation in areas that continue to have heat loads. According to the licensee's FIP, loss of ventilation analyses were performed 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 limits.

The key areas identified by the licensee for execution of the FLEX strategy activities are the MCR, RCIC pump rooms, Class 1E battery rooms, switchgear rooms in the Reactor Buildings, refuel floor (SFP area), ESSWPH, RHR rooms, and containment areas. Installed plant equipment needed for the FLEX strategy was specifically evaluated in the following areas: MCR; RCIC pump rooms; Class 1E battery rooms; switchgear rooms; and containment. The results of the licensee's room heat-up evaluations have concluded that temperatures remain within acceptable limits for all applicable rooms/areas using passive and active means of ventilation.

Main Control Room

According to its FIP, the licensee's strategy for maintaining the environment of the MCR is to open doors and use a portable fan during worst-case warm weather conditions. The licensee's FIP further concludes that actions taken to open Control Structure doors and using a portable fan would keep the MCR from exceeding 110ºF. The staff reviewed licensee calculation EC-030-1006, "Control Structure Temperature Response to a Station Blackout or Fire Induced Loss of Control Structure HVAC," Revision 14, and implementation documentation in AR-2013-04843, during the audit process. The staff also reviewed licensee guideline DC-FLEX-007, "Control Structure Ventilation Strategy," Revision 2, which directs operators to provide airflow through the MCR by opening selected doors and installing a portable fan. Equipment operability for instrumentation cabinets will be ensured by maintaining the cabinet temperature below the 120ºF design limit by opening cabinet doors after the onset of an ELAP event. The licensee's calculation showed that these actions would maintain MCR temperatures below 110°F for the duration of the postulated event.

In addition, the NRC staff notes that the licensee will receive offsite resources and equipment from an NSRC within 72 hours after the onset of an ELAP event. The NRC staff finds that it is reasonable to expect that the licensee could utilize these resources to reduce or maintain temperatures within the MCR to ensure that required electrical equipment survives indefinitely, if necessary.

The NRC staff concludes that the licensee's plan should maintain the MCR temperatures consistent with the analysis. Based on MCR temperature remaining below 120°F (the temperature limit for electronic equipment to be able to survive indefinitely, identified in NUMARC 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," [Reference 59]), the NRC staff expects that the electrical equipment in the MCR should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

RCIC Pump Rooms

According to the licensee's FIP, the RCIC room temperature would reach approximately 120°F approximately 5 hours from the onset of an ELAP event. If the specified Reactor Building doors are opened within 5 hours, room temperature would quickly drop to about 110°F. This action will support allowing plant personnel to enter the pump rooms to connect a FLEX cooling supply hose to the RCIC lube oil cooler. Providing this cooling water supply will help to ensure long-term operation of the RCIC pump. The licensee's FIP notes that the opening of doors will ensure that the RCIC room environment stays below 120°F, ensuring that electrical components will not be adversely affected by the temperature excursion. In the event high temperature and humidity prevent room entry, the licensee's FIP notes that the system would be operated for as long as possible without cooling of the lube oil. In this case, upon failure of the RCIC system, the RPV would be depressurized and makeup would be provided by a FLEX pump with suction from the spray pond. During the audit process, the NRC staff reviewed the licensee's calculation EC-SBOR-0505, "Evaluation of HPCI [high pressure coolant injection] and RCIC Room Temperature during Station Blackout", Revision 2, to confirm that equipment relied upon as part of the licensee's mitigation strategy will not be adversely affected by the increase in temperature as a result of loss of the normal cooling systems. The staff also confirmed that licensee guidelines DC-FLEX-101, "Cooling Water to Unit 1 RCIC Oil Cooler Using RHRSW System and Establishing RCIC Room Ventilation," Revision 2, and DC-FLEX-201, "Cooling Water to Unit 2 RCIC Oil Cooler Using RHRSW System and Establishing RCIC Room Ventilation," Revision 1, provide guidance for opening the applicable doors, as well as noting the time sensitive nature of the action (5 hours).

Based on the licensee's FIP description, confirmed by the audit review, the NRC staff finds that the licensee's ventilation strategy should maintain the temperature of the RCIC pump rooms below the functional design limit of the RCIC pumps during their required mission time. Therefore, the NRC staff finds that the RCIC function should not be adversely impacted during the required mission time by the loss of ventilation as a result of an ELAP event.

Class 1E Battery Rooms

According to the licensee's FIP, the battery rooms will receive ventilation during Phases 2 and 3 of the event through the use of one of the battery room exhaust fans, repowered from a FLEX power source. The NRC staff notes that the Class 1E 125 Vdc and 250 Vdc battery rooms would be at their normal operating temperature at the onset of the event. The battery rooms are located inside the Control Structure and the licensee's FIP indicates that the location and ventilation flow path would maintain temperatures that would preclude extreme high and/or low temperatures. During the audit process, the staff confirmed the licensee's Phase 2 strategy for ventilation of the 125 Vdc and 250 Vdc Battery Rooms by reviewing DC-FLEX-009, "Battery Room Ventilation Strategy," Revision 2. This procedure will restart one of the two redundant battery room exhaust fans and open various Control Structure doors. According to the licensee's FIP, these exhaust fans draw air from the battery rooms and discharge directly to the standby gas treatment system vent stack. Makeup air to the battery rooms is supplied from the general area of the Control Structure through dampers located in the battery room walls near the floor. Therefore, under summer and winter conditions, battery room temperatures are maintained consistent with the ambient Control Structure temperature, and general ambient building temperatures are expected to preclude extreme battery room temperatures under either summer or winter temperature profiles. The NRC staff finds that it is reasonable to assume that the battery rooms will remain near their pre-event temperature during the relatively short period of time until the FLEX CTGs are deployed and energize the battery room exhaust fans.

The NRC staff notes that the licensee will receive offsite resources and equipment from an NSRC within 72 hours after the onset of an ELAP event. The NRC staff finds that it is reasonable to expect that the licensee could utilize these resources to reduce or maintain temperatures within these areas to ensure that required electrical equipment survives indefinitely, if necessary.

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

Switchgear Rooms

According to the licensee's FIP, the emergency switchgear and load center rooms were analyzed and the temperatures at 72 hours into the event were found to be less than 120°F. The FIP also indicates that for event times greater than 72 hours doors can be opened to provide natural circulation cooling. During the audit process, the NRC staff reviewed licensee calculation EC-SBOR-504, "Reactor Building Heatup Analysis during Station Blackout," Revision 8, to verify that electrical equipment relied upon as part of the Susquehanna mitigation strategy will not be adversely affected by increased temperature as a result of loss of the normal ventilation systems. This calculation showed that peak temperatures in the switchgear rooms were expected to remain less than 120°F for at least 72 hours. For time greater than 72 hours, the staff confirmed that the licensee had procedural actions to open emergency switchgear and load center room doors and deploy portable fans to provide cooling of the equipment. Specifically, the staff confirmed that licensee guidelines DC-FLEX-107, "Ventilation of Switchgear Rooms – Unit 1," Revision 1, and DC-FLEX-207, "Ventilation of Switchgear Rooms – Unit 2," Revision 1, provide guidance for monitoring temperature, opening various doors, and establishing portable ventilation to ensure that temperature in the switchgear rooms remains below 120°F.

The NRC staff notes that the licensee will receive offsite resources and equipment from an NSRC within 72 hours after the onset of an ELAP event. The NRC staff finds that it is reasonable to expect that the licensee could utilize these resources to reduce or maintain temperatures within the switchgear rooms to ensure that required electrical equipment survives indefinitely, if necessary.

Based on the switchgear room temperature remaining below 120°F (the temperature limit for electronic equipment to be able to survive indefinitely, identified in NUMARC 87-00, the NRC staff concludes that the electrical equipment in the switchgear rooms should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Containment Areas

According to the licensee's FIP, containment conditions during an ELAP event are expected to remain below the design limits, except for suppression pool water temperature. During Phases 1 and 2, reactor core cooling is maintained using RCIC with suction from the suppression pool. The suppression pool will heat up as the SRVs remove decay heat from the RPV and discharge into the suppression pool. The suppression pool is expected to reach saturated conditions approximately 6 hours after the onset of an ELAP event. At approximately 5 hours into the event, operators would use the HCVS to vent containment to preserve containment capability and maintain parameters that allow continued use of the RCIC system.

The licensee's FIP indicates that a limited number of containment instruments that serve the technical specification post-accident monitoring function would be available. These instruments meet design and qualification requirements for seismic and environmental qualification, single failure criterion, utilization of emergency standby power, immediately accessible display, continuous readout, and recording of display. According to the licensee, because all the drywell parameters are staying within their applicable design basis limits, qualified components in the drywell, such as the SRVs and post-accident instrumentation, should remain available during an ELAP event. The SSES UFSAR, Section 7.3.1.1a.1.4.10, describes the solenoids associated with ADS SRV operation as being able to operate in the most severe loss-of-coolant accident environment.

The NRC staff also notes that the licensee will receive offsite resources and equipment from an NSRC within 72 hours after the onset of an ELAP event. The NRC staff finds that it is reasonable to expect that the licensee would utilize these resources to reduce or maintain temperatures within containment to ensure that required electrical equipment survives indefinitely, if necessary. The staff also notes that plant operators will continue to monitor containment parameters and perform additional actions that may be required to reduce containment temperature and pressure as described in Sections 2.6.3 and 2.6.5 of the licensee's FIP.

In summary, based on the licensee's FIP description, confirmed by the audit review, the NRC staff concludes that the essential station equipment required to support the FLEX mitigation strategy should perform its required function at the expected temperatures as a result of a loss of ventilation during the postulated event.

3.9.1.2 Loss of Heating

According to the licensee's FIP, under winter conditions, the general ambient temperatures in the Control Structure would preclude extreme low temperatures from adversely impacting the battery rooms. The staff notes that the SSES Class 1E station battery rooms are located inside safety-related structures and will not be directly exposed to extreme low temperatures. At the onset of the event, the Class 1E battery rooms would be at their normal operating temperature and the temperature of the electrolyte in the cells would build up due to the heat generated by the batteries discharging and during recharging. Temperatures in the battery rooms would not be expected to be sensitive to extreme cold conditions due to their location, the concrete walls isolating the rooms from the outdoors, and lack of forced outdoor air ventilation during the early phases of an ELAP event. Thus, the NRC staff concludes that the SSES Class 1E station batteries should perform their required functions as a result of loss of normal heating during an ELAP event.

The licensee's FIP identifies that, under worst case extreme cold conditions, the ESSWPH will need heaters powered from FLEX generators to maintain temperatures above freezing conditions. The pump house is normally maintained at or above 60°F during winter conditions. As part of the FLEX strategy, a hose is routed into the pump house and connected to a RHRSW connection inside the building, therefore, a door will be propped open during ELAP conditions. In the event of extreme cold, the portable 4160 VAC FLEX CTGs would be used to repower the existing heaters in the ESSWPH to maintain the temperatures above 32°F.

During the audit process, the NRC staff reviewed Appendix N of the licensee's calculation EC-SBOR-0504, "Reactor Building Heatup Analysis during Station Blackout," Revision 8, which determined the Reactor Building temperatures during an ELAP under winter conditions. None of the rooms modeled approached freezing by the end of the 72 hours, including areas critical to the licensee's strategy, such as the RCIC pump rooms. Therefore, no specific manual actions are required to maintain during cold weather conditions.

3.9.1.3 Hydrogen Gas Control in Vital Battery Rooms

The potential buildup of hydrogen in the 125 Vdc and 250 Vdc Class 1E battery rooms as a result of loss of ventilation during an ELAP event is an additional ventilation concern that is applicable to Phases 2 and 3. Off-gassing of hydrogen from batteries is only a concern when the batteries are charging. According to the licensee's FIP, a calculation was performed to evaluate hydrogen concentration in the battery rooms. During the audit process, the NRC staff reviewed licensee calculation EC-088-0526, "Battery Room Hydrogen Generation," Revision 3. This calculation demonstrated that under worst case conditions, with no dilution, it would take approximately 102 hours before hydrogen accumulation reached 2 percent of room volume from initiation of battery recharging in the 125 Vdc battery rooms. The calculation also demonstrated that the 250 Vdc battery rooms would remain below 2 percent for at least 54 hours. The licensee's FIP also states that ventilation will be restored to the battery rooms well within 24 hours. The staff confirmed that licensee guideline DC-FLEX-009, provides guidance for establishing required ventilation to maintain hydrogen concentration below 2 percent in the Class 1E battery rooms. The guidance directs operators to establish ventilation by re-energizing existing fans and opening various Control Structure doors.

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

3.9.2 Personnel Habitability

3.9.2.1 Main Control Room (MCR)

According to the licensee's FIP, the strategy for the warm weather, post-ELAP environment at SSES uses a combination of opening of selected doors and deployment of a portable fan to maintain the MCR temperature below 110°F. In addition, the licensee's FIP states that operators are trained in recognizing the symptoms of heat stress and proper hydration methods to combat heat stress. The licensee concludes that continued accessibility would be assured by evaluation of room environments, application of heat stress countermeasures, and rotation of personnel to the extent feasible.

During the audit process, the NRC staff reviewed Appendix L of calculation, EC-030-1006, "Control Structure Temperature Response to a Station Blackout or Fire Induced Loss of Control Structure HVAC," Revision 14, which was prepared by the licensee to address ELAP conditions. The staff review notes that the calculation assumes an ambient temperature of 92°F and a MCR heat load that is based on normal operating conditions when ac power is available. The staff observed that the use of normal MCR heat loads would be conservative, even as loads such as MCR lighting are reestablished in Phase 2. The calculation predicts the MCR could exceed 110°F by 36 hours into the event if forced ventilation is not provided. Thus, the licensee's calculation evaluated the use of a portable fan that can be deployed in combination with the opening of selected doors to mitigate the temperature rise. The NRC staff noted that the sizing of the portable fan was based on the higher, non-ELAP, heat load. In addition, the cooling provided by ventilation established by opening doors and installing the portable FLEX fan assumes a constant outdoor temperature of 92°F and does not credit diurnal temperature variations. The staff confirmed that the licensee's choice of ambient temperature is consistent with American Society of Heating Refrigerating and Air Conditioning Engineers design temperature for the local region.

Based on the FIP description, confirmed by the audit review, the staff concludes that the MCR temperature during an ELAP event should not impede the operators from performing their required actions to address the event.

3.9.2.2 Spent Fuel Pool Area

According to the licensee's FIP, a vent pathway for steam and condensate from the SFP is provided in accordance with the provisions of NEI 12-06. The east wall of SSES's refueling floor is equipped with hatches that open into an equipment area for ventilation ductwork that is outside secondary containment. This equipment area has a roof hatch that opens to the atmosphere. A similar configuration exists at the west wall of the refueling floor. These hatches (and a few additional doors) would be opened manually per procedural guidance to provide a vent path for SFP generated steam to be released from the refueling floor area.

According to the licensee's FIP, habitability in the SFP area was evaluated by a calculation that establishes the time sensitivity of completing the required actions before the general area temperatures reach 110°F. According to the FIP, the result of this evaluation concludes that at approximately 9.8 hours into the event, the vent path should be established.

During the audit process, the NRC staff reviewed calculation EC-012-6122, "Refuel Floor Venting during Extended Loss of AC Power Event", Revision 4, to confirm the licensee's FIP summary. The staff notes that the calculation also estimates the condensation rates from condensation of steam released from the SFP and that procedure DC-FLEX-103, "Reactor Building Flooding Control – Unit 1" (DC-FLEX-203 for Unit 2) provides for re-energizing Reactor Building sump pumps to permit removal of condensed steam, as needed. The staff also reviewed procedure DC-FLEX-005, "Refuel Floor Ventilation Strategy," Revision 1, to confirm the ventilation alignment is performed in accordance with the FIP description. Based on the FIP description, and confirmed by the audit review, the staff concludes that the licensee meets the guidance in Table C-3 of NEI 12-06 for establishing ventilation to support SFP cooling.

3.9.2.3 Other Plant Areas

As described in Section 3.9.1.1 of this safety evaluation, the licensee's strategy for the RCIC pump room anticipates that a RCIC pump room entry may be made to provide cooling water to the lube oil cooler after the FLEX pump is available approximately 5 hours into the event. To accomplish this, the licensee opens selected Reactor Building doors to drop the RCIC room temperature below 110°F, which would allow a room entry to be made.

The NRC staff concludes that, with the planned mitigating actions the thermal environment in the RCIC room should not prevent personnel from accessing the area in order to implement the elements of the FLEX strategy that provide for long-term availability of the RCIC system.

3.9.3 Conclusions

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

3.10 Water Sources

3.10.1 RPV Makeup

Phase 1

As described in the FIP, the CSTs are the normal suction source for the RCIC pump. However, they are not robust for all of the postulated external events. The FIP states that the RCIC suction will automatically swap to the suppression pool in the event the CST level decreases to the low level setpoint. The RCIC suction can also be manually swapped from the MCR. The suppression pool is located in the primary containment, is a Seismic Category I structure, and is protected from all applicable hazards.

Phase 2

During Phase 2, the licensee will transition from the RCIC pump to a FLEX pump to provide makeup water to the RPV. The FLEX pump will also provide makeup water to the suppression pool. As discussed in Section 2.16 of the FIP, the robust water source for the FLEX pump is from the safety-related spray pond (UHS) which is robust for all applicable hazards and holds approximately 25 million gallons of water.

Phase 3

For Phase 3, the RPV makeup strategy is the same as the Phase 2 strategy.

3.10.2 Suppression Pool Makeup

The licensee's plan describes a strategy to provide makeup to the suppression pool using a FLEX pump with suction from the UHS. The licensee's FIP timeline indicates that there is sufficient time to deploy the FLEX pump before makeup is required.

3.10.3 Spent Fuel Pool Makeup

The licensee plans to provide makeup to the SFP using a FLEX pump with suction from the UHS.

3.10.4 Containment Cooling

In Phase 3, the licensee may use the UHS to supply the RHRSW system to support suppression pool cooling mode of RHR operation.

3.10.5 Conclusions

Based on the evaluation above, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should maintain satisfactory water sources following a BDBEE consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.11 Shutdown and Refueling Analyses

Order EA-12-049 requires that licensees must be capable of implementing the mitigation strategies in all modes. In general, the discussion above focuses on an ELAP occurring during power operations. This is appropriate, as plants typically operate at power for 90 percent or more of the year. When the ELAP occurs with the plant at power, the mitigation strategy initially focuses on the use of the steam-driven RCIC pump to provide the water initially needed for decay heat removal. If the plant has been shut down and all or most of the fuel has been removed from the RPV and placed in the SFP, there may be a shorter timeline to implement the makeup of water to the SFP. However, this is balanced by the fact that, if immediate cooling is not required for the fuel in the RPV, the operators can concentrate on providing makeup to the SFP. The licensee's analysis shows that following a full core offload to the SFP from one unit, about 55 hours are available to implement makeup before boil-off results in the water level in the SFP dropping to a level approximately 11 feet above fuel assemblies. The staff notes that during outage conditions there is likely to be additional personnel available on-site, beyond the minimum staffing level assumed in the staffing evaluation, that will allow this timeline to be met.

When a plant is in a shutdown mode in which steam is not available to operate a steam-powered pump such as RCIC (which typically occurs when the RPV has been cooled below about 300°F), another strategy must be used for decay heat removal. In its FIP, the licensee stated that it would follow an NEI position paper regarding shutdown/refueling modes [Reference 43] that has been endorsed by the NRC [Reference 44]. This 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 predeploying or pre-staging equipment to support maintaining or restoring key safety functions in the event of a loss of shutdown cooling.

The NRC staff has concluded that the position paper provides an acceptable approach for demonstrating that the licensees are capable of implementing mitigating strategies in shutdown and refueling modes of operation. Section 2.17 of the licensee's FIP states that Susquehanna has implemented the guidance in this position paper and Section 2.4.1 of the FIP describes how the station has used the guidance from the position paper to enhance the shutdown risk process.

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

3.12 Procedures and Training

3.12.1 Procedures

In its FIP, the licensee stated that the overall plant response to an ELAP with loss of normal access to the UHS event is accomplished through normal plant command and control procedures and practices. The plant EOPs or abnormal operating procedures (AOPs) will govern the operational response. The FLEX strategies will be deployed in support of the AOPs/EOPs using separate FSGs, which will provide direction for using FLEX equipment in maintaining or restoring key safety functions. The licensee indicated that the inability to predict actual plant conditions that require the use of BDB equipment has prompted the creation of a new set of procedures. These procedures (FSGs) provide guidance for deployment of FLEX equipment. The FSGs are written such that they can be implemented during a variety of post event conditions. When the use of FLEX equipment is required for response to a FLEX stylized BDBEE, EOPs or AOPs will direct the entry into and exit from the appropriate FSG. According to the licensee, this procedure approach conforms to NEI 12-06, Section 11.4, guidance for the relationship between FLEX procedures and other relevant plant procedures.

3.12.2 Training

In its FIP, the licensee stated that training has been developed and delivered to the target populations (Operations, Maintenance, Chemistry, Radiation Protection, Security, and ERO staff) using the Systematic [NRC term - Systems] Approach to Training (SAT) process. In addition, ERO decision makers receive additional training on directing actions and implementing strategies following a BDBEE.

3.12.3 Conclusions

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

3.13 Maintenance and Testing of FLEX Equipment

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

In its FIP, the licensee stated that periodic testing and preventative maintenance of the BDB/FLEX equipment conforms to the guidance provided in INPO [Institute of Nuclear Power Operations] AP-913. The licensee stated that the standard EPRI industry PM process (similar to the Preventive Maintenance Basis Database) is used to establish the maintenance and testing actions for FLEX equipment. The EPRI has completed and issued the Preventive Maintenance Basis for FLEX Equipment – Project Overview Report. This provides assurance that stored or pre-staged FLEX equipment is being properly maintained and tested. The EPRI FLEX maintenance templates (where provided) were used to develop the specific maintenance and testing guidance for the associated FLEX equipment. In the absence of an EPRI FLEX template, existing maintenance templates (where available) were used to develop the specific maintenance and testing guidance. For all other equipment not covered by a maintenance template, manufacturer or industry standards were used to determine the recommended maintenance and testing.

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

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

The NRC staff reviewed the unavailability provisions listed in the licensee's FIP and noted that unavailability provisions of NEI 12-06, Revision 0, were not fully described. Specifically, out-of-service provisions for equipment greater than 90 days, and provisions for forecast site-specific external events were not listed. The staff consulted licensee document EP-11, "Beyond Design Basis External Events Program Description," Revision 0, and confirmed that these provisions are included in the licensee's program, as described in NEI 12-06, Revision 0. Thus, the staff concludes that the licensee's plan contains the applicable unavailability provisions of NEI 12-06, Revision 0, and is therefore acceptable. Further, the NRC staff finds that the licensee has adequately addressed equipment maintenance and testing activities associated with FLEX equipment because a maintenance and testing program has been established in accordance with NEI 12-06, Section 11.5.

3.14 Alternatives to NEI 12-06, Revision 0

3.14.1 Reduced Set of Hoses and Cables as Backup Equipment

In its FIP, the licensee described an alternative approach to the NEI 12-06 guidance for hoses and cables. In NEI 12-06, Section 3.2.2 states that in order to assure reliability and availability of the FLEX equipment required to meet these capabilities, the site should have sufficient equipment to address all functions at all units on-site, plus one additional spare, i.e., an "N+1" capability, where "N" is the number of units on-site. Thus, a dual-unit site would nominally have at least three portable pumps, three sets of portable ac/dc power supplies, three sets of hoses and cables, etc. On behalf of the industry, NEI submitted a letter to the NRC [Reference 45] proposing an alternative regarding the quantity of spare hoses and cables to be stored on site. The alternative proposed was that that either: (a) 10 percent additional lengths of each type and size of hoses and cabling necessary for the "N" capability plus at least one spare of the longest single section/length of hose and cable be provided; or (b) that spare cabling and hose of sufficient length and sizing to replace the single longest run needed to support any FLEX strategy. By letter dated May 18, 2015 [Reference 46], the NRC agreed that the proposed alternative approach was reasonable, but that the licensees may need to provide additional justification regarding the acceptability of various cable and hose lengths with respect to voltage drops, and fluid flow resistance. The licensee's FIP states that Susquehanna has provided additional hoses or cables equivalent to 10 percent of the total length of each type/size of hose or cable (or at least one length of hose or cable) necessary for the "N" capability, as described in the NEI proposal and the NRC's endorsement letter, to establish the quantities of spare "N+1" hose and cable. Based on conformance to the NEI proposal, as endorsed, the NRC staff approves this alternative to NEI 12-06, Revision 0, as being an acceptable method of compliance with the order.

In conclusion, the NRC staff finds that although the guidance of NEI 12-06, Revision 0, has not been met, if this alternative is implemented as described by the licensee, it will meet the requirements of the order.

3.15 Conclusions for Order EA-12-049

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

4.0 TECHNICAL EVALUATION OF ORDER EA-12-051

By letter dated February 28, 2013 [Reference 30], the licensee submitted its OIP for SSES in response to Order EA-12-051. By letter dated June 17, 2013 [Reference 31], the NRC staff sent a request for additional information (RAI) to the licensee. The licensee provided a response by letter dated July 3, 2013 [Reference 32]. By letter dated November 6, 2013 [Reference 33], the NRC staff issued an ISE and RAI to the licensee.

By letters dated August 26, 2013 [Reference 34], February 27, 2014 [Reference 35], August 27, 2014 [Reference 36], and February 25, 2015 [Reference 37], the licensee submitted status reports for the OIP. The OIP 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 July 2, 2015 [Reference 38], the licensee reported that full compliance with the requirements of Order EA-12-051 was achieved.

The licensee has installed a SFP level instrumentation system designed by Mohr Test and Measurement, LLC (Mohr). The NRC staff reviewed the vendor's SFP level instrumentation system design specifications, calculations and analyses, test plans, and test reports during a vendor audit. The staff issued an audit report regarding the Mohr system on August 27, 2014 [Reference 39].

The staff performed an onsite audit to review the implementation of SFP level instrumentation related to Order EA-12-051. The scope of the audit included verification that: (a) the site's seismic and environmental conditions were 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 April 13, 2015 [Reference 24], the NRC issued an audit report on the licensee's progress.

4.1 Levels of Required Monitoring

The licensee's compliance letter dated July 2, 2015 [Reference 38], identified Level 1 as elevation 817'-1". The letter notes that this level is slightly higher than the originally designated Level 1, as specified in the OIP, and now corresponds to the top of the weir plate over which the SFP water flows to enter the skimmer surge tank, the suction source for the SFP cooling pumps. Therefore, the staff concludes that the licensee's designated Level 1 is consistent with the guidance of NEI 12-02, because it corresponds to the level at which reliable suction loss occurs due to uncovering of the inlet weir. The NRC staff also notes that the top of the instrument span is at 818'-0" and that the high water level alarm is at 817'-7". Therefore, the staff also concludes that the high end of the instrument span covers the full range of normal spent fuel cooling operation.

The licensee's compliance letter identifies Level 2 as elevation 804'-4" and Level 3 at elevation 794'-10". The staff finds that Level 2 corresponds to a level that is 10 feet above the top of the fuel racks, which are at elevation 794'-4", and thus it provides adequate shielding for a person in the SFP area, meeting the NEI 12-02 guidance for Level 2. The licensee's Level 3 is approximately 6 inches above the top of the fuel racks and is therefore within 1 foot of the top of the fuel racks, consistent with the provisions of NEI 12-02.

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

4.2 Evaluation of Design Features

Order EA-12-051 requires 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. Below is the staff's assessment of the design features of the SFP level instrumentation.

4.2.1 Design Features: Instruments

In its compliance letter, the licensee provided sketches that depict the installed SFP level instrumentation configuration at SSES. One of the instruments is located near the southwest corner of Unit 2 SFP and the other is located near the northwest corner of the Unit 1 SFP. The conduit routings proceed straight west from the instruments and maintain separation in the vicinity of the SFPs.

The Unit 1 and Unit 2 SFPs are separated by a cask storage pool, which has gated connections to each SFP. The licensee's compliance letter states that the gates are not normally installed. While the UFSAR does note that certain specific plant evolutions could require the gates to be installed, according to the licensee's compliance letter, they have not been installed since the site implemented a dry fuel storage process in 2006. The licensee also stated that gate insertion is procedurally controlled and will have the existing SFP level instruments and personnel observation as backup. The staff notes that should the gates ever need to be installed, the licensee would need to follow the provisions of Section 4.3 in NEI 12-02 regarding out-of-service controls for the impacted instrumentation.

Based on a review of the sketches provided in the licensee's compliance letter, the NRC staff determined that the bottom of the cask storage pool gates is below the licensee's designated Level 3 and therefore both primary and secondary instruments can detect the full level range for either pool. During the audit process, the NRC staff also performed a walkdown of the SSES refueling floor. During the walkdown, the NRC staff confirmed that the proposed installation locations were consistent with the endorsed guidance.

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

4.2.2 Design Features: Arrangement

Based on the layout of the installed equipment as described in Section 4.2.1 of this safety evaluation, and the NRC staff's on-site audit walkdown of the refueling floor, the NRC staff found that there is sufficient channel separation within the SFP area between the primary and back-up level instruments and routed cables to provide reasonable protection against loss of level indication due to missiles that may result from damage to the structure over the SFPs. The NRC staff also noted that the conduits for each channel are set in routed reliefs in the concrete floor, providing additional protection from missiles and falling debris.

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

4.2.3 Design Features: Mounting

The licensee's compliance letter provided a sketch and description of the as-installed mounting hardware for the level instruments. The licensee stated that the probe flange is bolted to a rigid steel mounting bracket that is welded to the SFP liner plate. Further, the licensee stated that the loading calculated for the probe mount and probe body includes both seismic and hydrodynamic loading, using seismic response spectra that bounds the site design basis maximum seismic loads applicable to the installation location. During the audit process, the staff reviewed Mohr Document 1-0410-9.14, "Mohr SFP-1 Site-Specific Seismic Analysis Report," Revision 1, and NAI-1791-008, "Seismic Induced Hydraulic Response in the PPL Susquehanna Spent Fuel Pool," Revision 1, to confirm the licensee's compliance letter description. The flange, flange plate, and mounting bracket design were previously reviewed as part of the Mohr vendor audit.

Based on the compliance letter description, confirmed by the audit reviews, 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 should adequately address the requirements of the order.

4.2.4 Design Features: Qualification

4.2.4.1 Augmented Quality Process

Appendix A-1 of NEI 12-02 describes a quality assurance process for non-safety systems and equipment that are not already covered by existing quality assurance requirements. In JLD-ISG-2012-03, the NRC staff found the use of this quality assurance process to be an acceptable means of meeting the augmented quality requirements of Order EA-12-051. In its OIP, the licensee stated that instrument channel reliability will be assured by use of an augmented quality assurance process, similar to what the site uses for fire protection.

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

4.2.4.2 Instrument Channel Reliability

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

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

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

For the Mohr system, equipment reliability performance testing was performed to: (1) demonstrate that the SFP instrumentation will not experience failures during postulated BDB conditions of temperature, humidity, emissions, surge, and radiation; and (2) to verify those tests envelope the plant-specific requirements. The NRC staff reviewed the Mohr system qualification testing and results during the vendor audit and documented the staff review in letter dated August 27, 2014 [Reference 39]. The staff notes that the SSES SFP level instrument configuration has only passive components with no electronic devices in the SFP area.

The licensee's compliance letter provides a summary of the methods used to demonstrate the reliability of the SFP level instrument system, with references to specific documents regarding channel qualification. During the audit process the staff reviewed these documents to confirm that instrument channel reliability has been demonstrated in accordance with the provisions of NEI 12-02. Specifically the staff reviewed Mohr Document 1-0410-9.14 "Mohr SFP-1 Site-Specific Seismic Analysis Report," Revision 1, and NAI-1791-008, "Seismic Induced Hydraulic Response in the PPL Susquehanna Spent Fuel Pool", Revision 1, EC-030-1006, "Control Structure Temperature Response to SBO or Fire, Loss of Control Structure HVAC", Revision 14, and EC-RADN-1171, "Equipment Qualification and Area Doses for SFP Drawdown" Revision 0. The staff confirmed the qualification and anticipated post-event ELAP conditions for each location where SFP level instrumentation equipment is installed.

For radiation considerations, the staff review noted that the equipment in the SFP area contains no active components and their performance is not susceptible to the anticipated radiological conditions. The vendor provided testing documentation shows the coaxial signal cable met the radiation aging criteria of 1E7 Rads. Shielding provided by the concrete walls for the electronic components outside the SFP area limits exposure to less than 1E3 Rads. The staff confirmed that these results were sufficient for the anticipated SSES radiological conditions and the Mohr equipment.

Temperature and humidity conditions in the pool area, per NEI 12-02, are assumed to be 212°F, with 100 percent relative humidity. During the vendor audit, the staff observed that the Mohr vendor testing confirms that this temperature does not impact the performance of the equipment in the SFP area. The condensing steam conditions, however, may have minor impact to the instrument accuracy, but as determined in the vendor audit, the impact is less than the accuracy criteria in NEI 12-02. The staff confirmed the anticipated maximum temperature of the MCR during ELAP would be within the 130°F qualification temperature of the signal electronics and display.

Seismic qualification was discussed in Section 4.2.3 of this safety evaluation. The staff notes the peak ground acceleration for SSES is relatively low and bounded by the qualification testing observed during the vendor audit, thus confirming the seismic qualification is consistent with the NEI 12-02 guidance. The staff also observed that the displays and signal processing electronics are mounted outside the SFP area, in each unit's MCRs, as Seismic Category I components.

The licensee's compliance letter describes the testing and analysis performed to assess shock and vibration testing for the SFP level instruments. Based on the licensee's description, confirmed by the staff's on-site audit walkdown of instrument locations at SSES, the NRC determined that the as-installed configuration is consistent with the guidance for shock and vibration.

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

4.2.5 Design Features: Independence

Physical separation in the SFP area is described in Sections 4.2.1 and 4.2.2 of this safety evaluation. The signal processing electronics and display units for each instrument are mounted in the MCRs of each unit. The licensee's compliance letter states that cable routing between the MCR and the SFP is through separate units and that the signal from each probe is not cross-connected at any point. The licensee's compliance letter also states that the level instrument installed on Unit 1 is powered from Division I panel 1Y216-10 and the instrument for Unit 2 is powered from Division II panel 2Y226-13. These panels have separate safety-related power sources and will have backup power provided by the EDGs or the FLEX CTGs.

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

4.2.6 Design Features: Power Supplies

According to the licensee's compliance letter, the SFP level instrumentation batteries have sufficient capacity to power the instruments until the site ac power supplies are reenergized using the FLEX strategy. This will occur approximately 6 hours after the initiating event and supply power before the dedicated SFP level instrument batteries are depleted. The SFP level instrument dedicated battery capacity and hold-up time were reviewed as part of the vendor audit [Reference 39], and the staff confirmed that the SSES FLEX timeline should reenergize the appropriate panels before the batteries are depleted.

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

4.2.7 Design Features: Accuracy

The NRC staff reviewed the accuracy of the Mohr SFP level instrumentation system during the vendor audit and found that it met the NEI 12-02 provision of ±12 inches. Details are available in the August 27, 2014 vendor audit report [Reference 39]. The licensee's compliance letter states, in part, that accuracy is approximately ±1.06 percent which corresponds to ±3 inches over the 23'-7" span.

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

4.2.8 Design Features: Testing

The NRC staff reviewed the testing and calibration of the Mohr SFP level instrumentation system during the vendor audit and found that it met the provisions of NEI 12-02. Details of this review can be found in the August 27, 2014 [Reference 39], vendor audit report. The licensee's compliance letter states that periodic calibration and testing will be established in accordance with station processes and procedures with consideration of the vendor recommendations.

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

4.2.9 Design Features: Display

The licensee stated, in part, in its full compliance letter, that displays would be located in each unit's MCR. The MCR is the preferred display location as described in the NEI 12-02 guidance, as it provides the optimal location for accessibility. The functional aspects of the display units were evaluated during the vendor audit [Reference 39].

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

4.3 Evaluation of Programmatic Controls

Order EA-12-051 specifies 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 SSES SFP level instrumentation.

4.3.1 Programmatic Controls: Training

In its OIP, the licensee stated, in part, that the SAT process will be used to identify the population to be trained and to determine both the initial and continuing elements of the required training. According to the licensee, personnel will complete training prior to being assigned responsibilities associated with this instrument.

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

4.3.2 Programmatic Controls: Procedures

The licensee's OIP states that procedures will be developed using guidelines and vendor instructions to address the maintenance, operations, and abnormal response issues associated with the new SFP instrumentation consistent with NEI 12-02. The licensee provided a partial list of applicable procedures in its compliance letter. During the on-site audit the NRC staff reviewed a sampling of the available procedures.

Based on the OIP description, the NRC staff finds that the licensee's procedure development plan appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order, assuming that it is implemented as described.

4.3.3 Programmatic Controls: Testing and Calibration

According to the licensee's compliance letter, the compensatory actions for one or both SFP level instruments not functioning have been established in procedure EP-115, "Equipment Important to Emergency Response". The NRC staff also reviewed, as part of the audit process, Susquehanna document EP-11 "Beyond Design Basis External Events Program Description," Revision 0, which includes a description of the SFP level instrument functional test performance requirements as well as out-of-service times and related compensatory actions.

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

4.4 Conclusions for Order EA-12-051

In its letter dated February 28, 2013 [Reference 30], the licensee stated that they would meet the requirements of Order EA-12-051 by following the guidelines of NEI 12-02, as endorsed by JLD-ISG-2012-03. In the evaluation above, the NRC staff finds that, if implemented appropriately, the licensee has conformed to the guidance in NEI 12-02, as endorsed by JLD-ISG-2012-03. In addition, the NRC staff concludes that if the SFP level instrumentation is installed at SSES according to the licensee's design, it should adequately address the requirements of Order EA-12-051.

5.0 CONCLUSION

In August 2013, the NRC staff started audits of the licensee's progress on Orders EA-12-049 and EA-12-051. The staff conducted an onsite audit in December 2014 [Reference 24] at SSES. The licensee reached its final compliance date on April 30, 2018, for Order EA-12-049, and on May 23, 2015, for Order EA-12-051, and has declared that both of the reactors are in compliance with the orders. The purpose of this safety evaluation is to document the strategies and implementation features that the licensee has committed to. Based on the evaluations above, the NRC staff concludes that the licensee has developed guidance and 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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SUBJECT: SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2 – SAFETY EVALUATION REGARDING IMPLEMENTATION OF MITIGATING STRATEGIES AND RELIABLE SPENT FUEL POOL INSTRUMENTATION RELATED TO ORDERS EA-12-049 AND EA-12-051 (CAC NOS. MF0888, MF0889, MF0890, AND MF0891; EPID NOS. L-2013-JLD-0021 AND L-2013-JLD-0022) DATED November 7, 2018

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