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

August 21, 2018

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

SUBJECT: LASALLE COUNTY 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. MF1119, MF1120, MF1121, AND MF1122; EPID NOS. L-2013-JLD-0023 AND L-2013-JLD-0012)

Dear Mr. Hanson:

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

By letter dated February 28, 2013 (ADAMS Accession No. ML13060A421), Exelon Generation Company, LLC (Exelon, the licensee) submitted its OIP for LaSalle County Station, Units 1 and 2 (LaSalle), 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 February 21, 2014 (ADAMS Accession No. ML14030A223), and March 23, 2015 (ADAMS Accession No. ML15061A054), the NRC issued an Interim Staff Evaluation (ISE) and an audit report, respectively, on the licensee's progress. By letter dated April 4, 2017 (ADAMS Accession No. ML17094A587), Exelon reported that LaSalle, Unit 2, was in full compliance with Order EA-12-049. By letter dated May 9, 2018 (ADAMS Accession No. ML18130A751), Exelon reported that LaSalle, Unit 1, was in full compliance with Order EA-12-049, and submitted a Final Integrated Plan for LaSalle, Units 1 and 2.

By letter dated February 28, 2013 (ADAMS Accession No. ML13063A323), the licensee submitted its OIP for LaSalle, 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 26, 2013 (ADAMS Accession No. ML13275A145), and March 23, 2015 (ADAMS Accession No. ML15061A054), the NRC staff issued an ISE and an audit report, respectively, on the licensee's progress. By letter dated March 26, 2014 (ADAMS Accession No. ML14083A620), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-051 in accordance with NRC NRR Office Instruction LIC-111, similar to the process used for Order EA-12-049. By letter dated April 27, 2015 (ADAMS Accession No. ML15117A635), Exelon submitted a compliance letter in response to Order EA-12-051. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-051 at LaSalle, Units 1 and 2.

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

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

Sincerely,

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

Docket Nos.: 50-373 and 50-374

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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

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

EXELON GENERATION COMPANY, LLC

LASALLE COUNTY STATION, UNITS 1 AND 2

DOCKET NOS. 50-373 AND 50-374

1.0 INTRODUCTION

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

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

On March 12, 2012, the NRC also issued Order EA-12-051, "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, the NRC staff provided SECY-12-0025, "Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami," [Reference 2] to the Commission. This paper included a proposal to order licensees to implement enhanced BDBEE mitigation strategies. As directed by the Commission in Staff Requirements Memorandum (SRM)-SECY-12-0025 [Reference 3], the NRC staff issued Orders EA-12-049 and EA-12-051.

2.1 Order EA-12-049

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

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

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

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

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

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

On December 10, 2015, following submittals and discussions in public meetings with NRC staff, the Nuclear Energy Institute (NEI) submitted document NEI 12-06, Revision 2, "Diverse and

Flexible Coping Strategies (FLEX) Implementation Guide," [Reference 6] to the NRC to provide revised specifications for an industry-developed methodology for the development, implementation, and maintenance of guidance and strategies in response to the Mitigation Strategies order. The NRC staff reviewed NEI 12-06, Revision 2, and on January 22, 2016, issued Japan Lessons-Learned Division (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-01, Revision 1, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," [Reference 7], endorsing NEI 12-06, Revision 2, with exceptions, additions, and clarifications, as an acceptable means of meeting the requirements of Order EA-12-049, and published a notice of its availability in the *Federal Register* (81 FR 10283).

2.2 Order EA-12-051

Order EA-12-051, Attachment 2, [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.
>
> 1. The spent fuel pool level instrumentation shall include the following design features:
>
> 1.1 Instruments: The instrumentation shall consist of a permanent, fixed primary instrument channel and a backup instrument channel. The backup instrument channel may be fixed or portable. Portable instruments shall have capabilities that enhance the ability of trained personnel to monitor spent fuel pool water level under conditions that restrict direct personnel access to the pool, such as partial structural damage, high radiation levels, or heat and humidity from a boiling pool.
>
> 1.2 Arrangement: The spent fuel pool level instrument channels shall be arranged in a manner that provides reasonable protection of the level indication function against missiles that may result from damage to the structure over the spent fuel pool. This protection may be provided by locating the primary instrument channel and fixed portions of the backup instrument channel, if applicable, to maintain instrument channel separation within the spent fuel pool area, and to utilize inherent shielding from missiles provided by existing recesses and corners in the spent fuel pool structure.
>
> 1.3 Mounting: Installed instrument channel equipment within the spent fuel pool shall be mounted to retain its design configuration during and

following the maximum seismic ground motion considered in the design of the spent fuel pool structure.

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

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

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

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

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

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

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

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

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

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

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

3.0 TECHNICAL EVALUATION OF ORDER EA-12-049

By letter dated February 28, 2013 [Reference 10], Exelon Generation Company, LLC (Exelon, the licensee) submitted an Overall Integrated Plan (OIP) for LaSalle County Station, Units 1 and 2 (LaSalle), in response to Order EA-12-049. By letters dated August 28, 2013 [Reference 11], February 28, 2014 [Reference 12], August 28, 2014 [Reference 13], February 27, 2015 [Reference 14], August 28, 2015 [Reference 15], February 26, 2016 [Reference 16], August 26, 2016 [Reference 17], February 28, 2017 [Reference 18], August 28, 2017 [Reference 19], and February 28, 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 February 21, 2014 [Reference 23], and March 23, 2015 [Reference 24], the NRC issued an Interim Staff Evaluation (ISE) and audit report, respectively, on the licensee's progress. By letter dated April 4, 2017 [Reference 25], Exelon reported that LaSalle, Unit 2, was in full compliance with Order EA-12-049. By letter dated May 9, 2018 [Reference 26], Exelon reported that LaSalle, Unit 1 was in full compliance with Order EA-12-049, and submitted a Final Integrated Plan (FIP) for LaSalle, 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.

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.

LaSalle is a General Electric (GE) boiling-water reactor (BWR) Model 5 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. 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 fully robust, the licensee's mitigating strategy assumes that the RCIC pump suction realigns to the suppression pool. Within approximately 20 minutes, the operators take manual control of the SRVs and begin a controlled cooldown and depressurization of the RPV. The cooldown is stopped when RPV pressure reaches a control band of 150 to 250 pounds per square inch gauge (psig), to ensure sufficient steam pressure to operate the RCIC pump. When the suppression chamber reaches a predetermined pressure setpoint, the vent to atmosphere is opened to mitigate the suppression pool temperature rise and allow the RCIC system to continue to function. The RPV makeup will continue to be provided from the RCIC system until the gradual reduction in RPV pressure resulting from diminishing decay heat requires a transition to Phase 2 methods. 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 FLEX portable diesel-driven pump (PDDP). This pump is sized 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 to support indefinite coping.

Each unit at LaSalle has a SFP located in the Reactor Building. The Unit 1 and Unit 2 pools are connected by a transfer canal. To maintain SFP cooling capabilities, the licensee stated that the required action is to establish the water injection lineup before the environment on the SFP operating deck degrades due to boiling in the pool so that personnel can access the refuel floor to accomplish the coping strategies. The pools will initially heat up due to the unavailability of the normal cooling system. The licensee has calculated that, for a normal heat load, boiling could start at approximately 12 hours after the start of the ELAP. With this heat load, the water level would drop to the top of the fuel racks in approximately 123 hours. The licensee determined that habitability on the SFP operating deck area could become compromised as early as 12 hours after the ELAP, so valve lineups and hose deployments are planned prior to that time.

To makeup to the SFPs, the licensee has multiple strategies that can be used. If the refuel floor is accessible and habitable, the primary strategy uses a combination of installed piping and hoses connected to the same FLEX PDDP as is used in the RPV makeup strategy. The supply from the FLEX PDDP can connect to primary or alternate installed piping locations. The discharge ends of the hoses on the refuel floor are routed to the SFPs and flow can be

controlled locally. In addition the licensee's plan has provisions to use this lineup and control the flow from a more remote location. In addition, if the refuel floor is not accessible or habitable, an alternate strategy using installed piping in conjunction with the installation of a spool piece is included in the plan. This strategy does not require access to the refuel floor to provide makeup.

The operators will perform dc bus load shed to extend safety-related battery life sufficient to allow time for the deployment of a FLEX diesel generator (DG) for each unit. An initial load shed is initiated within approximately 5 minutes of the event and a deeper load shed is initiated approximately 180 minutes into the event. The licensee estimates that the load shed activities will be completed within approximately 4.5 – 5.5 hours of the event initiation. Following the load shed and prior to battery depletion at approximately 8 hours, a 500-kilowatt (kW), 480 Volts-ac (Vac) DG will be deployed for each unit. These DGs will be used to repower essential battery chargers and are expected to be operational within approximately 6 hours of ELAP initiation.

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

Below are specific details on the licensee's strategies to restore or maintain core cooling, containment, and SFP cooling capabilities in the event of a BDBEE, and the results of the staff's review of these strategies. The NRC staff evaluated the licensee's strategies against the endorsed NEI 12-06, Revision 2, guidance.

3.2 Reactor Core Cooling Strategies

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

As reviewed in this section, the licensee's core cooling analysis presumes that, per the endorsed guidance from NEI 12-06, both units would have been operating at full power prior to the event. Therefore, the suppression pool may be credited as the heat sink for core cooling during the event. Maintenance of sufficient RPV inventory, despite steam release from the SRVs and ongoing system leakage expected under ELAP conditions, is accomplished through a combination of installed systems and FLEX equipment. The licensee's strategy for ensuring compliance with Order EA-12-049 for conditions where one or 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 injection of cooling water into the RPV will be accomplished through the RCIC system. Because the turbine for the RCIC pump is driven by steam from the RPV, operation of the RCIC system further assists the SRVs with RPV pressure control. The RCIC system suction on each unit is initially lined up to the unit's CST and will pump water into the core from that source, if it is available. The CSTs are not a fully protected source of water for the ELAP event. In the event that the CST is not available, the RCIC pump will take suction from the suppression pool. The LaSalle strategy assumes that only the water from the suppression pool is available.

According to the licensee's FIP, pressure control of the RPV is accomplished using the automatic depressurization system (ADS) SRVs which are powered by the 125 Volts-dc (Vdc) buses. Within 20 minutes after the initiation of the event, operators will utilize the SRV's to depressurize the RPV at a rate of less than 20 degrees Fahrenheit (°F) per hour. The RPV pressure is lowered to a control band between 150 and 250 psig to allow sufficient steam pressure for continued operation of the RCIC system. There is a backup nitrogen system in place that will be aligned within 5 hours of event initiation to allow the continued operation of the SRV's for at least 24 hours after the initiation of the event.

According to the licensee's FIP, station batteries and the Class 1E 125 Vdc distribution system provide power to RCIC systems and instrumentation. The FIP's "Sequence of Events" shows that initial dc load shedding begins concurrent with the declaration of a station blackout after the initiation of the ELAP event. An extended dc load shed is also completed. The load shedding ensures that the installed batteries can power the Phase I systems and instrumentation, and also allows time for the FLEX DGs to be deployed as a power source.

3.2.1.2 Phase 2

According to the licensee's FIP, RCIC will continue to be used until necessary to transfer to the FLEX PDDP, one for both units. The FLEX PDDP takes suction from the UHS and can be used for RPV injection, suppression pool makeup, and makeup to the SFP. The PDDP is rated at 4000 gallons per minute (gpm) at 150 pounds per square inch (psi) head and thus has the sufficient capacity to provide the required makeup flows of 600 gpm to the RPV, 100 gpm to the suppression pool, and 250 gpm to the SFP for each unit. In order to support deployment of the FLEX PDDP, two hydraulically-driven suction booster pumps are placed in the UHS. The primary RPV injection strategy on each unit uses hoses from the PDDP distribution header to connect to the "B" Fuel Pool Cooling (FC) emergency makeup line. A second hose then connects the FC emergency makeup line to the "B" Residual Heat Removal (RHR) drywell spray line which allows water injection into the RPV with the proper valve lineup. This path also allows for makeup to the suppression pool. The alternate core cooling strategy involves a similar strategy, using "A" train components of the same systems. This provides diverse injection paths into the RPV, as well as the suppression pool.

The licensee's strategy utilizes the hardened containment vent system (HCVS) to support core cooling and to maintain containment capability. The licensee plans to open the vent when the suppression chamber pressure reaches approximately 12 psig. The licensee's FIP timeline and supporting analysis shows that would occur approximately 5.4 hours after the event start. After

the vent is initially opened, the system valves would be cycled to maintain the suppression chamber pressure between 5 and 10 psig.

To support the Phase 2 strategy a portable FLEX DG will be deployed on each unit. The FLEX DG will power the necessary 125 Vdc and 250 Vdc battery chargers, as well as selected valves for injection and makeup.

3.2.1.3 Phase 3

According to the LaSalle FIP, the Phase 3 strategy would be to maintain and supplement/replace the Phase 2 equipment with Phase 3 equipment as needed. The Phase 3 equipment begins to arrive within 24 hours of NSRC notification. According to the licensee, the majority of the Phase 3 equipment can utilize the connection points established for the Phase 2 strategies.

3.2.2 Variations to Core Cooling Strategy for Flooding Event

In the licensee's FIP, Figure 2 states that the deployment location for the FLEX PDDP, including the hydraulically-driven submersible pumps, may be different for a flooding event. Otherwise, the FIP does not identify any variations in the strategy for 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

In the FIP, Section 2.3.1 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 takes suction from the CST or from the suppression pool. However, the CST is not seismically robust or protected from tornado/high wind hazards, so RCIC suction can be transferred to the suppression pool, a safety-related component located in primary containment. The RCIC system is located in the Reactor Building. According to the LaSalle Updated Final Safety Analysis Report (UFSAR) [Reference 29], Section 3.8.4.1, the Reactor Building is a Seismic Category I structure. In addition, the LaSalle UFSAR, Section 3.5.2.2, describes Seismic Category I buildings as being designed to withstand internal and external missiles, including tornado missiles. The top (refuel) floor of the Reactor Building could be exposed to tornado missiles, however Section 3.5.2.1 of the LaSalle UFSAR indicates that all potentially exposed safety-related components have been reviewed and determined to be acceptable. In addition, the RCIC system is designed as Seismic Category I equipment, as described in UFSAR Section 5.4.6.2.2.

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 ADS SRVs. These valves require dc control power from the station's batteries and pneumatic pressure for operation. The FIP, Section 3.1.4.3, states that seven of the 18 total SRVs are used for the ADS. These ADS valves are equipped with backup nitrogen bottles to ensure the valves will operate following the loss of the normal air supply. Additionally, the licensee has FLEX air compressors to provide pneumatic capability if the backup nitrogen bottles are exhausted. The SRVs are located in the in the Reactor Building, which is robust to all applicable hazards. As described in Table 3.2-1 of the LaSalle UFSAR, the ADS SRVs and 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, which includes provisions for reliable and rugged performance to ensure that it remains functional following a seismic event.

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 for LaSalle is to monitor instrumentation in the main control room (MCR) or remote shutdown panel 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 DGs. A more detailed evaluation of the instrumentation power supply is contained in Section 3.2.2.6 of this safety evaluation.

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

- RCIC Turbine Steam Inlet Pressure
- RPV Level (Wide Range)
- RPV Pressure
- Drywell Pressure
- Suppression Pool Pressure
- Suppression Pool Water Level

- Suppression Pool Water Temperature

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

In accordance with NEI 12-06, Section 5.3.3.1, guidelines for obtaining critical parameters locally should be provided for the plant operators. According to the licensee's FIP, LaSalle procedure LOA-FSG-001, "Loss of Vital Instrumentation," provides alternate methods for obtaining critical parameters if key parameter instrumentation is unavailable.

3.2.3.2 Thermal-Hydraulic Analyses

The licensee concluded that its mitigating strategy at LaSalle 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, LaSalle 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 subsequently in Section 3.4.4.2 of this safety evaluation.

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

To provide analytical justification for their mitigating strategies in response to Order EA-12-049, a number of licensees for BWRs and pressurized-water reactors (PWRs) completed analysis of the ELAP event using Version 4 of the MAAP code (MAAP4). Although MAAP4 and predecessor code versions have been used by 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 analyses with the TRACE code to obtain an independent assessment of the predictions of the MAAP4 code.

To support the NRC staff's review of the use of MAAP4 for ELAP analyses, in June 2013, EPRI issued a technical report entitled "Use of Modular Accident Analysis Program (MAAP) in Support of Post-Fukushima Applications" [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 for LaSalle, the NRC staff verified that the licensee's MAAP4 calculation, along with an associated addendum, addressed the limitations from the NRC staff's endorsement letter. The licensee utilized the generic roadmap and response template that had been developed by EPRI to support consistency in individual licensees' responses to the limitations from the endorsement letter. In particular, based upon review of the MAAP4 calculation documentation, the staff concluded that appropriate inputs and modeling options had been selected for the code parameters expected to have dominant influence for the ELAP event. The NRC staff further observed that the limitations imposed in the endorsement letter, particularly those concerning the RPV collapsed liquid level being maintained above the reactor core and the primary system cooldown rate being maintained within Technical Specification limits, were satisfied. Specifically, the licensee's analysis calculated that LaSalle 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, 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, maintaining the entire reactor core submerged throughout the ELAP event is consistent with the staff's expectation that the licensee's flow capacity for primary makeup (i.e., installed RCIC pump and, subsequently, FLEX PDDP) 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 LaSalle audit, 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 MAAP calculations assumed an initial seal leakage rate of 100 gpm at 1000 psig and also discussed the system response to the variation of seal leakage rate as a function of RPV pressure in the thermal-hydraulic simulation. The assumed leakage leakage can be compared to the 18 gpm leakage rate per recirculation pump seal specified in accordance with NRC Generic Letter 91-07, "GI-23, 'Reactor Coolant Pump Seal Failures' and its Possible Effect on Station Blackout" [Reference 49], plus additional primary system leakage equal to the Technical Specification limit of 25 gpm, resulting in a total expected leak rate of 61 gpm. Since the licensee assumed 100 gpm of leakage in their calculation, this additional margin gives confidence in the ability to maintain water level. The RCIC pump capability can accommodate the assumed leakage rate plus steam removal. In addition the FLEX PDDP pump capability of 600 gpm to the RPV (at a lower RPV pressure) provides significant margin to accommodate the projected leakage rates during the event.

Considering the above factors, the NRC staff concludes that the leakage rate assumed by LaSalle is reasonable based on the guidance provided in Generic Letter 91-07, and the conservative assumption of 100 gpm at 1000 psig. 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, LaSalle 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.

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 the LaSalle UFSAR, Section 4.3.2.4, the control rods provide adequate shutdown margin under all anticipated plant conditions, with the assumption that the highest-worth control rod remains fully withdrawn. LaSalle 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 analyzed by the licensee's existing shutdown margin calculation. Furthermore, the strategy 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 FLEX PDDP during Phase 2 to supply both units. The FLEX PDDP has two hydraulically-driven submersible pumps that provide suction head for the PDDP. When RCIC is no longer available, the FLEX PDDP is used to inject water into the RPV from the UHS. As described in FIP Section 2.3.4.6, the PDDP takes suction from the UHS downstream of the ice melt discharge line. The FLEX PDDP is rated at 4000 gpm at 150 psig, and the accompanying submersible pumps are each rated at 4000 gpm at 32 feet lift. According to the licensee's FIP, only one of submersible pumps is required to support the needed flow of the PDDP. To evaluate the PDDP capacity, the licensee performed hydraulic calculation L-003961, "FLEX Pump Sizing Hydraulic Calculation," Revision 1, to verify the volumetric flow rate and head needed to remove decay heat following a BDBEE. During the audit process the staff reviewed this calculation and confirmed that one FLEX PDDP 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 PDDP to confirm the evaluations of the pump staging locations, hose distance runs, and connection points as described in the hydraulic analysis and summarized in the FIP.

In the FIP, Section 2.3.7.1 states that two FLEX PDDPs are available, satisfying the need for a spare pump ("N+1", where "N" is the number of units on a site) because one pump, and one submersible pump can supply adequate flow to both units. The FLEX pumps described in this section are also used for SFP makeup and thus this flow is incorporated into the hydraulic analysis. According to Section 2.7 of the licensee's FIP, the PDDPs and submersible pumps are stored in a fully protected FLEX storage building (Building 23).

Based on the staff's review of the FLEX pumping capabilities at LaSalle, as described in the FIP and confirmed in the hydraulic analysis, 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 event. The electrical strategies described in the FIP for maintaining or restoring core cooling, containment capability, and SFP cooling, are generally integrated, and any differences for the containment and SFP cooling functions will be identified in Sections 3.3.4.4 and 3.4.4.4 of this safety evaluation.

During the first phase of an ELAP event, the licensee would rely on the safety-related Class 1E batteries to provide power to key instrumentation and applicable dc components. The LaSalle Class 1E station batteries and associated dc distribution systems are located within safety-related structures designed to meet applicable design basis external hazards. According to the licensee's FIP, procedures LOA-AP-101, "Unit 1, AC Power System Abnormal – Attachment K and N," and LOA-AP-201, "Unit 2, AC Power System Abnormal – Attachment K and N," direct operators to conserve dc power during the event by stripping non-essential loads. Operators will strip or shed unnecessary loads to extend battery life until backup power is available in Phase 2. According to the timeline in the licensee's FIP, the plant operators would commence load shedding of the station batteries within 5 minutes and will complete deep load shedding within approximately 4.5 - 5.5 hours from the initiating event.

As part of the mitigating strategies, the licensee is crediting the Class 1E 125 and 250 Vdc batteries (1DC07E, 1DC14E, 2DC07E, 2DC14E – 125 Vdc and 1DC01E, 2DC01E – 250 Vdc). Exide Technologies manufactured each battery. The 125 Vdc station batteries are model GNB NCN-17 with a nominal capacity of 141 ampere-hours (AH). The 250 Vdc station batteries are model GNB NCN-27 with a nominal capacity of 1945 AH. In their FIP, the licensee stated the station batteries could cope for at least 8 hours.

In order to confirm the licensee's FIP summary, the NRC staff reviewed the licensee's dc coping calculations L-003447, "LaSalle Units 1 and 2, 125VDC System Analysis," Revision 0, and L-003448, "LaSalle Units 1 and 2, 250VDC System Analysis," Revision 1, which verified the capability of the dc system to supply power to the required loads during the first phase of the LaSalle FLEX mitigation strategy plan for an ELAP. The licensee's calculation identified the required loads and their associated ratings (ampere (A) and minimum required voltage) and the non-essential loads that would be shed within 4.5 to 5.5 hours, as applicable, to ensure battery operation for at least 8 hours. Based on its review of the licensee's calculation, the NRC staff found that the Class 1E 125 and 250 Vdc batteries should have sufficient capacity to supply power for at least 8 hours.

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

The licensee's Phase 2 strategy includes repowering the Class 1E battery chargers within 6 hours after initiation of an ELAP to maintain the safety-related dc buses and other essential loads. The licensee's Phase 2 strategy relies on one portable 500 kW 480 Vac FLEX DG per unit. The licensee has a total of three 480 Vac 500 kW FLEX DGs. The 480 Vac FLEX DG would provide power to the 125 and 250 Vdc battery chargers, and other selected loads.

To confirm the FIP summary, the NRC staff reviewed licensee engineering changes (ECs) 396062, "FLEX U1 Primary Strategy – Electrical Install 480V Power Source to 480V SWGR Buses 135X, 135Y, 136X and 136Y from a Portable 480V Generator," Revision 5, and EC 396069, "FLEX U2 Primary Strategy – Electrical Install 480V Power Source to 480V SWGR Buses 235X, 235Y, 236X and 236Y from a Portable 480V Generator," Revision 4, single line diagrams, and the separation and isolation of the FLEX DGs from the emergency diesel generators (EDGs). Based on the NRC staff's review of ECs 396062 and 396069, the minimum required loads for the licensee's Phase 2 500 kW FLEX DG for Unit 1 and Unit 2 are 293 kW and 236 kW, respectively. The staff noted that the licensee took the FLEX cable lengths into consideration (i.e., ensured that the voltage drop did not exceed the minimum voltage required at the limiting component). Based on its review of the licensee's calculation, the NRC staff finds that a single 500 kW FLEX DG per unit is adequate to support the electrical loads required for the licensee's Phase 2 strategies. The staff also confirmed that licensee procedure LOA-FSG-002, "FLEX Electrical Strategy," Revision 8, provides direction for staging and connecting a FLEX DG to energize the electrical buses to supply required loads within the required timeframes.

For Phase 3, the licensee plans to continue the Phase 2 coping strategy with additional assistance provided from offsite equipment/resources. The offsite electrical equipment that will be provided by an NSRC includes four (two per unit) 1-megawatt (MW) 4160 Vac CTGs, two

(one per unit) 1100 kW 480 Vac CTGs, and distribution panels (including cables and connectors). The licensee plans to only utilize the 480 Vac CTGs and not the 4160 Vac CTGs. Based on the additional margin available due to the higher capacity (1100 kW) of the 480 Vac CTGs as compared to the Phase 2 FLEX DGs (500 kW), the NRC staff finds that the 480 Vac CTGs being supplied from an NSRC should have sufficient capacity and capability to supply the required loads.

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

3.2.4 Conclusions

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

3.3 Spent Fuel Pool Cooling Strategies

Guidance document NEI 12-06, Table 3-1 and Appendix C summarize an approach consisting of two separate capabilities for the SFP cooling strategies. This approach uses a portable injection source to provide the capability for: (1) makeup via hoses on the refueling floor capable of exceeding the boil-off rate for the design basis heat load; and (2) makeup via connection to SFP cooling piping or other alternate location capable of exceeding the boil-off rate for the design basis heat load. However, in JLD-ISG-2012-01, Revision 1 [Reference 7], the NRC staff did not fully accept this approach, and added another requirement to either have the capability to provide spray flow to the SFP, or complete an SFP integrity evaluation which demonstrates that a seismic event would have a very low probability of inducing a crack in the SFP or its piping systems so that spray would not be needed to cool the spent fuel. The evaluation must use the reevaluated seismic hazard described in Section 3.5.1 below if it is higher than the site's current safe shutdown earthquake (SSE). During the event, the licensee selects the SFP makeup method to use based on plant conditions. This approach also requires a strategy to mitigate the effects of steam from the SFP, such as venting the Reactor Building.

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 full core offload to the SFP is addressed in Section 3.11. According to the FIP, the licensee can provide the spray flow described in JLD-ISG-2012-01.

3.3.1 Phase 1

The licensee stated in its FIP that no actions are required during ELAP Phase 1 for SFP makeup because the time to boil is sufficient to enable deployment of Phase 2 equipment. 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 PDDP to supply water from the UHS to the SFP. The FLEX pump discharge can be routed to either the "A" or "B" FC emergency makeup system up to the refueling floor and then via portable hoses to the pool. Flow to the pool can be controlled on the refueling floor, but the licensee's FIP also states that flow can be established without refueling floor access. This capability is accomplished by installing a spool piece between the "B" RHR piping and the SFP cooling system and using those installed systems to provide a makeup flow path.

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.

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) the SFP cooling system is intact, including attached piping.

During the audit process the staff reviewed the licensee's calculation regarding habitability on the SFP refuel floor to confirm the licensee's FIP assertions regarding access during the postulated event. This calculation and the FIP indicate that boiling begins at approximately 12.1 hours during a normal, non-outage situation. The staff's review notes that the licensee's sequence of events timeline in the FIP indicates that operators will deploy hoses and spray nozzles as a contingency for SFP makeup within 12 hours from event initiation to ensure the SFP area remains habitable for personnel entry.

As described in the licensee's FIP, the licensee's Phase 1 SFP cooling strategy does not require any specific operator actions. However, the licensee does establish a ventilation path to cope with temperature, humidity and condensation from evaporation and/or boiling of the SFP that will eventually occur. Specifically, the operators are directed to open roof hatches and personnel doors and deploy portable fans in the Reactor Building to establish the ventilation path. The licensee's plan also has provisions to cut a hole in the Reactor Building roof if necessary.

The licensee's Phase 2 and Phase 3 SFP cooling strategy involves the use of the FLEX PDDP (or NSRC-supplied pump for Phase 3), with suction from the UHS, to supply water to the SFP, similar to the strategy employed for RPV makeup. The staff's evaluation of the robustness and availability of FLEX connection points for the FLEX pump are discussed in Section 3.7.3.1 of this safety evaluation. Furthermore, the staff's evaluation of the robustness and availability of the UHS for an ELAP event is discussed in Section 3.10.3 of this safety evaluation.

3.3.4.1.2 Plant Instrumentation

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

3.3.4.2 Thermal-Hydraulic Analyses

As described in Sections 2.5.1 and 2.5.6 of the FIP, for the normal operating heat load, the SFP will boil sometime after 12 hours. Further, Section 3.2 of the FIP describes the two bounding scenarios that were analyzed: (1) the maximum normal operating heat load, and (2) the maximum refueling heat load, which corresponds to a full core offload. The heat loads are listed in the table below.

	Heat Load	Time to Boil	Time to Uncovery
Case 1	27.38 million Btu/hour	12.1 hours	123 hours
Case 2	56.03 million Btu/hour	5.86 hours	60.1 hours

According to the licensee's FIP, LaSalle EC 392196, "Spent Fuel Pool Uncovery Time for Outage and Online Scenarios," determined that an SFP boil off rate of approximately 121 gpm corresponds to Case 2. Since the FLEX PDDP 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 licensee's FIP, the SFP cooling strategy relies on the same FLEX PDDP to provide SFP makeup during Phase 2 that is used for RPV and suppression pool makeup. In the FIP, Section 2.3.7 describes the hydraulic performance criteria (e.g., flow rate, discharge pressure) for the FLEX pump. During the audit process, the staff reviewed the licensee's hydraulic evaluation and concluded that the FLEX PDDP can provide the specified SFP makeup flow, in addition to the RPV and suppression pool makeup flows, as described in Section 3.2.3.5 of this safety evaluation. The staff also confirmed 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 the onsite FLEX pump were to fail. As stated above, the SFP makeup rate of 120 gpm and the SFP spray rate of 250 gpm (per unit) meet or exceed the projected rate necessary to maintain SFP level.

3.3.4.4 Electrical Analyses

The licensee's mitigating strategies for SFP cooling do not rely on electrical power except for power to SFP level instrumentation. The SFP level instrumentation is evaluated in Section 4.0 of this safety evaluation.

3.3.5 Conclusions

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

3.4 Containment Function Strategies

In order to evaluate FLEX strategies, the industry guidance document, NEI 12-06, Table 3-1, provides examples of acceptable approaches for demonstrating the baseline capability of the containment strategies to effectively maintain containment functions during all phases of an ELAP event. One such approach is for a licensee to perform an analysis demonstrating that containment pressure control is not challenged. The licensee's strategy at LaSalle is to use anticipatory venting of containment to maintain suppression chamber pressure less than or equal to 15 psig such that the peak suppression pool temperature remains below 250°F. Operation of the containment venting system will utilize plant batteries and compressed gas systems supplemented/replaced by FLEX equipment as needed. The staff finds that this is consistent with the guidance provided by NEI 12-06.

In order to evaluate the containment parameters, the licensee's FIP describes a containment evaluation, LAS-MISC-017, "MAAP Analysis to Support Initial FLEX Strategy," Revision 3. During the audit process the NRC staff reviewed this calculation and confirmed that it was based on the boundary conditions described in Section 2 of NEI 12-06. The calculation analyzed the strategy of venting the suppression chamber to maintain the suppression pool less than 250°F. It concluded that the containment parameters of pressure and temperature remain

well below the respective UFSAR Section 6.2, Table 6.2-1, design limits of 45 psig for both the drywell and suppression chamber, 340°F for the drywell, and 275°F for the suppression chamber. The calculation evaluated a time period of more than 72 hours. From its audit review of the calculation, the NRC staff noted that actions to maintain containment capability and the required instrumentation functions have been evaluated by the licensee, and are summarized below.

3.4.1 Phase 1

During Phase 1, primary containment integrity is maintained by normal design features of the containment, such as the containment isolation valves. With the containment isolated, the initial Phase 1 activity regarding the containment function is to monitor containment parameters. According to the licensee, drywell pressure, suppression chamber pressure, and suppression pool temperature will be available in the MCR via installed plant instrumentation powered by the safety-related batteries.

After the postulated loss of power occurs, the RCIC system automatically starts and injects water into the RPV. RCIC will remove some decay heat energy from the RPV and pump water to the RPV with RCIC turbine exhaust returning to the suppression pool. Decay heat from the reactor is absorbed by the reactor cooling water and is discharged through the SRVs to the suppression pool. The energy deposited to the containment is from radiative heat transfer of the RPV and connected piping, leakage from the reactor recirculation pump seals, SRV discharge to the suppression pool, RCIC turbine exhaust to the suppression pool, and RPV leakage other than the recirculation pump seals.

The suppression chamber is vented via the HCVS to remove decay heat from the containment and to prevent suppression pool temperature from exceeding 250°F. The HCVS is used to maintain suppression chamber pressure within its design limit and supports continued operation of RCIC for core cooling. According to the licensee's FIP, station emergency procedures are used to maintain containment parameters within limits.

3.4.2 Phase 2

The licensee's Phase 2 strategy involves the continuation of the Phase 1 actions. FLEX equipment will be available to replace/recharge the necessary batteries and to supply pneumatic power where it is required.

3.4.3 Phase 3

Phase 3 will continue Phase 2 actions and any necessary actions to reduce containment temperature and pressure will utilize existing plant systems restored by off-site equipment and resources.

3.4.4 Staff Evaluations

3.4.4.1 Availability of Structures, Systems, and Components

Below are the baseline assumptions for the availability of SSCs for maintaining containment functions during an ELAP.

3.4.4.1.1 Plant SSCs

Primary Containment

At LaSalle, the containment consists of a drywell and suppression chamber. According to the licensee's UFSAR, Section 3.8, the design of the primary containment considers loading combinations that include the SSE. The LaSalle UFSAR, Section 3.5.2.2, also describes Seismic Category I structures as being able to withstand postulated external or internal missiles which may impact them. The LaSalle UFSAR, Section 6.2.1.1.2 describes the drywell as a steel-lined, post-tensioned concrete vessel in the shape of a truncated cone having a base diameter of approximately 83 feet and a top diameter of 32 feet. The floor of the drywell serves both as a pressure barrier between the drywell and suppression chamber and as the support structure for the reactor pedestal and downcomers. The drywell houses the reactor and its associated auxiliary systems. The primary function of the drywell is to contain the effects of a design-basis recirculation line break and direct the steam released from a pipe break into the suppression chamber pool. The drywell is designed to resist the forces of an internal design pressure of 45 psig in combination with thermal, seismic, and other forces. Table 6.2-1 of the LaSalle UFSAR describes a drywell design temperature of 340°F.

The LaSalle UFSAR, Section 6.2.1.1.2, describes the primary function of the suppression chamber as providing a reservoir of water capable of condensing the steam flow from the drywell following design-basis recirculation line break and collecting the non-condensable gases in the suppression chamber air space. The suppression chamber is a stainless steel-lined post-tensioned concrete vessel in the shape of a cylinder with a minimum volume of water in the suppression chamber of 128,800 cubic feet. The suppression chamber is designed for the same internal pressure as the drywell in combination with the applicable thermal, seismic, and other forces. Table 6.2-1 of the LaSalle UFSAR describes a suppression chamber design temperature of 275°F.

Secondary Containment

According to the LaSalle UFSAR, Section 6.2.3, the Reactor Building encloses the reactor and its primary containment. The structure provides secondary containment when the primary containment is in service, and provides primary containment function when the primary containment is open, as during refueling or maintenance. The Reactor Building houses the refueling and reactor servicing equipment and the new and spent fuel storage facilities. The principal purpose of the secondary containment is to confine the leakage of airborne radioactive materials from the primary containment and provide a means for a controlled, elevated release to the atmosphere. The Reactor Building is a Seismic Category I structure. Above the refueling floor elevation, the superstructure's metal siding and roof deck are not designed to withstand tornadoes. The Reactor Building below the refueling floor is designed to withstand postulated tornado-generated missiles as listed in the UFSAR, Section 3.5.1.4.

Hardened Containment Vent System

According to the licensee's FIP, the HCVS is designed and installed to meet the operational requirements of NRC Order EA-13-109 [Reference 51]. The HCVS permits venting the suppression chamber to the atmosphere. The HCVS system can be operated from either the MCR or from a remote operating station. Pneumatic supply to valves and dc power for instrumentation and controls are provided by nitrogen bottles and an HCVS battery located in the Auxiliary Building. Both can support system operation for at least 24 hours.

Residual Heat Removal (RHR) System

The RHR system piping and the FLEX PDDP are utilized to provide suppression pool makeup as described in Section 3.2.1 of this safety evaluation. The RHR system consists of two independent loops ("A" and "B"). Each RHR loop can provide FLEX water makeup to the RPV or to the suppression pool. The RHR valves in the flow path to the RPV or the suppression pool can be opened manually or electrically if power is available from the portable FLEX DG. The RHR system is classified as Seismic Category I and is located in the Reactor Building where it is protected from wind-generated missiles.

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 the appropriate MCR instrumentation would be available due to the coping capability of the station batteries in Phase 1, or the portable FLEX DGs deployed in Phase 2. If no ac or dc power was available, the FIP states that key credited plant parameters, including these containment parameters, would be available using alternate methods.

Instruments credited for the containment FLEX strategy are:

Drywell Pressure (MCR),
Suppression Pool Pressure (MCR)
Suppression Pool Water Level (MCR)
Suppression Pool Water Temperature (MCR)

In addition to these indications, the licensee's FIP states that Operating Abnormal Procedure, LOA-FSG-001, "Loss of Vital Instrumentation," provides guidance for obtaining instrument readings by alternate methods.

Based on this information, the NRC staff concludes that the licensee should have the ability to appropriately monitor the key containment parameters as delineated in NEI 12-06, Table 3-1.

3.4.4.2 Thermal-Hydraulic Analyses

The MAAP4 computer code evaluations were used to simulate ELAP conditions for LaSalle. Several MAAP cases were run to analyze methods of containment heat removal, including containment venting strategies, to control containment heat up and pressurization. Using the FLEX strategies developed, the licensee's FIP states that the MAAP cases show that primary containment temperature and pressure will remain below containment design limits during the

analyzed event. The anticipatory containment venting strategy is used while RCIC is injecting into the RPV to extend the time that RCIC is available. Once RCIC is no longer available, the HCVS is used to control primary containment pressure less than the primary containment pressure limit.

The licensee's FIP describes the analysis case evaluating the containment response including the following key features:

- Nominal reactor power level is 3546 MW-thermal
- RCIC automatically starts on low-low reactor water level and injects to the RPV from the suppression pool suction to recover RPV water level to -30" to +50".
- SRVs are operated consistent with EOP guidance to a RPV pressure band of 150 – 250 psig while RCIC is in service.
- Containment venting using the HCVS system occurs when suppression chamber pressure exceeds 12 psig.
- The HCVS is cycled to maintain suppression chamber pressure between 5 psig and 10 psig.
- Makeup to the suppression pool from the FLEX pump begins when the NPSH [net positive suction head] curve for RCIC is exceeded.
- The reactor coolant leakage is 100 gpm.

The results indicate the peak drywell pressure will be 16.5 psig at a temperature of 261°F. The peak suppression chamber pressure is calculated to be 12.5 psig with an airspace temperature of 261°F, and a peak suppression pool temperature of 239°F.

The NRC staff reviewed the licensee's MAAP calculation as described in Section 3.2.3.2 of this safety evaluation. In addition, the staff confirmed that the calculated primary containment parameters remain below the design parameters presented in the UFSAR. Thus, the staff concludes that the licensee has adequately demonstrated that there is sufficient margin before a containment limit would be reached.

3.4.4.3 FLEX Pumps and Water Supplies

Makeup water can be added to the suppression pool from the FLEX pump through the RHR piping. This will be done as a "batch feed" process as needed based on the indicated suppression pool water level and water temperature. The staff evaluated the ability of the licensee's FLEX pump to provide the needed flow in Section 3.2.3.5 of this safety evaluation and found it to be sufficient.

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 integrity using normal design features of the containment, such as the containment isolation valves and the HCVS. The MCR indication for containment pressure and temperature is available for the duration of the event. The licensee's strategy to repower instrumentation using the Class 1E station batteries 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 installed HCVS has one dedicated 125 Vdc battery and battery charger to supply both units.

The licensee's Phase 2 coping strategy is to continue monitoring containment pressure and temperature using installed instrumentation and maintaining containment integrity. The licensee's strategy to repower instrumentation using a 500 kW FLEX DG is identical to what was described in Section 3.2.3.6 of this safety evaluation and is adequate to ensure continued containment monitoring. The licensee also plans to repower the HCVS battery charger utilizing the 500 kW FLEX DG. The staff's audit review of licensee ECs 396062 (Unit 1) and 396069 (Unit 2), as previously described, shows that the addition of the HCVS battery charger is within the limit of the FLEX DG. The licensee would transition to Phase 2 prior to depleting the HCVS battery (i.e., within 24 hours). During the audit process, the staff also confirmed that licensee procedure LOA-FSG-002 provides guidance to place the HCVS battery charger in service and power them from the FLEX DG.

The licensee's Phase 3 strategy is to continue its Phase 2 strategy throughout the event. The site will receive offsite resources and equipment from an NSRC within approximately 24 - 72 hours after the onset of an ELAP event. Given the capacity of the 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 containment capability indefinitely.

Based on its review, the NRC staff concludes that the electrical equipment available onsite (e.g., Class 1E batteries, HCVS battery, and 500 kW FLEX DGs) 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 or restore 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* Part 50, 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 52]. The MBDBE rule would make the intent of Orders EA-12-049 and EA-12-051 generically applicable to all present and future power reactor licensees, while also requiring that licensees consider the reevaluated hazard information developed in response to the 50.54(f) letter.

The NRC staff requested Commission guidance related to the relationship between the reevaluated flooding hazards provided in response to the 50.54(f) letter and the requirements for Order EA-12-049 and the MBDBE rulemaking (see COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards" [Reference 50]). The Commission provided guidance in an SRM to COMSECY-14-0037 [Reference 28]. The Commission approved the staff's recommendations that licensees would need to address the reevaluated flooding hazards within their mitigating strategies for BDBEEs, and that licensees may need to address some specific flooding scenarios that could significantly impact the power plant site by developing scenario-specific mitigating strategies, possibly including unconventional measures, to prevent fuel damage in reactor cores or SFPs. The NRC staff did not request that the Commission consider making a requirement for mitigating strategies capable of addressing the reevaluated flooding hazards be immediately imposed, and the Commission did not require immediate imposition. In a letter to licensees dated September 1, 2015 [Reference 41], 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 the site seismic and flood hazards as requested in the NRC's 50.54(f) letter. After the NRC staff approves the reevaluated hazards, licensees will use this information to perform flood and seismic mitigating strategies assessments (MSAs) per the guidance in NEI 12-06, Revision 2[1], Appendices G and H [Reference 6]. The NRC staff endorsed Revision 2 of NEI 12-06 in JLD-ISG-2012-01, Revision 1 [Reference 7]. The licensee's MSAs will evaluate the mitigating strategies described in this safety evaluation using the revised seismic hazard information and, if necessary, make changes to the strategies or equipment. The licensee has performed MSAs for seismic and flooding [References 55 and 44, respectively]. These MSAs have been assessed by the NRC staff [References 56 and 45, for seismic and flooding, respectively].

1. The seismic MSA for LaSalle was submitted in accordance with NEI 12-06, Revision 4 (ADAMS Accession No. ML16354B421), as endorsed by the NRC in JLD-ISG-2012-01, Revision 2 (ADAMS Accession No. ML17005A188). The NRC staff notes that for seismic Path 4 plants such as LaSalle, there are no significant technical differences between NEI 12-06, Revisions 2 and 4.

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, the SSE. As described in UFSAR Section 3.7, the SSE seismic criteria for the site is two-tenths of the acceleration due to gravity (0.20g) peak horizontal ground acceleration. 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 described above, is often used as a shortened way to describe the hazard. The licensee has appropriately screened in this external hazard and identified the hazard levels to be evaluated.

In order to assess the reevaluated seismic hazard the licensee submitted an MSA to the NRC on October 28, 2016 [Reference 55]. The purpose of the MSA was to review the FLEX strategies against the reevaluated seismic hazard to determine whether the FLEX strategies developed in accordance with Order EA-12-049 can be implemented considering the impacts of the reevaluated seismic hazard. For LaSalle, the reevaluated seismic hazard exceeds the SSE in certain frequency ranges. The licensee's MSA concluded that for the reevaluated hazard levels, the FLEX strategy would be capable of being implemented and deployed, as designed, and would thus not have to be modified to account for the reevaluated hazard. By letter dated August 14, 2018 [Reference 56], the NRC staff concluded that the licensee's plans for the development and implementation of guidance and strategies under Order EA-12-049 appropriately address the reevaluated seismic hazard information. Based on the FIP description and the MSA review, the staff concludes that the licensee has appropriately reviewed this external hazard and identified the hazard levels to be evaluated.

3.5.2 Flooding

In its FIP, the licensee described that the current design basis for the limiting site flooding event is a local Probable Maximum Precipitation (PMP) event at the plant site. A Probable Maximum Flood (PMF) event on the Illinois River is not postulated since the plant floor elevation of 710.5 feet mean sea level is 188 feet higher than the PMF river flood level, plus wave run-up. According to the licensee's FIP, the site is considered to be a "dry site" with respect to Illinois River flooding. This is consistent with the description of the site in the LaSalle UFSAR, Section 2.4. In addition, the licensee's FIP states that the design-basis PMP event with antecedent conditions on the cooling lake, as well as local PMP event, were reviewed for consideration in the FLEX strategy development. The licensee concluded that LaSalle is a "dry site" with respect to these flooding mechanisms as well. 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 a MSA to the NRC on October 28, 2016 [Reference 44]. The purpose of the MSA was to review the FLEX strategies against flooding mechanisms that were not bounded by the design basis. For LaSalle, this was the local intense precipitation (LIP) and probable maximum storm surge flood causing mechanisms. The licensee's MSA concluded that for the reevaluated hazard levels, the FLEX strategy would be capable of being implemented and deployed as designed, and would not

have to be modified to account for the reevaluated hazard. By letter dated January 11, 2017 [Reference 45], the NRC staff concluded that the FLEX strategies at LaSalle, including deployment, were not affected by the impacts of the reevaluated flooding hazard. Based on the FIP description and 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 <u>High Winds</u>

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

The screening for high wind hazards associated with hurricanes should be accomplished by comparing the site location to NEI 12-06, Figure 7-1 (Figure 3-1 of U.S. NRC, "Technical Basis for Regulatory Guidance on Design Basis Hurricane Wind Speeds for Nuclear Power Plants," NUREG/CR-7005, December 2009); if the resulting frequency of recurrence of hurricanes with wind speeds in excess of 130 miles per hour (mph) exceeds 1E-6 per year, the site should address hazards due to extreme high winds associated with hurricanes using the current licensing basis for hurricanes.

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

According to the LaSalle UFSAR Section 2.1.1, the site location is at 41° 14' 44" North latitude and 88° 40' 06" West longitude. Based on that location, NEI 12-06 Figure 7-2, "Recommended Tornado Design Wind Speeds for the 1E-6/year Probability Level," indicates the site is in a region where the tornado design wind speed exceeds 130 mph. Therefore, the plant screens in for an assessment for high winds and tornados, including missiles produced by these events. The LaSalle UFSAR, Section 2.3.1.2.2, lists the following tornado design parameters: (1) maximum translational wind speed - 60 mph, (2) maximum rotational wind speed - 300 mph, and (3) external pressure drop - 3 psi in 3 seconds. In addition, the design wind velocity for the site is 90 mph. In terms of tornado missiles, the LaSalle UFSAR, Section 3.5.1.4, lists the following design missiles:

Missile	Physical Properties	Impact Velocity (mph)
Wood Plank	4 inch x 12 inch x 12 feet	225
Automobile (4000 pounds)	20 square feet front area	50
Steel Rod	1 inch outside diameter, 3 feet long, 8 pounds	216 horizontally 175 vertically
Utility Pole	13-½ inch outside diameter, 35 feet long, 1490 pounds	144 horizontally 116 vertically

The licensee's FIP states that LaSalle is not susceptible to hurricanes due to location. The NRC staff notes that the site is beyond the range of high winds from a hurricane per NEI 12-06, Figure 7-1. The NRC staff concludes that a hurricane hazard is not applicable and need not be addressed, consistent with the licensee's assessment.

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

3.5.4 Snow, Ice, and Extreme Cold

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

According to the LaSalle UFSAR, Section 2.1.1, the site location is at 41° 14' 44" North latitude and 88° 40' 06" West longitude. In addition, the licensee's FIP states that the site is located within the region characterized by NEI 12-06, Figure 8-2, as ice severity level 5. Consequently, the site is subject to extreme icing conditions that could cause catastrophic damage to electrical transmission lines. In its FIP, the licensee stated that the lowest recorded temperature at nearby Ottawa, Illinois was -26°F, with minimum temperatures in the site vicinity falling below 0°F several times each winter. The licensee's FIP also states that the LaSalle UFSAR lists a design snow loading of 83.2 pounds per square foot for the safety-related building roofs. 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 LaSalle UFSAR, Section 2.3.1.1, the highest recorded temperature at nearby Ottawa, Illinois, was 112°F and that summer temperatures reach 90°F or more nearly 20 times per year.

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

3.5.6 Conclusions

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

3.6 Planned Protection of FLEX Equipment

3.6.1 Protection from External Hazards

According to the licensee's FIP, two robust buildings were constructed to protect the "N" equipment at LaSalle. The two buildings are referred to as a 60' x 90' protected (robust) building (Building 22) located outside the power block, and a 30' x 40' protected (robust) building (Building 23) located near the UHS. In addition, a 50' x 60' commercial (non-robust) storage building (Building 24) was built inside the protected area to store some of the licensee's "N+1" FLEX equipment.

The larger robust FLEX storage structure (Building 22) is used to protect and house much of the equipment that will be needed to support the FLEX strategy. According to the licensee's FIP, the structure is designed to meet the requirements specified in NEI 12-06, Revision 2, and any specific LaSalle requirements. External hazards that exceed the minimum requirements of typical local building codes, but are specifically required by NEI-12-06, Revision 2 are: tornado, seismic, flood, wind, temperature, and snow/ice. The 30' x 40' robust FLEX building (Building 23) is built to the same design standards as Building 22. In general, this storage facility houses the "N" and "N+1" PDDPs and support equipment. According to the licensee's FIP, all FLEX "N" equipment credited for implementation of the FLEX strategies at LaSalle is either stored in a robust FLEX Building or in a plant structure that meets the station's SSE design bases, such as the Reactor Building and Auxiliary Building. The licensee's FIP states that all actions required to access and deploy the FLEX equipment can be accomplished manually (without the need for ac power).

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 2, a robust structure means that the design either meets the current plant design basis for the applicable external hazard(s) or the current NRC design guidance for the applicable hazard; or has been shown by analysis or test to meet or exceed the current design basis. Therefore, the licensee's two "N" FLEX Buildings (Buildings 22 and 23) must protect the equipment stored within from an earthquake at the design basis (SSE) level such that the equipment survives the event and is subsequently deployable. In order to confirm the licensee's FIP statements regarding the robustness of the two "N" storage facilities, the NRC staff reviewed the design packages for the two buildings during the audit process. Specifically the staff reviewed EC 389688, "Installation of 60' x 90' FLEX Robust Storage Structure Inside PA Building 22," Revision 3, and EC 389689, "Installation of 30' x 40' FLEX Robust Storage Structure Outside PA Building 23," Revision 2, to confirm the designed seismic capability of these structures.

According to the licensee's FIP, for both of the robust storage buildings, equipment spacing is credited during a seismic event to preclude seismic interaction that could cause damage to the FLEX equipment. Where a specific piece of equipment could not be credited based on spacing, tie-downs are used. Tie-downs are used on all applicable equipment in the building as an additional barrier to seismic interaction.

Based on the FIP description of the storage buildings, confirmed by the audit review, the NRC staff concludes that the licensee's protection of FLEX equipment adequately accounts for seismic considerations. In addition, the NRC staff's evaluation of the licensee's mitigating strategies assessment [Reference 56] concluded that the licensee's FLEX strategies were adequately protected from the reevaluated seismic hazard.

3.6.1.2 Flooding

As previously discussed in this safety evaluation, LaSalle 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 flooding conditions. Based on the FIP description of the design-basis flooding levels and the "dry site" description, the NRC staff concludes that the licensee's protection of FLEX equipment adequately accounts for flooding considerations. In addition, the NRC staff's evaluation of the licensee's mitigating strategies assessment [Reference 45] concluded that the licensee's FLEX strategies were adequately protected from the reevaluated flooding hazards, for those mechanisms where the reevaluated elevations exceeded the design-basis elevation (LIP and storm surge).

3.6.1.3 High Winds

According to NEI 12-06, Revision 2, a robust structure means that the design either meets the current plant design basis for the applicable external hazard(s) or the current NRC design guidance for the applicable hazard; or has been shown by analysis or test to meet or exceed the current design basis. Therefore, the licensee's two "N" FLEX Buildings (Buildings 22 and 23) 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. In order to confirm the licensee's FIP statements regarding the robustness of the two "N" storage facilities, the NRC staff reviewed the design packages for the two buildings during the audit process. Specifically, the staff reviewed EC 389688, "Installation of 60' x 90' FLEX Robust Storage Structure Inside PA Building 22," Revision 3, and EC 389689, "Installation of 30' x 40' FLEX Robust Storage Structure Outside PA Building 23," Revision 2, to confirm the design high wind/missile capability of these structures.

3.6.1.4 Snow, Ice, Extreme Cold and Extreme Heat

According to NEI 12-06, Revision 2, a robust structure means that the design either meets the current plant design basis for the applicable external hazard(s) or the current NRC design guidance for the applicable hazard; or has been shown by analysis or test to meet or exceed the current design basis. Therefore, the licensee's two "N" FLEX Buildings (Buildings 22 and 23) must provide protection from snow, ice, cold, and heat consistent with the design basis. In addition, according to the licensee's ninth six-month update dated August 28, 2017 [Reference 19], the licensee stated that Exelon will incorporate provisions for snow, ice, extreme cold, and high temperatures into the storage protection plan at LaSalle. In order to confirm the licensee's FIP and ninth six-month update statements, the NRC staff reviewed the licensee's site program plan, CC-LA-118-1001, "Site Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program," Revision 5, during the audit process. This document indicates that the large diesel-driven equipment that can be susceptible to extreme cold weather is outfitted with battery chargers/tenders and onboard heating equipment, as necessary, to ensure their starting capability even if the building heating system is inoperable for some period of time. Otherwise, the installed building heating systems

are capable of maintaining acceptable temperature conditions in the winter and the ventilation system will maintain acceptable temperature conditions in the summer.

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 DGs, the FLEX PDDPs, hoses and cables, and the water manifolds. For the FLEX DGs, the licensee's strategy uses one DG per unit with a third DG available as a spare to meet the "N+1" criteria. The two "N" DGs are stored in the larger robust storage building and the "N+1" DG is stored in the commercial building. This meets the provisions of NEI 12-06, Revision 2, as long as the out-of-service provisions as described in Section 3.13 of this safety evaluation are met. Regarding the FLEX PDDPs, one pump is sufficient to supply both units. Both the "N" and "N+1" pumps are stored in the smaller robust FLEX building and thus the licensee's storage plan for these pumps meets the "N+1" provisions of NEI 12-06. The licensee uses "wye" connectors as spares for the water manifolds. This provides the same functionality as the manifolds and, and as long as properly stored, meets the "N+1" provision of NEI 12-06, Revision 2. For hoses and cables, NEI 12-06, Revision 2, incorporates a provision that spare capability must be in place such that either: (1) 10 percent of the total length, or (2) sufficient spare cabling to replace the longest run of individual hose and cable lengths, must be available. According to the licensee's FIP, the licensee satisfies the spare hoses and cables provision of NEI 12-06, Revision 2.

Based on the number of portable FLEX pumps, FLEX DGs, and support equipment identified in the FIP, the NRC staff finds that, if implemented appropriately, the licensee's FLEX strategies include a sufficient number of portable FLEX pumps, FLEX DGs, and equipment for RPV makeup and core cooling, SFP makeup, and maintaining containment consistent with the "N+1" recommendation in Section 3.2.2.16 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 DGs (one per unit) and the FLEX PDDP(s) (one pump for both units). According to the licensee's FIP, the portable FLEX DGs will be moved from the FLEX storage

location (Building 22) using a Kubota tractor or the F-750 truck. The same vehicles will be used to position the associated cable trailers. The FLEX PDDP pump(s), and support equipment, are stored in Robust FLEX Storage Building 23 on the north shore of the UHS. A battery powered trailer moving device called a "Tugger" is used to move the FLEX PDDP(s) from the building to the pad near the water where they are deployed. The "Tuggers" are stored in the FLEX storage buildings (1 each in all three buildings).

3.7.1 Means of Deployment

According to the licensee's FIP, debris removal equipment such as the FLEX tractors and F-750 truck are stored inside robust FLEX Building 22 in order to be reasonably protected from external events such that the equipment will remain functional and deployable to clear obstructions from the pathway between the storage and deployment locations. The licensee states that the equipment is stored in a manner to facilitate the deployment sequence. In addition, FLEX debris removal hand tools are also available. According to the license's FIP, deployment of the FLEX debris removal equipment from the storage location is not dependent on off-site power and all actions required to access and deploy debris removal equipment and FLEX equipment can be accomplished manually.

3.7.2 Deployment Strategies

The licensee has pre-determined staging locations and deployment routes for the major pieces of FLEX equipment such as the FLEX PDDPs and FLEX DGs. In addition, deployment paths and staging areas are contained in the snow removal plan. Additionally, the haul paths are checked monthly for possible obstructions via a monthly surveillance, as well as after an event via a FLEX support guideline (FSG).

According to the license's ninth six-month update, a liquefaction study has been performed which evaluates the planned deployment paths and storage locations. During the audit process the staff reviewed this analysis, L-004000, "Evaluation of Liquefaction Potential for BDBEE FLEX Staging Area and Equipment Deployment Paths," Revision 0, to confirm the liquefaction review. The analysis concludes that all haul path areas are not susceptible to liquefaction with the exception of one localized area near the deployment path associated with FLEX Building 22. The analysis stated that the vertical settlement resulting from liquefaction in this area could be approximately 2 inches. The licensee stated that the mobile FLEX equipment vehicles have more than sufficient capacity to traverse this magnitude of localized roadway depressions, should they appear following a seismic event.

According to the licensee's FIP, the submersible hydraulically driven pumps which supply the PDDP are placed in the UHS downstream of the station's ice melt line discharge, thus ensuring open water in winter months.

3.7.3 Connection Points

3.7.3.1 Mechanical Connection Points

Core Cooling

In the FIP, Section 2.3.2 describes the primary and alternate core cooling connection points for the FLEX PDDP. The FLEX PDDP will supply water to the connection points via a combination

of portable hose and underground buried piping. The hose will be routed into the Reactor Building through a 10" penetration in the Unit 1 DG Corridor vestibule for Unit 1 and the Unit 2 DG Corridor to the Unit 2 Reactor Building air lock. The primary connection is located on the "B" FC emergency makeup pump discharge pipe on the 710'-6" level. Water is then routed up to the 761' level using the installed FC emergency makeup piping where a temporary hose is connected to the "B" RHR system. Flow is then directed to the RPV and the suppression pool using the "B" low pressure coolant injection path (or the "B" shutdown cooling return) and "B" suppression chamber spray path (or the "B" RHR full flow test valve), respectively. The alternate connection uses a similar flow path but connects to the "A" train of FC emergency makeup and RHR. The RHR and FC emergency makeup systems are listed as Seismic Category 1 in the LaSalle UFSAR, Table 3.2-1. The connections are located in the Reactor Building which is a seismic and missile-protected structure. Based on the licensee's FIP description and the LaSalle UFSAR, the staff concludes that the mechanical connection points for the FLEX PDDP are robust and should be available following a BDBEE.

The licensee's FIP describes the initial conditions and assumptions described in NEI 12-06, noting that installed systems that are robust may be assumed to be available to support the FLEX strategies. The buried piping section and hardened hose station included in the licensee's strategy were installed in accordance with a site EC package. In order to confirm the licensee's use of these components in the FLEX strategy as robust components the staff reviewed EC 398941, "FLEX-Buried Water and Diesel Pipe, Road Improvements and Railroad Track Removal," Revision 2. The design package specifies that the buried piping and hardened hose stations have been seismically qualified and are protected from tornado missiles. The EC also notes that the buried pipe can be bypassed using temporary hose if unavailable. Thus, the staff concludes that the buried piping and hardened hose stations should be available for use following a BDBEE.

SFP Cooling

In the FIP, Section 2.5.2 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 to the "A" or "B" FC emergency makeup piping on the refueling floor and can be routed directly into the pool. Furthermore, an alternate strategy using a SFP makeup path from the "B" RHR system that requires installation of a RHR to FC system spool piece is included in the licensee's plan. The staff notes that the LaSalle UFSAR classifies the FC emergency makeup system as Seismic Category I.

Given the design and location of the primary and alternate connection points, as described in the FIP and UFSAR, the staff concludes that at least one of the connection points should be available to support core and SFP cooling via a portable pump during an ELAP caused by an external event, consistent with NEI 12-06 Section 3.2.2. 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 strategy is to supply power to equipment required to maintain or restore core cooling, containment, and SFP cooling using a combination of permanently installed and portable components.

The licensee's FLEX strategy to re-power the station's battery chargers requires the use of a single 500 kW, 480 Vac FLEX DG per unit. A total of three FLEX DGs are available, but only one is required per unit. The third FLEX DG satisfies the "N+1" provision of NEI 12-06. The deployed FLEX DG location for Unit 1 is south of the Unit 1 main power transformer (MPT) and north of the Unit 2 MPT for Unit 2. For the primary electrical strategy, the FLEX DGs are connected to FLEX primary distribution panels in the Unit 1 DG corridor vestibule and the Unit 2 DG corridor to Reactor Building air lock. For the alternate electrical strategy, the FLEX DGs will be deployed to the same location as the primary strategy. The FLEX DGs will be connected to 480 Vac mobile distribution panels. The 480 Vac mobile distribution panels are stored in the DG corridor (Unit 1) and in the Auxiliary Building at elevation 710'-6" (Unit 2). The 480 Vac Mobile Distribution Panels provide connection points to power the 125 Vdc Division I and Division II battery chargers, and the 250 Vdc battery chargers.

According to the licensee's FIP, procedure LOA-FSG-002 provides direction for staging and connecting a 500 kW FLEX DG to energize the LaSalle electrical buses. During the audit process the NRC staff confirmed that the licensee performed phase rotation checks during post modification testing to ensure proper phase rotation existed between the FLEX DGs and LaSalle electrical buses. In addition, the connections and cables are color coded to ensure that proper phase rotation is maintained.

For Phase 3, the licensee plans to only connect the 480 Vac CTGs and not the 4160 Vac CTGs. The 480 Vac CTGs would be deployed in the vicinity of the 480 Vac FLEX DGs. Licensee procedure LOA-FSG-013, "Long-Term FLEX Recovery Actions," Revision 2, provides guidance for connecting the 480 Vac CTGs to the LaSalle electrical buses. This procedure states that licensee staff will coordinate with the MCR before swapping the Phase 2 FLEX DG with an NSRC CTG. The NRC staff expects that this coordination would include verification of proper phase rotation when connecting any NSRC CTG to the LaSalle electrical distribution system.

3.7.4 Accessibility and Lighting

According to the licensee's FIP, portable lighting available for use during a FLEX event includes:

- Hardhat lights
- Flashlights
- Safe Shutdown Flashlights
- Lights on cable trailers powered by generators on the trailers
- 10 foot PRISM (inflatable) lights (in plant) powered by FLEX spider boxes
- 14 foot PRISM (inflatable) lights (in plant) powered by FLEX spider boxes

In addition, the FIP states that FLEX actions required in the first 6 hours can be completed by operators with flashlights, hardhat lights, and dc emergency lighting that remains energized. After the first 6 hours of the event, when additional resources are available from offsite, the licensee has pre-established a set of locations for the deployment of supplemental lighting.

Additionally, the licensee's FIP notes that additional lighting may be available during a FLEX event including: eight-hour emergency lighting battery packs (ELBPs), portable FLEX generators repowering some ELBPs, or portable FLEX generators repowering some permanently installed lighting.

3.7.5 Access to Protected and Vital Areas

According to the licensee's FIP, all actions required to access and deploy FLEX equipment can be accomplished manually. During the audit process, the staff confirmed that the licensee has the ability to provide vehicular access to the protected area without ac power being available and that the licensee has contingencies in place to provide access to areas required for the ELAP response if the normal access control systems are without power.

3.7.6 Fueling of FLEX Equipment

In its FIP, Section 2.9.3, the licensee states that a LaSalle procedure directs operators to refuel the FLEX equipment using various identified fuel oil sources, including the five EDG day tanks, the five EDG fuel storage tanks, and some non-robust tanks, if available. The LaSalle UFSAR, Table 3.2-1, classifies the EDG day tanks and storage tanks as Seismic Category I. The FIP lists the following volumes available in the EDG day tanks and fuel oil storage tanks:

Day tanks: "0, 1A, and 2A" EDGs – 750 gallons each; "1B" and "2B" EDGs – 1000 gallons each

Storage Tanks: "0, 1A, and 2A" EDGs – 40,000 gallons each; "1B" and "2B" EDGs – 30,000 gallons each

The licensee will deploy a FLEX trailer mounted tank with a capacity of 390 gallons to transfer fuel from the any of the above tanks to refuel portable equipment. LaSalle also has two, 118-gallon fuel tanks mounted on the FLEX Truck F-750. Based on the design and location of these available fuel oil tanks and their protection from hazards, the staff finds the Seismic Category I 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 100,000 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 fuel oil study, EC 400694, "FLEX Diesel Fuel Oil Study," Revision 0, during the audit process. This study found that the total FLEX equipment consumption for the first 72 hours is around 9000 gallons. Given this fuel demand and the large amount of available fuel, the staff concludes LaSalle 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 LaSalle SAFER Plan

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

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

By letter dated September 26, 2014 [Reference 46], the NRC staff issued its assessment of the NSRCs established in response to Order EA-12-049. In its assessment, the staff concluded that SAFER has procured equipment, implemented appropriate processes to maintain the equipment, and developed plans to deliver the equipment needed to support site responses to BDBEEs, consistent with NEI 12-06 guidance; therefore, the staff concluded in its assessment that licensees can reference the SAFER program and implement their SAFER response plans to meet the Phase 3 requirements of Order EA-12-049.

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

3.8.2 Staging Areas

In general, up to four staging areas for NSRC-supplied Phase 3 equipment are identified in the SAFER plans for each reactor site. These are a Primary (Area "C") and an Alternate (Area "D"), if available, which are offsite areas (within about 25 miles of the plant) utilized for receipt of ground transported or airlifted equipment from the NSRCs. From Staging Areas "C" and/or "D", the SAFER team will transport the Phase 3 equipment to the on-site Staging Area "B" for interim staging prior to it being transported to the final location in the plant (Staging Area "A") for use in Phase 3. Though not mentioned in the FIP, the LaSalle SAFER plan specifies the Braidwood Station owner controlled area as Staging Area "D". This location is approximately 25 miles east of the site (travel distance 28.6 miles). Staging Area "C" is the Pontiac Municipal Airport, approximately 25 miles south of the site (travel distance 43.7 miles). Staging Area "B" is the LaSalle site parking lot. Staging Area "A" corresponds to the various deployment locations for the FLEX equipment in the vicinity of the applicable plant buildings.

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

3.8.3 Conclusions

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

3.9 Habitability and Operations

3.9.1 Equipment Operating Conditions

3.9.1.1 Loss of Ventilation and Cooling

Following a BDBEE and subsequent ELAP event at LaSalle, ventilation that provides cooling to occupied areas and areas containing required equipment will be lost. Per the guidance given in NEI 12-06, FLEX strategies must be capable of execution under the adverse conditions (unavailability of installed plant lighting, ventilation, etc.) expected following a BDBEE resulting in an ELAP. The licensee's FIP states that LaSalle can cope indefinitely using the Phase 2 equipment in responding to the postulated ELAP with loss of normal access to the UHS.

The primary concern with regard to ventilation is the heat buildup which occurs with the loss of forced ventilation in areas that continue to have heat loads. The licensee performed loss of ventilation analyses to quantify the maximum steady-state temperatures expected in specific areas related to FLEX implementation to ensure that the environmental conditions remain acceptable such that the FLEX strategy can be implemented as planned.

The key areas identified by the licensee for all phases of execution of the FLEX strategy activities are the MCR, auxiliary electric equipment rooms (AEERs), switchgear rooms, battery rooms, RCIC pump rooms, and primary containment. In order to support the FIP assertions for indefinite coping in accordance with NEI 12-06, the licensee evaluated these areas to determine the temperature profiles following the postulated event. During the audit process, the staff reviewed the licensee's loss of ventilation evaluations as described below.

Main Control Room

The licensee performed calculation L-003969, "U1/U2 Transient Heat-Up Analysis for the Control Room, AEERs, Div. 1, Div. 2 Switchgear Rooms following a BDBEE," Revision 0, which modeled the transient temperature response in the MCR for 72 hours and determined what actions are needed to respond to the event. This calculation determined that the maximum MCR temperature at 72 hours would be 108°F, assuming that certain actions are taken. During the audit process the staff reviewed licensee procedure LOA-FSG-005, "Area Ventilation," Revision 5, which provides guidance to establish portable ventilation and open doors within 7 hours, consistent with the assumptions of the analysis. The staff notes that the procedure also provides guidance to restore MCR ventilation if there is operating margin available on the FLEX DG.

Based on MCR temperature remaining below 120°F (the temperature limit, as identified in NUMARC-87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," for electronic equipment to be able to survive indefinitely),

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.

Auxiliary Electric Equipment Rooms

Licensee calculation L-003969 modeled the transient temperature response for 72 hours in the AEERs. The temperature in the Unit 1 and Unit 2 AEERs exceeds 120°F at 46.5 and 46 hours, respectively. The temperature at 72 hours in the Unit 1 and Unit 2 AEERs would be 122.5°F and 123°F, respectively. The licensee's analysis used initial heat loads that were calculated for a station blackout event as compared to the lower heat loads that would be expected in a FLEX event due to the deeper load shed. In addition, the heat loads assumed for the time greater than 6 hours were the normal operating heat loads which are also conservative. The licensee's calculation does account for the opening of doors and portable fan deployment that occurs at 7 hours in this area.

Based on the conservative nature of the heat loads assumed in the licensee's analysis and the licensee's ventilation strategy (opening doors and establishing portable ventilation), the NRC staff finds that the calculated exceedance of the temperature limit by approximately 3 degrees in these areas should not adversely impact the FLEX strategy during the event. The staff also notes that between 24 - 72 hours into the event, the licensee would have additional personnel and equipment available to respond to any adverse environmental conditions.

Switchgear Rooms

Licensee calculation L-003969, modeled the transient temperature response for 72 hours in the switchgear rooms and determined what actions are needed to maintain equipment operability. The temperature in the Unit 1 Division 1 and Division 2 switchgear room at 72 hour is 117°F. The temperature in the Unit 2 Division 1 and Division 2 switchgear room at 72 hour is 117.5°F and 117°F, respectively.

Based on the above, the NRC staff finds that the licensee's ventilation strategy (opening doors and establishing portable ventilation) should maintain switchgear rooms temperature below 120°F (the temperature limit, as identified in NUMARC-87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors"). Therefore, the NRC staff finds that the electrical equipment located in the switchgear rooms will not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Class 1E Battery Rooms

Licensee calculation L-003969, modeled transient temperature response for 72 hours in the Class 1E station battery rooms and determined what actions are needed to maintain equipment operability. The temperature in the Unit 1 battery rooms at 72 hours is 119°F, 113.5°F, and 119.5°F. The temperature in the Unit 2 battery rooms at 72 hours is 114°F, 111°F, and 119°F. The staff confirmed during the audit process that licensee procedure LOA-FSG-005 provides guidance to establish portable ventilation and open doors within 7 hours to ensure indefinite coping of the equipment in these areas.

Based on the above, the NRC staff concludes that the licensee's ventilation strategy (establishing portable ventilation and opening doors) should maintain battery room temperature below the maximum temperature limit (120°F) of the batteries, as specified by the battery

manufacturer (Exide Technologies). Therefore, the NRC staff finds that the electrical equipment located in the battery rooms will not be adversely impacted by the loss of ventilation as a result of an ELAP event.

RCIC Area

According to the licensee's FIP, ventilation is established in the RCIC rooms to support RCIC survivability during the postulated event. In order to confirm the FIP description, the NRC staff reviewed calculation ATD-0351, "RCIC Pump Room Temperature Transient Following Station Blackout with Gland Seal Leakage," Revision 3, and EC 392331 Attachment A, "FLEX RCIC/HPCI GOTHIC Analysis," Revision 0, during the audit process. The licensee's evaluation shows that RCIC room temperature increases steadily and reaches 169°F at approximately 13 hours into the event. The licensee identifies 169°F as the limit for the RCIC room, based on RCIC turbine governor control signal components. The calculation also shows that RCIC room temperature drops dramatically after portable ventilation at 5000 cubic feet per minute is provided and that this ventilation will stabilize the room temperature at approximately 132°F (below the limit) indefinitely. Therefore, the licensee's FIP indicates that procedural direction to establish the assumed airflow is contained in Operating Abnormal Procedure LOA-FSG-005, "Area Ventilation." The FIP states that actions to establish ventilation in the RCIC room are time sensitive and must be established within 11 hours. Based on the FIP description of the portable ventilation compensatory measure, confirmed by the audit review of the licensee's calculations and procedures, the staff concludes that the RCIC pump should be capable of operating, as assumed in the licensee's plan, with a loss of the normal ventilating system that would result from the ELAP conditions.

Containment

The licensee performed analysis LS-MISC-017, "MAAP Analysis to Support FLEX Initial Strategy," Revision 3, which modeled the transient temperature response in the containment for the first 72 hours. The calculation incorporated anticipatory venting of the suppression chamber at 15 psig. The results of the analysis showed that the peak drywell pressure will be 16.5 psig at a temperature of 261°F, the peak suppression chamber pressure will be 12.5 psig with an airspace temperature of 261°F. The peak suppression pool temperature is calculated to be 239°F. The containment parameters of pressure and temperature remain well below the respective UFSAR Section 6.2, Table 6.2-1 design limits of 45 psig for both the drywell and suppression chamber and 340°F for the drywell and 275°F for the suppression pool for more than 72 hours.

To assess equipment with electrical components located in the drywell, such as the SRV's, the staff reviewed the LaSalle UFSAR, Section 7.3.1.2.2.8 and Table 3.11-4. According to the UFSAR, the SRV's are qualified for environmental conditions that include a drywell temperature of greater than or equal to 250°F (as high as 340°F) for the first 24 hours after a postulated loss of coolant accident, which bounds the MAAP analysis for the ELAP event. Thus, the staff concludes that the SRVs should perform as intended in the licensee's plan.

Based on projected temperature profile, the ability to vent the suppression chamber via the HCVS system, and the eventual availability of offsite resources, the NRC staff finds that the electrical equipment in primary containment should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

The staff also notes that the licensee will receive offsite resources and equipment from an NSRC between 24 and 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 the appropriate equipment areas supporting the FLEX strategy to ensure that required electrical equipment survives indefinitely, beyond the 72 hour timeframe evaluated, if necessary.

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

3.9.1.2 Loss of Heating

The licensee's FIP states that the site has cold weather garments and foul weather gear, in various sizes, for responders to wear during foul weather conditions as needed when implementing the FLEX mitigating actions. This equipment is stored in the FLEX Storage Buildings, which are protected structures.

During the audit process, the staff noted that the LaSalle 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, these 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 are not expected to be sensitive to extreme cold conditions due to their location, the concrete walls isolating the rooms from the outdoors, and lack of forced outdoor air ventilation during the early phases of an ELAP event.

Based on the above, the NRC staff finds that LaSalle Class 1E station batteries should perform their required functions as a result of loss of normal heating during the postulated ELAP event.

3.9.1.3 Hydrogen Gas Control in Vital Battery Rooms

An additional ventilation concern that is applicable to Phases 2 and 3, is the potential buildup of hydrogen in the battery rooms as a result of loss of ventilation during an ELAP event. Off-gassing of hydrogen from batteries is only a concern when the batteries are charging. During the audit process the staff reviewed the licensee's hydrogen generation analysis VX-09, "Battery Rooms Hydrogen Concentration," Revision 12C. This calculation demonstrates that the limiting battery room's hydrogen concentration would be less than 2.0 percent during an ELAP event for at least 174 minutes (approximately 3 hours) after the batteries start charging when the FLEX DGs are deployed approximately 6 hours into the event. The licensee plans to establish portable ventilation and open doors to the battery rooms and procedure LOA-FSG-005 implements this action if normal battery room ventilation can't be restored. According to the licensee's FIP, the action is time sensitive and should be completed within 7 hours of the initiation of the event.

Based on its review of the licensee's battery room ventilation strategy, including the time-sensitive action to restore ventilation, the NRC staff finds that hydrogen accumulation in the

LaSalle 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

According to the licensee's FIP, ventilation is established in the MCR as an operator time-sensitive action during the postulated event. In order to confirm the FIP description, the NRC staff reviewed calculation L-003969, "U1/U2 Transient Heat-up Analysis for the Control Room, AEERs, Div. 1, and Div. 2 Switchgear Rooms Following a BDBEE," Revision 0. This analysis used the Generation of Thermal Hydraulic Information in Containment (GOTHIC) Version 7.0 thermal-hydraulic computer code to model the various rooms. The program modeled 72 hours of an ELAP. Outdoor air temperature was assumed to be a constant 95°F. The model demonstrates that with the compensatory actions of opening select doors and deploying portable fans, the MCR will remain below 110°F for the duration of the event. According to the licensee's FIP, procedure LOA-FSG-005, "Area Ventilation," provides guidance for establishing ventilation for the MCR.

Section 3.2.1.8 of NEI 12-06 indicates that the effects of a loss of HVAC [Heating, Ventilating, and Air Conditioning] may be addressed consistent with NUMARC 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors". NUMARC 87-00 considers with light work, a room temperature of 110°F is acceptable for a 4-hour period. Calculation L-003969 uses NUMARC 87-00 to establish the acceptable temperature of 110°F. The calculation shows that after 72 hours, assuming temporary ventilation (portable fans and opening selected doors) is established, the MCR temperature would be approximately 108°F at 72 hours. The NRC staff notes that the heat-up analysis did not take credit for any diurnal temperature variation. The staff concludes that with a diurnal temperature variation and the ability to move operators to cooler plant locations as relief personnel become available beyond 6 hours into the event, the licensee should be able to coordinate the BDBEE mitigating strategies from the MCR as planned.

3.9.2.2 Spent Fuel Pool Area

According to the licensee's FIP, the Reactor Building Refuel floor includes the SFP area. In order to establish ventilation in this area, the FIP states that ventilation may be achieved by opening and restraining selected doors and the Reactor Building roof hatch. This strategy includes the installation of a portable fan. The licensee has an additional strategy that involves cutting a hole in the Reactor Building roof. According to the licensee, the ventilation method would be chosen based on actual SFP area conditions during an event. In order to confirm the FIP description, the NRC staff reviewed calculation L-003968, "Temperature and Humidity Transient in the Reactor Building 843'-6" Operating Floor Following a BDBEE for FLEX," Revision 0, and EC 400418, "FLEX Refuel Floor Venting Evaluation," Revision 0. The licensee's calculation (L-003968) included various cases including full and partial core offloads and different ventilation combinations. As applicable, the calculation modeled opening doors and cutting a relief hole in the Reactor Building roof to establish natural circulation at 6½ hours into the event. The calculation demonstrates that the temperatures at the 843'-6" Operating Floor will not prevent operators, using appropriate personal protective equipment for the conditions, from completing their required actions to implement FLEX strategies prior to the onset of boiling in the SFP. The staff also reviewed Operating Abnormal Procedure LOA-FSG-

005, "Area Ventilation," Revision 1, which implements the ventilation strategy. This procedure includes guidance for establishing ventilation to the SFP area. The staff confirmed that LOA-FSG-005 indicates the marked areas on the Reactor Building roof to cut the relief hole such that structural members remain to support personnel cutting the hole and that the debris from the hole will not fall into the SFPs, should that method be employed. Based on the FIP description, confirmed by the audit review, the staff concludes that the licensee has established a plan that accounts for the postulated conditions in the SFP area, such that the FLEX strategy should be able to be effectively implemented.

3.9.2.3 Other Plant Areas

RCIC Pump Room

As described in Section 3.9.1.1 of this safety evaluation, the staff reviewed the licensee's FIP description and supporting calculations for the RCIC pump area. Based on the licensee's projections, the RCIC room will stabilize at approximately 132°F. While personnel are not stationed continuously in the RCIC room, if operator access is required, the licensee's FIP states that procedure SA-AA-111, "Heat Stress Control", provides guidance to protect personnel performing work in areas of elevated temperatures. Based on the FIP description, the staff concludes that the licensee's plan has sufficient provisions to accommodate any necessary short term RCIC room entries without compromising the overall FLEX strategy.

Other Areas

The licensee's FIP indicates that certain other areas of the plant critical for the FLEX strategies may exceed 120°F. During the audit process the staff reviewed calculation L-003969, which forecasts the temperatures in the Unit 1 and Unit 2 AEERs, Unit 1 and Unit 2 Division I and Division II switchgear rooms, and Unit 1 and Unit 2 battery rooms. The estimated room temperatures are:

Room	Max Allowable	Temp. @ 72 hours
Unit 1 AEER	120°F	122.5°F*
Unit 1 Div. I switchgear	122°F	117°F
Unit 1 Div. II switchgear	122°F	117°F
Unit 1 battery room (107)	120°F	119°F
Unit 1 battery room (109)	120°F	113.5°F
Unit 1 battery room (202)	120°F	119.5°F
Unit 2 AEER	120°F	123°F*
Unit 2 Div. I switchgear	122°F	117.5°F
Unit 2 Div. II switchgear	122°F	117°F
Unit 2 battery room (117)	120°F	114°F
Unit 2 battery room (119)	120°F	111.5°F
Unit 2 battery room (211)	120°F	119°F

*See section 3.9.1.1 for justification of temperature exceedances

According to the licensee's FIP, LOA-FSG-005 provides guidance for mitigating the loss of ventilation. The licensee states that they use a "toolbox" approach where the actions taken are commensurate with the conditions at the time of the event, which may, or may not, include the most ambient conditions. In addition, the licensee's FIP states that procedure SA-AA-111,

"Heat Stress Control", provides guidance for protecting employees from the adverse effects of performing work in thermally elevated environments.

The NRC staff reviewed the licensee's FIP description as well as the supporting calculation and procedural guidance. The staff notes that personnel are not continually stationed in these areas such that the stay times should be limited. The staff concludes that adequate mitigating actions and procedural guidance are available for personnel to be able to complete any required actions to implement the BDBEE mitigating strategy in these areas despite the potential for elevated temperatures.

3.9.3 Conclusions

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

3.10 Water Sources

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 potential BDB seismic and high wind events. The FIP states that the RCIC suction will automatically swap to the suppression pool in event the CSTs are unavailable. The suppression pool is located in the primary containment and is a Seismic Category I structure, and it is protected from all applicable hazards.

Phase 2

During Phase 2, the licensee will transition from the RCIC pump to a FLEX PDDP to provide makeup water to the RPV and the suppression pool. As discussed in Section 2.15 of the FIP, the robust water source for the FLEX PDDP is from the safety-related UHS which is robust for all applicable hazards. The UHS is an excavated pond with a capacity of 340 acre-feet (approximately 111 million gallons).

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 PDDP with suction from UHS. The licensee's FIP timeline indicates that there is sufficient time to deploy the FLEX PDDP before makeup is required.

3.10.3 Spent Fuel Pool Makeup

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

3.10.4 Containment Cooling

The licensee will use the suppression chamber vent to control pressure and temperature in the primary containment structure.

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. If an ELAP occurs with the plant at power, the mitigation strategy initially focuses on the use of the steam-driven RCIC pump to provide the water initially needed for decay heat removal. If the plant has been shut down and all or most of the fuel has been removed from the RPV and placed in the SFP, there may be a shorter timeline to implement the makeup of water to the SFP. However, this is balanced by the fact that, if immediate cooling is not required for the fuel in the reactor vessel, the operators can concentrate on providing makeup to the SFP. The licensee's analysis shows that, following a full core offload to the SFP, about 60 hours are available to implement makeup before boil-off results in the water level in the SFP dropping far enough to uncover fuel assemblies, and the licensee has stated that they have the ability to implement makeup to the SFP within that time.

When a plant is in a shutdown mode in which steam is not available to operate a steam-powered pump such as RCIC (which typically occurs when the RPV has been cooled below about 300°F), another strategy must be used for decay heat removal. In its FIP, the licensee stated that it would follow an NEI position paper regarding shutdown/refueling modes [Reference 53] that has been endorsed by the NRC [Reference 54]. 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 pre-deploying or pre-staging equipment to support maintaining or restoring key safety functions in the event of a loss of shutdown cooling. The position paper, as endorsed, was subsequently incorporated into NEI 12-06, Revision 2. The licensee's FIP states that procedures applicable to shutdown and refueling modes have been modified and/or developed to comply with the NEI position paper.

Based on the licensee's incorporation of the use of FLEX equipment in the shutdown risk process and procedures, the NRC staff concludes that the licensee has developed guidance that if implemented appropriately should maintain or restore core cooling, SFP cooling, and

containment following a BDBEE in shutdown and refueling modes consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.12 Procedures and Training

3.12.1 Procedures

In its FIP, the licensee indicated that the inability to predict actual plant conditions that require the use of BDB equipment makes it impossible to provide specific procedural guidance. As such, the LaSalle FSGs provide guidance that can be employed for a variety of conditions. Clear criteria for entry into FSGs will ensure that FLEX strategies are used only as directed for BDBEE conditions, and are not used inappropriately in lieu of existing procedures. When FLEX equipment is needed to accomplish FLEX strategies or supplement EOPs, procedural guidance will direct the entry into and exit from the appropriate FSG procedure. The licensee also stated that FLEX strategy guidelines have been developed in accordance with BWR owners group guidelines. The FSGs provide available, pre-planned FLEX strategies for accomplishing specific tasks. The FSGs are used to supplement (not replace) the existing procedure structure that establishes command and control for the event. In addition, the licensee indicated in its FIP that procedural interfaces have been incorporated into a site operating abnormal procedure to include appropriate reference to FSGs and provide command and control for the ELAP.

3.12.2 Training

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

In its FIP, the licensee stated that personnel assigned to direct the execution of mitigation strategies for BDBEEs have received the necessary training to ensure familiarity with the associated tasks, considering available job aids, instructions, and mitigating strategy time constraints. Upon SAFER equipment deployment and connection in an event, turnover and familiarization training on each piece of SAFER equipment will be provided to station operators by the SAFER deployment/operating staff.

3.12.3 Conclusions

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

3.13 Maintenance and Testing of FLEX Equipment

As a generic issue, NEI submitted a letter to the NRC dated October 3, 2013 [Reference 42], which included EPRI Technical Report 3002000623, "Nuclear Maintenance Applications Center: Preventive Maintenance Basis for FLEX Equipment." By letter dated October 7, 2013

[Reference 43], 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 an Institute of Nuclear Power Operations document. In addition, the licensee stated that a fleet procedure has been developed to address preventative maintenance (PM) activities using EPRI templates or manufacturer provided information/recommendations, equipment testing, and the unavailability of equipment. The EPRI has completed and has issued "Preventive Maintenance Basis for FLEX Equipment - Project Overview Report." Preventative Maintenance Templates for the major FLEX equipment including the portable diesel pumps and generators have also been issued.

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

The licensee's FIP states that the unavailability of FLEX equipment and applicable connections that perform a FLEX mitigation strategy for core cooling, containment, and SFP cooling is controlled and managed per a LaSalle procedure such that risk to mitigating strategy capability is minimized. According to the licensee, the guidance in this procedure conforms to the guidance of NEI 12-06, Revision 2, for FLEX equipment as follows:

- The unavailability of plant equipment is controlled by existing plant processes such as the Technical Specifications. When plant equipment which supports FLEX strategies becomes unavailable, then the FLEX strategy affected by this unavailability does not need to be maintained during the unavailability.

- If FLEX equipment is likely to be unavailable during forecast site specific external events (e.g., hurricane), appropriate compensatory measures should be taken to restore equivalent capability in advance of the event

- The required FLEX equipment may be unavailable for 90 days provided that the site FLEX capability (N) is met. If the site FLEX (N) capability is met but not protected for all of the site's applicable hazards, then the allowed unavailability is reduced to 45 days

- One of the connections to plant equipment required for FLEX strategies can be unavailable for 90 days provided the remaining connection remains available such that the site FLEX strategy is available

- If FLEX equipment or connections become unavailable such that the site FLEX capability (N) is not maintained, initiate actions within 24 hours to restore the site FLEX capability (N) and implement compensatory measures (e.g., use of alternate suitable equipment or supplemental personnel) within 72 hours.

- If FLEX equipment or connections to permanent plant equipment required for FLEX strategies are unavailable for greater than 45/90 days, restore the FLEX capability or implement compensatory measures (e.g., use of alternate suitable equipment or supplemental personnel) prior to exceedance of the 45/90 days.

The NRC reviewed the unavailability provisions listed in the licensee's FIP and concludes that they are consistent with NEI 12-06, Revision 2, and are 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 2

The licensee's FIP does not identify any alternatives to NEI 12-06, Revision 2.

3.15 Conclusions for Order EA-12-049

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

4.0 TECHNICAL EVALUATION OF ORDER EA-12-051

By letter dated February 28, 2013 [Reference 30], the licensee submitted its OIP for LaSalle in response to Order EA-12-051. By letter dated June 7, 2013 [Reference 31], supplemented by email dated June 25, 2013 [Reference 32], 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 33]. By letter dated November 26, 2013 [Reference 34], the NRC staff issued an ISE and RAI to the licensee.

By letters dated August 28, 2013 [Reference 35], February 28, 2014 [Reference 36], August 28, 2014 [Reference 37], and February 27, 2015 [Reference 38], the licensee submitted status reports for the Integrated Plan and the RAI in the ISE. The Integrated Plan describes the strategies and guidance to be implemented by the licensee for the installation of reliable SFP level instrumentation which will function following a BDBEE, including modifications necessary to support this implementation, pursuant to Order EA-12-051. By letter dated April 27, 2015 [Reference 39], the licensee reported that full compliance with the requirements of Order EA-12-051 was achieved at both units.

The licensee has installed a SFP level instrumentation system designed by Westinghouse, LLC. The NRC staff reviewed the vendor's SFP level instrumentation system design specifications, calculations and analyses, test plans, and test reports during a vendor audit. The staff issued an audit report regarding the Westinghouse system on August 18, 2014 [Reference 40]. The staff performed an onsite audit to review the implementation of SFP level instrumentation related to Order EA-12-051 at LaSalle. The scope of the audit included verification of: (a) whether the site's seismic and environmental conditions are enveloped by the equipment qualifications, (b) whether the equipment installation met the requirements and vendor's recommendations, and (c) whether program features met the order requirements. By letter

dated March 23, 2015 [Reference 24], the NRC issued an audit report on the licensee's progress.

According to the licensee's OIP, the two LaSalle units share a common Reactor Building that contains two SFPs, one for each unit. The two pools are normally hydraulically connected such that the level in both SFPs is the same. Thus, the licensee's two installed SFP indication channels (one in each pool) monitor the level in both pools as long as the hydraulic connection is maintained.

4.1 Levels of Required Monitoring

In its RAI response letter dated July 3, 2013, the licensee provided: (1) an explanation for Level 1 determination and, (2) a clearly labeled sketch illustrating the SFP levels of monitoring. These responses are summarized as follows:

1) The SFP has skimmers and scuppers located at the 842'-1" elevation that water must flow into. From there the water is routed to the surge tanks from which the Fuel Pool Cooling (FC) pumps draw suction. The suction trip is at an approximate 819'-6" elevation. Thus, the 842'-1" elevation reflects the higher of the two points noted in NEI 12-02, section 2.3.1.

2) Level 1, Level 2, and Level 3 correspond to plant elevations of 842'-1", 830'-0", and 820'-0", respectively.

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

- Level 1: According to the provisions of NEI 12-02, Level 1 should be the higher of two points. These two points are: (1) the level at which reliable suction loss occurs due to uncovering of the coolant inlet weir or, (2) the level corresponding to the required net positive suction head for the SFP cooling pump. The licensee's Level 1 (842 feet - 1 inch) is higher than the suction trip (819 feet - 6 inches) of the FC pumps. Level 1 corresponds to the elevation of the fuel pool weirs which maintain the flow path for recirculation of water from the SFP through the cooling system. The staff concludes that the licensee's designated Level 1 setting corresponds to the higher of the two points described in NEI 12-02 for Level 1, and is therefore acceptable.

- Level 2: According to NEI 12-02, Level 2 corresponds to an elevation that is 10 feet (plus or minus one foot) above the top of the storage racks seated in the SFP. Alternatively this level can correspond to a level that provides adequate radiation shielding to maintain personnel radiological dose levels acceptable while performing local operations in the vicinity of the pool. The licensee's Level 2 (830 feet - 0 inches) is consistent with the first of these two options since is approximately 10 feet above the highest point of any fuel rack seated in the SFP (819 feet - 8-3/4 inches) and is therefore acceptable.

- Level 3: According to NEI 12-02, Level 3 corresponds to an elevation that equals the highest point of any fuel rack seated in the SFP (plus or minus one foot). The licensee's designated Level 3 (820 feet - 0 inches) is slightly above the top of the storage racks seated in the LaSalle SFP. This is consistent with the NEI 12-02 guidance for Level 3,

and is therefore acceptable.

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

4.2 Evaluation of Design Features

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

4.2.1 Design Features: Instruments

In its OIP, the licensee stated that the SFP level instrumentation design will install fixed primary and backup level sensors. Related to the SFP level instrumentation measurement range, in its RAI response letter dated July 3, 2013, the licensee clarified that the primary and backup SFP instrument channels will provide continuous level indication over a minimum range of 22 feet – 7-3/4 inches, from the top of the spent fuel racks at approximately 820 feet – 0 inches to the SFP normal water level elevation of 842 feet – 6 inches. The NRC staff notes that the instrument's measurement range fully covers the licensee's designated Levels 1, 2, and 3.

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

4.2.2 Design Features: Arrangement

In its OIP, the licensee stated the plan was to install the level sensors in the southeast corner of the Unit 1 SFP and in the northeast corner of the Unit 2 SFP; separated by a distance of approximately 103 feet. The sensors themselves will be mounted, to the extent practical, near the pool walls and below the pool curb to minimize their exposure to damaging debris and not interfere with SFP activities. Instrument channel electronics and power supplies will be located in seismic and missile protected areas either below the SFP operating floor or in buildings other than the Reactor Building. The areas to be selected will provide suitable radiation shielding and environmental conditions for the equipment consistent with instrument manufacturer's recommendations. Equipment and cabling for power supplies and indication for each channel will be separated equivalent to that provided for redundant safety related services.

In RAI response letter dated July 3, 2013, the licensee provided a sketch of the SFP clarifying the location of the SFP level instruments. The sketch provided that the SFP sensors will now be installed in the northwest corner of the Unit 1 SFP and in the southwest corner of the Unit 2 SFP and be separated by a distance of approximately 35 feet – 9 inches.

The NRC staff reviewed the locations specified in the RAI response letter and concludes that the two channels are separated by a distance comparable to the shortest length of the SFP, which is consistent with the provisions of NEI 12-02 for channel sensor separation. Further, during the LaSalle audit process, the NRC staff walked down the locations of the primary and

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

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

4.2.3 Design Features: Mounting

With regard to the mounting design of the level probe, in its third six-month update letter dated August 28, 2014, the licensee stated, in part, that the model used by Westinghouse to calculate the stresses in the bracket assembly, considers load combinations for the dead load, live load and seismic load on the bracket. The reactionary forces calculated from these loads become the design inputs to design the mounting bracket anchorage to the refuel floor to withstand an SSE. The seismic loads are obtained from LaSalle's station response spectra curves (Seismic Response Spectra Design Criteria). According to the licensee, the following methodology was used in determining the stresses on the bracket assembly:

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

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

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

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

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

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

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

Related to the mounting of the SFP level instrumentation electronics equipment in the Auxiliary Building (primary - Unit 1 elevation 731 feet, backup - Unit 2 elevation 731 feet), in its third six-month update letter dated August 28, 2014, the licensee stated, in part, that the level sensor and its bracket, display enclosure and its bracket, were subjected to seismic testing, including shock and vibration test requirements. The level sensor electronics are enclosed in a [National Electrical Manufacturers Association] NEMA-4X housing. The display electronics panel utilizes a NEMA-4X rated stainless steel housing as well. These housings are mounted to a seismically qualified wall and contain the active electronics, and aid in protecting the internal components from vibration-induced damage.

The NRC staff notes that the total load for the mounting bracket appropriately includes the dead load, live load, design-basis maximum seismic loads, and the hydrodynamic loads that could result from pool sloshing. Further, the assumptions, analytical, and model used in the sloshing analysis for the sensor mounting bracket appear to be adequate. The staff concludes that the instruments will function per design following the maximum seismic ground motion.

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

4.2.4 Design Features: Qualification

4.2.4.1 Augmented Quality Process

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

In its OIP, the licensee stated that reliability of the instrumentation would be assured through compliance with the guidance (NEI 12-02, as endorsed). Further the licensee also stated that reliability would be established through the use of an augmented quality assurance process. In its third six-month update, the licensee stated that appropriate quality measures will be selected for the SFP instrumentation system, consistent with Appendix A of NEI 12-02.

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

4.2.4.2 Instrument Channel Reliability

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.

According to the licensee's third six-month update letter, equipment reliability performance testing was performed to: (1) demonstrate that the SFP instrumentation will not experience failures during BDB conditions of temperature, humidity, emissions, surge, and radiation, and (2) to verify those tests envelope the plant-specific requirements.

During the vendor audit [Reference 40], the NRC staff reviewed the Westinghouse SFP level instrumentation's qualifications and testing for temperature, humidity, radiation, shock and vibration, and seismic capability. The staff further reviewed the projected seismic, radiation, and environmental conditions at LaSalle to confirm that they are bounded by the testing program. Below is the staff's assessment of the equipment reliability of the LaSalle SFP level instrumentation.

4.2.4.2.1 Radiation, Temperature, and Humidity

4.2.4.2.1.1 Radiation

In its third six-month update letter dated August 28, 2014, the licensee stated that environmental conditions applicable to the SFP instrumentation system components installed in the SFP area are bounded by the qualification test conditions, except for radiation Total Integrated Dose (TID) 12 inches above the top of the fuel rack for BDB conditions. According to the licensee, the BDB radiation TID 12 inches above the top of the fuel rack for LaSalle is 4.E07 Rγ [Rad gamma]. The BDB radiation value to which the Westinghouse equipment is qualified to is 1.E07 Rγ. The site-specific BDB radiation value at this level is thus higher than the value to which Westinghouse qualified the instrument. However, the value of 4.E07 Rγ is applicable only when the water is at Level 3, and the only components of the indicating system that are exposed to this high of a radiation dose are the stainless steel probe and the stainless steel anchor. According to the licensee, these materials are inherently resistant to radiation effects. The licensee also noted that with the SFP at level 2, the TID reduces to 2.E07 Rγ and it further reduces to 8.E06 Rγ at Level 1 and above, and would therefore be bounded by the instrument qualification testing level. Thus, the licensee concluded that the higher site-specific dose applicable to the probe and anchor would not adversely impact the overall instrument qualification. The NRC staff notes that the licensee's plan for compliance with the mitigating strategies order should ensure that Level 3 is never approached in the SFPs.

Further, even if the SFP levels dropped to Level 3, the components that would be exposed to a radiation level higher than their qualification level would still be likely to perform their function. Thus, the staff concludes that the radiation qualification of the SFP instrument components located in the vicinity of the SFP is acceptable.

The anticipated BDB radiological conditions in the Unit 1 and Unit 2 Division 2 switchgear rooms, where the electronics equipment is located, were summarized in the licensee's letter

dated August 28, 2014. In this letter, the licensee stated that the level sensor transmitter and bracket, electronics display enclosure and bracket are designed and qualified to operate reliably at radiation levels ≤ 1E3 Rγ. During the audit process the staff confirmed that the Unit 1 and Unit 2 Division 2 switchgear rooms where the electronics are located constitutes a mild environment under the postulated conditions and thus the staff concludes that the Westinghouse equipment's design limits envelop the anticipated LaSalle BDB radiological conditions for this area.

4.2.4.2.1.2 Temperature and Humidity

The licensee's OIP states that the SFP level instrumentation will consider the environmental conditions of temperature and humidity during normal operation, the event, and post-event conditions for no fewer than 7 days post-event or until off-site resources can be deployed. In its letter dated August 28, 2014, the licensee stated that the level sensor probe, coax coupler and connector assembly, launch plate and pool side bracket assembly, and coax cable are designed and qualified to operate reliably in the below specified (SFP area) environmental conditions.

Parameter	Normal	BDB
Temperature	50 - 140°F	212°F
Pressure	Atmospheric	Atmospheric
Humidity	0 – 95% Relative Humidity (RH)	100% (saturated steam)

In addition, in its letter dated August 28, 2014, the licensee also provided the environmental design and qualification levels applicable to the area where the electronics equipment is located. These conditions apply to the level sensor transmitter and bracket, electronics display enclosure, and bracket.

Parameter	Normal	BDB	BDB (Level Sensor Electronics Only)
Temperature	50 - 120°F	140°F	140°F
Pressure	Atmospheric	Atmospheric	Atmospheric
Humidity	0 – 95% RH	0 – 95% (non-condensing)	0 – 95% (non-condensing)

During the audit process, the NRC staff compared the design conditions to the projected LaSalle specific conditions in the SFP area, as well as the Unit 1 and Unit 2 Division 2 switchgear rooms and concluded that the Westinghouse equipment's design limits envelop the anticipated LaSalle temperature, pressure, and humidity conditions.

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

4.2.4.2.2 Shock and Vibration

Guidance document NEI 12-02, as endorsed, specifies that instrument channel reliability shall be demonstrated regarding the effects of shock and vibration. It further provides methods for

the manufacturer to establish shock and vibration ratings. In its letter dated August 28, 2014, the licensee stated that the probe, coaxial cable, and mounting brackets are inherently resistant to shock and vibration loadings. The remaining instrumentation components were subjected to testing that included shock and vibration requirements.

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

4.2.4.2.3 Seismic

In its letter dated August 28, 2014, the licensee stated, in part, that the seismic adequacy of the SFP level instrumentation components was demonstrated by vendor testing and analysis in accordance with the following:

- IEEE [Institute of Electrical and Electronics Engineers] 344-2004, "IEEE Recommended Practice for Seismic Qualification of Class 1E Electrical Equipment for Nuclear Power Generating Stations"
- IEEE-323-1974, "Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations"
- Regulatory Guide 1.100, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants," Revision 3
- Regulatory Guide 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis," Revision 1
- Calculation L-003913, "Evaluation of Mounting Details for Components 1/2LT-FC165 & 1/2PLH13J, A Grouted Conduit Support & a 3" Diameter Core Hole for a 1½" Conduit"
- L-003911 Evaluation of SFPIS Sensor Mounting Bracket Anchor Plate Detail for Component 1/2LE-FC165

Based on the licensee's letter, use of appropriate standards, with confirmation by the vendor and onsite audit reviews, and also considering the evaluation of the SFP level instrumentation mounting that is addressed in Section 4.2.3 of this safety evaluation, the NRC staff concludes that the SFP level instrumentation was evaluated and/or tested to seismic conditions that envelop the anticipated SSE at LaSalle.

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

4.2.5 Design Features: Independence

In its third six-month update dated August 28, 2014, the licensee stated, in part, that the two channels of the level measurement system will be installed such that:

- The level probes will be mounted on the west side of the SFP and will be separated by

distance greater than the span of the shortest side of the pool. This meets the NEI 12-02, Revision 1 guidance for channel separation.

- The coaxial cable that extends from the two sensors toward the location of the transmitters (sensor electronics) will be installed using separate routes and separate conduits.

- Physical and spatial separation of the level sensors and the electronics/UPS enclosures for primary and backup instrument channels is maintained by routing the associated instrument channel cables through Unit 1 and Unit 2 respectively.

Further, the licensee's update letter stated that the instrument channels are located in the respective Unit 1 (primary) and the Unit 2 (backup) sides of the Auxiliary Building. Both channels are on elevation 731 feet of the Auxiliary Building.

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

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

4.2.6 <u>Design Features: Power Supplies</u>

In its OIP, the licensee stated that each channel will be powered from a different 120 Vac bus. In its third six-month update dated August 28, 2014, the licensee stated that the primary SFP instrument will be powered from Unit 1 Division 1 120 Vac distribution panel at 480 Vac motor control center (MCC) 135X-3 and the backup SFP instrument channel will be powered from Unit 2 Division 2 120 Vac distribution panel at MCC 236X-3. The 120 Vac distribution channels are on different safety related buses, which maintain power source independence. Therefore, the loss of any one bus will not result in the loss of ac power to both instrument channels. Furthermore, both of the MCC's that feed the power sources are backed up by a power supply which is part of the station FLEX strategy.

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

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

Order EA-12-051 states that the instruments should be maintained within the designed accuracy following a power supply interruption or change in power source without recalibration. Further, NEI 12-02 states that accuracy should be sufficient to allow trained personnel to determine level without conflicting or ambiguous indication and that Levels 2 and 3 should correspond to their respective levels ±1 foot. Based on the licensee's letter dated August 28, 2014 the NRC staff finds that, if implemented properly, the instrument channels should maintain the designed accuracy following a power source change or interruption without the need of recalibration and provide the necessary information regarding SFP level. The staff concludes that the licensee's proposed instrument accuracy appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.8 Design Features: Testing

In its third six-month update letter dated August 28, 2014, the licensee stated that a Westinghouse calibration procedure and functional test procedure describe the capabilities and provisions of SFP level instrumentation periodic testing and calibration, including in-situ testing.

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

Order EA-12-051 states that processes shall be established and maintained for scheduling and implementing necessary testing and calibration of the SFP level instrumentation to maintain the channels within their design accuracy. Guidance document NEI 12-02 states that testing and calibration shall be consistent with vendor recommendations or other documented basis. The NRC staff notes by comparing the levels in the instrument channels and the maximum level allowed deviation for the instrument channel design accuracy, the operators could determine if recalibration or troubleshooting is needed.

Based on the licensee's letter dated August 24, 2014, the NRC staff finds that the licensee's SFP level 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

In its third six-month update letter dated August 28, 2014, the licensee stated that the primary and backup instrument channels are located in the Unit 1 and Unit 2 Division 2 switchgear room, respectively. These locations were selected due to the display location proximity to the MCR and alternate shutdown panel.

According to the licensee, radiological habitability at this location has been evaluated against LaSalle UFSAR Table 3.11-26, "Controlled Environment Zone C2 – Conditions Inside the Essential Switchgear Rooms," and radiological habitability for transit routes to both displays has been evaluated against LaSalle UFSAR Table 3.11-21, "Normal Environment Zone N1 – Service Conditions in the Auxiliary Building," as well as estimate dose rates from SFP drain-down conditions to Level 3. The licensee states that exposure to personnel monitoring SFP levels would remain less than emergency exposure limits allowable for emergency responders to perform this action. The location is at an elevation below the SFP operating floor and is located in a different building, physically separated by concrete walls and closed airlock/fire doors from the SFP, such that heat and humidity from a boiling SFP would not compromise habitability and accessing these displays. The SFP level monitoring will be the responsibility of operations personnel.

According to the licensee, diverse communication methods are available for operators to contact the MCR to provide the SFP level from display locations, for both the primary and backup channels displays. It takes up to 6 minutes to reach the display location, for both the primary and backup channels, when an operator is dispatched from the MCR. The actual time for accessing the display locations is based on walk downs. The walk down (MCR to Unit 1 and Unit 2 switchgear rooms) to access the display locations is within robust Seismic Category 1 structures. The licensee assesses that being able to provide the indicated SFP level within approximately 10 minutes is not considered an unreasonable delay.

Guidance document NEI 12-02 states that display locations should be: (1) promptly accessible to the appropriate plant staff giving appropriate consideration to various drain down scenarios, (2) outside of the area surrounding the SFP floor, (3) inside a structure providing protection against adverse weather, and (4) outside of any very high radiation areas or locked high radiation areas during normal operation. Based on the licensee's description, the NRC staff review concludes that each of these characteristics of the display location are met at LaSalle. The NRC staff finds that the licensee's proposed location and design of the SFP instrumentation displays appear to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.3 Evaluation of Programmatic Controls

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

4.3.1 Programmatic Controls: Training

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

Guidance document NEI 12-02 specifies that the SAT process can be used to identify the population to be trained and also to determine both the initial and continuing elements of the required training. Based on the licensee's OIP, the NRC staff finds that the licensee's plan to train personnel in the operation, maintenance, calibration, and surveillance of the SFP level instrumentation, including the approach to identify the population to be trained, appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.3.2 Programmatic Controls: Procedures

In its OIP, the licensee stated that site procedures will be developed using guidelines and vendor instructions to address the maintenance, operation and abnormal response issues associated with the primary and backup channels of SFP instrumentation. In its third six-month update letter dated August 28, 2014, the licensee stated these procedures will be developed in accordance with Exelon's procedural control process. Technical objectives to be achieved in each of the respective procedures are described below:

- System Inspection: To verify that system components are in place, complete, and in the correct configuration, and that the sensor probe is free of significant deposits of crystallized boric acid.

- Calibration and Test: To verify that the system is within the specified accuracy, is functioning as designed, and is appropriately indicating SFP water level.

- Maintenance: To establish and define scheduled and preventive maintenance requirements and activities necessary to minimize the possibility of system interruption.

- Repair: To specify troubleshooting steps and component repair and replacement activities in the event of system malfunction.

- Operation: To provide sufficient instructions for operation and use of the system by plant Operations staff.

- Responses: To define the actions to be taken upon observation of system level indications, including actions to be taken at the levels defined in NEI 12-02.

Guidance document NEI 12-02 states that procedures will be developed using guidelines and vendor instructions to address the maintenance, operation, and abnormal response issues associated with the instrumentation. It also states that licensees will have a strategy to ensure SFP water level addition is initiated at an appropriate time based on the mitigating strategies developed in response to Order EA-12-049.

Based on the licensee's description, the staff finds that the licensee's procedure development appears to be consistent with NEI 12-02, as endorsed by JLD-ISG-2012-03. Thus, if implemented as described, the licensee's procedure development should adequately address the requirements of Order EA-12-051.

4.3.3 Programmatic Controls: Testing and Calibration

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

In its third six-month update letter dated August 28, 2014, the licensee further stated that the level displayed by the channels will be verified per the station administrative and operating procedures. If the level is not within the required accuracy, channel calibration will be performed. Functional checks will be performed at the vendor's recommended frequency. Calibration tests will be performed in accordance with the vendor's calibration procedure and at the vendor's recommended frequency. Manual calibration and operator performance checks will be performed periodically with additional maintenance on an as-needed basis when flagged by the system's automated diagnostic test. The licensee also stated that the SFPI channel/equipment maintenance/preventative maintenance and testing program requirements will be established to ensure design and system readiness. These program requirements will be established in accordance with Exelon's processes and procedures with consideration for vendor recommendations to ensure that appropriate regular testing, channel checks, functional tests, periodic calibration, and maintenance is performed.

In its third six-month update letter dated August 28, 2014, the licensee provided the planned compensatory actions for extended out-of-service events which are summarized as follows:

Number of Channel(s) Out-of-Service	Required Restoration Action	Compensatory Action if Required Restoration Action not Completed Within Specified Time
1	Restore Channel to functional status within 90 days (or if channel restoration no expected within 90 days, then proceed to Compensatory Action)	Immediately initiate action in accordance with note below
2	Initiate action within 24 hours to restore one channel to functional status and restore one channel to functional status within 72 hours	Immediately initiate action in accordance with note below

Note: Present a report to the onsite Plant Operations Review Committee (PORC) within the following 14 days. The report shall outline the planned alternate method of monitoring, the cause of the non-functionality, and the plans and schedule for restoring the instrumentation channel(s) to functional status.

Guidance document NEI 12-02 states that the testing and calibration of the instrumentation shall be consistent with the vendor recommendations or other documented basis. Based on the licensee's submittals, the NRC staff concludes that the licensee's testing and calibration plan appears to be consistent with the vendor recommendations. Further, the staff concludes that the licensee's maintenance program also appears to be consistent with the vendor

recommendations. Additionally, compensatory actions for instrument channel(s) out-of-service appear to be consistent with guidance in NEI 12-02.

Based on the evaluation above, the 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 April 27, 2015 [Reference 39], the licensee stated that they would meet the requirements of Order EA-12-051 for each unit by following the guidelines of NEI 12-02, which has been endorsed, with clarifications and exceptions, by JLD-ISG-2012-03. In the evaluation above, the NRC staff finds that, if implemented appropriately, the licensee has conformed to the guidance in NEI 12-02, as endorsed by JLD-ISG-2012-03. In addition, the NRC staff concludes that if the SFP level instrumentation is installed at LaSalle according to the licensee's design, it should adequately address the requirements of Order EA-12-051.

5.0 CONCLUSION

In August 2013, the NRC staff started audits of the licensee's progress on Orders EA-12-049 and EA-12-051. The staff conducted an onsite audit at LaSalle in January 2015 [Reference 24]. The licensee reached its final compliance date on March 13, 2018, for Order EA-12-049, and February 26, 2015 for Order EA-12-051, and has declared that both of the reactors are in compliance with the orders. The purpose of this safety evaluation is to document the strategies and implementation features that the licensee has committed to. Based on the evaluations above, the NRC staff concludes that the licensee has developed guidance and designs that, if implemented appropriately, should adequately address the requirements of Orders EA-12-049 and EA-12-051. The NRC staff will conduct an onsite inspection to verify that the licensee has implemented the strategies and equipment to demonstrate compliance with the orders.

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SUBJECT: LASALLE COUNTY 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. MF1119, MF1120, MF1121, AND MF1122; EPID NOS. L-2013-JLD-0023 AND L-2013-JLD-0012) DATED August 21, 2018

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