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

July 14, 2016

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

SUBJECT: R. E. GINNA NUCLEAR POWER PLANT – 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. MF1152 AND MF1147)

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 March 8, 2013 (ADAMS Accession No. ML13074A056), Constellation Energy Group, LLC (CENG), acting for R. E. Ginna Nuclear Power Plant, LLC, (the licensee) submitted the OIP for R. E. Ginna Nuclear Power Plant (Ginna) in response to Order EA-12-049. Subsequently, Exelon Generation Company, LLC (Exelon, the licensee) purchased Ginna, and is now licensed as the operating authority in conjunction with R.E. Ginna Nuclear Power Plant, LLC. At six month intervals following the submittal of the OIP, the licensee submitted reports on its progress in complying with Order EA-12-049. These reports were required by the order, and are listed in the attached safety evaluation. By letter dated August 28, 2013 (ADAMS Accession No. ML13234A503), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" (ADAMS Accession No. ML082900195). By letters dated February 19, 2014 (ADAMS Accession No. ML14007A704), and June 18, 2015 (ADAMS Accession No. ML15154B332), the NRC issued an Interim Staff Evaluation (ISE) and audit report, respectively, on the licensee's progress. By letter dated January 4, 2016 (ADAMS Accession No. ML16006A050), Exelon submitted its compliance letter and Final Integrated Plan (FIP) in response to Order EA-12-049. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-049.

By letter dated February 28, 2013 (ADAMS Accession No. ML13066A172), Exelon submitted its OIP for Ginna in response to Order EA-12-051. At six month intervals following the submittal of the OIP, the licensee submitted reports on its progress in complying with Order EA-12-051.

These reports were required by the order, and are listed in the attached safety evaluation. By letters dated December 5, 2013 (ADAMS Accession No. ML13337A625), and June 18, 2015 (ADAMS Accession No. ML15154B332), the NRC staff issued an ISE and audit report, respectively, on the licensee's progress. By letter dated March 26, 2014 (ADAMS Accession No. ML14083A620), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-051 in accordance with NRC NRR Office Instruction LIC-111, similar to the process used for Order EA-12-049. By letter dated December 15, 2015 (ADAMS Accession No. ML15350A130), Exelon submitted its compliance letter in response to Order EA-12-051. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-051.

The enclosed safety evaluation provides the results of the NRC staff's review of Exelon's strategies for Ginna. 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 191, "Implementation of Mitigation Strategies and Spent Fuel Pool Instrumentation Orders and Emergency Preparedness Communications/Staffing/ Multi-Unit Dose Assessment Plans" (ADAMS Accession No. ML14273A444). This inspection will be conducted in accordance with the NRC's inspection schedule for the plant.

If you have any questions, please contact John Boska, Orders Management Branch, R. E. Ginna Project Manager, at 301-415-2901 or at John.Boska@nrc.gov.

Sincerely,

Mandy K Halter

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

Docket No.: 50-244

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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EXELON GENERATION COMPANY, LLC

R. E. GINNA NUCLEAR POWER PLANT

DOCKET NO. 50-244

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

2.2 Order EA-12-051

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

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

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

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

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

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

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

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

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

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

3.0 TECHNICAL EVALUATION OF ORDER EA-12-049

By letter dated March 8, 2013 (ADAMS Accession No. ML13074A056), Constellation Energy Group, LLC (CENG), acting for R. E. Ginna Nuclear Power Plant, LLC, (the licensee) submitted the OIP for R.E. Ginna Nuclear Power Plant (Ginna) in response to Order EA-12-049. Subsequently, Exelon Generation Company, LLC (Exelon, the licensee) purchased Ginna, and is now licensed as the operating authority in conjunction with R.E. Ginna Nuclear Power Plant, LLC. By letters dated August 27, 2013 [Reference 11], February 27, 2014 [Reference 12], August 26, 2014 [Reference 13], February 20, 2015 [Reference 14], and August 28, 2015 [Reference 50] the licensee submitted six-month updates to the OIP.

By letter dated August 28, 2013 [Reference 15], 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 36]. By letters dated February 19, 2014 [Reference 16] and June 18, 2015 [Reference 17], the NRC issued an Interim Staff Evaluation (ISE) and an audit report on the licensee's progress. By letter dated January 4, 2016 [Reference 18] the licensee reported that full compliance with the requirements of Order EA-12-049 was achieved, and submitted a Final Integrated Plan (FIP).

3.1 Overall Mitigation Strategy

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

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

Ginna is a two loop Westinghouse pressurized-water reactor (PWR) with a dry ambient pressure containment. The FIP describes the licensee's three-phase approach to mitigate a postulated ELAP event. The approach is very similar in the event the plant receives warning of a pending flood and is discussed in Section 3.2.2. below.

At the onset of an ELAP the reactor is assumed to trip from full power. The reactor coolant pumps (RCPs) coast down and flow in the reactor coolant system (RCS) transitions to natural circulation. Operators will take prompt actions to minimize RCS inventory losses by isolating potential RCS letdown paths. Decay heat is removed by steaming from the steam generators (SGs) through the SG atmospheric relief valves (ARVs) or SG safety valves, and makeup to the SGs is initially provided by the turbine-driven auxiliary feedwater (TDAFW) pump, if available, taking suction from the condensate storage tank (CST). Since the non-robust TDAFW pump may not be credited for certain BDBEEs, operators can be sent to the standby auxiliary feedwater (SAFW) building to make up to the SGs using one of two installed SAFW pumps powered from the new SAFW diesel generator (DG), taking suction from the new 160,000 gallon (usable capacity), robustly designed SAFW deionized (DI) water storage tank. Subsequently, the operators would begin a controlled cooldown and depressurization of the RCS by manually operating the SG ARVs. The SGs are first depressurized in a controlled manner to approximately 360 pounds per square inch gauge (psig) and then maintained at this pressure while the operators borate the RCS. This SG depressurization will reduce RCS temperature and pressure. The reduction in RCS temperature will result in inventory contraction in the RCS, with the result that the pressurizer would be expected to drain and a steam void form in the reactor vessel upper head. Some leakage from the RCS is anticipated, especially from the RCP seals. Borated water injection from safety injection (SI) accumulators is expected to replenish the RCS volume due to inventory contraction and leakage, in the process increasing shutdown margin. It is also important to ensure that the nitrogen in the SI accumulators does not enter the RCS because that could impede natural circulation and degrade primary-to-secondary heat transfer. The initial SG depressurization setpoint of 360 psig is set to prevent nitrogen injection into the RCS, and procedures further direct isolation or venting of the SI accumulators before operators decrease the RCS pressure to a value that would otherwise allow nitrogen injection. In order to follow the Westinghouse recommendation to perform an extended cooldown to support the integrity of the second stage RCP seal, operators will perform a further RCS cooldown and depressurization within 24 hours to less than 350 degrees Fahrenheit (°F) in the RCS cold legs and less than 400 psig.

If available, the TDAFW pump would be used for core cooling initially, with water supplied from the CST. Although the TDAFW pump may be able to operate long-term and supply adequate AFW flow to the SGs for heat removal from the reactor core, the non-robust TDAFW pump and CST are not part of the credited FLEX strategy. Therefore, the credited Phase 1 strategy is to commence feeding the SGs from either SAFW pump powered from the SAFW DG and taking suction from the SAFW DI water storage tank, which the licensee stated has sufficient capacity to remove residual heat for 24 hours. In Phase 2, a dedicated FLEX pump can be used to refill the SAFW DI water storage tank from Lake Ontario, the UHS, although any existing source of demineralized water on site will be preferentially used until the National Strategic Alliance for FLEX Emergency Response (SAFER) Response Center (NSRC) water treatment system arrives. The licensee intends to continue core cooling indefinitely, or until long-term recovery actions are determined, using an SAFW pump powered from the SAFW DG, with provision for refilling the SAFW DI water storage tank and SAFW DG fuel tank. However, additional NSRC-supplied equipment will be available in Phase 3 to supplement the onsite FLEX equipment to support the indefinite mission time.

The dc bus load stripping will be initiated within the first hour to ensure safety-related battery life is extended to 8 hours. Following dc load stripping and prior to battery depletion, power to one or more of the protected battery chargers for the 125 Volt dc (Vdc) batteries will be provided from the one megawatt (MW) SAFW DG to ensure vital instrumentation remains powered. Alternatively, a FLEX DG rated at 480 volt alternating current (Vac) and 100 kilowatts (kW) will be connected to one or more of the protected battery chargers.

RCS makeup and boron addition will conservatively be initiated within 8 hours of the ELAP event to ensure that natural circulation, reactivity control, and boron mixing is maintained in the RCS. In Phase 2, operators will be able to inject borated water from the refueling water storage tank (RWST) via an alternate RCS injection pump, newly installed in the SAFW building and powered from the SAFW DG. Under Phase 3 (using NSRC-supplied equipment), portable equipment and consumables will be used to reinforce and secure for an indefinite coping time the measures implemented during Phase 2, mainly additional boric acid and the ability to re-power equipment.

The SFP is located in the auxiliary building. The SFP will initially heat up due to the unavailability of the normal cooling system. The licensee has calculated that boiling could start as soon as 4.9 hours from event initiation with a full core offload, assuming an initial SFP temperature of 150 °F. The licensee was not required to start with the large decay heat level of a full core offload, but conservatively decided to do so to cover all modes of operation. The licensee determined that it would take approximately 45 hours with those initial conditions for pool water level to drop to a level requiring the addition of makeup to maintain sufficient radiation protection for personnel (Level 2 in Section 4.1 below). The SFP makeup strategy is accomplished using a portable FLEX pump with water supply from Lake Ontario and discharging into the SFP.

For Phases 1 and 2, the licensee's calculations demonstrate no actions are required to maintain containment pressure below design limits for at least 72 hours. No mitigation actions are necessary to maintain or restore containment cooling during Phases 1 or 2. Containment status will be monitored. During Phase 3, actions can be taken to maintain containment pressure less than 20 psig, which is well below the containment design pressure of 60 psig, to avoid affecting instrumentation located in the containment building. At approximately 35 hours from the start of the ELAP event, equipment provided from an NSRC can be available to power one or more containment recirculation fans (CRFs) and supply cooling water from Lake Ontario to one or more CRF coolers (CRFCs) if containment temperature is greater than 200 °F or containment pressure is greater than 15 psig.

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

3.2 Reactor Core Cooling Strategies

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

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

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

3.2.1 Core Cooling Strategy and RCS Makeup

3.2.1.1 Core Cooling Strategy

3.2.1.1.1 Phase 1

Ginna's Phase 1 strategy directs operators to begin controlling RCS temperature within 30 minutes of the start of the ELAP with loss of normal access to the UHS event by locally throttling open the SG ARVs. This initial RCS cold leg temperature decrease to 547 °F is implemented to protect the RCP seal o-rings, as some of the currently installed RCP seal o-rings are only qualified to 550 °F (see Section 3.2.3.3, below). Operators will begin an additional cooldown of the RCS beginning no later than 2 hours from the start of the event, at a rate of 50 to 100 °F/hr, and continue the cooldown until SG pressure reaches 360 psig (which approximately corresponds to an RCS cold leg temperature of 438 °F). Cooldown and depressurization of the RCS significantly extends the expected coping time under ELAP conditions because it reduces the potential for damage to RCP seals (as discussed in Section 3.2.3.3) and allows borated coolant stored in the nitrogen-pressurized cold leg accumulators to passively inject into the RCS to offset system leakage.

As stated in the FIP, the heat sink for core cooling in Phase 1 would be provided by the two SGs, which would be fed simultaneously by the ac-independent TDAFW pump, taking suction from the CST, if this equipment is available. As the TDAFW pump and CST are not robust against all applicable hazards, the credited water source for the SGs is one of two SAFW pumps, either one of which can perform the core cooling function for both SGs simultaneously. Per Section 10.5.3.2 of Ginna's Updated Final Safety Analysis Report (UFSAR), the SAFW pumps are motor-driven pumps capable of providing 235 gallons per minute (gpm) at 1085 psig. The pumps will be powered by the 1-MW SAFW DG and take suction from the 160,000 gallon SAFW DI water storage tank. The SAFW DG is not connected to, and cannot be connected to, the offsite or onsite emergency ac power systems; the NRC staff has therefore determined that the SAFW DG is not an "alternate ac power source" that would be assumed to be unavailable per the conditions of NEI 12-06 or Order EA-12-049, and that it can be credited in an ELAP with loss of normal access to the UHS scenario. Procedure ECA-0.0 directs operators to initially verify adequate TDAFW flow to the SGs, and to initiate SAFW flow if TDAFW flow cannot be verified or established.

The licensee's plant-specific calculations using the RELAP5 MOD3.3 code (see Section 3.2.3.2 below) indicate that SG dryout conditions would be reached within 43 minutes if no feedwater is supplied; the licensee further states that table-top/walkthrough exercises have confirmed that SAFW will be established within 39 minutes, which would satisfy this time constraint. The NRC staff's audit review of the SG dryout calculation indicated that some sections of the calculation had potentially nonconservative assumptions that would reduce the rate of energy absorption from the SGs. The licensee performed a technical evaluation, ESR-16-0159, Revision 0, "Evaluation of S/G Dry Out Time for FLEX," which evaluated the margins for SG dryout in the RELAP5 analysis. The NRC staff's review of this evaluation indicates that the conservatism in the RELAP5 analysis, including margin when comparing best-estimate decay heat values to the conservative decay heat values assumed in the RELAP5 analysis, is sufficient to conclude that the RELAP5 analysis for SG dryout is acceptable. As a result, the NRC staff concluded that the licensee's plans for establishing SAFW flow prior to the SG dryout time stated in the calculation should maintain the SGs as a secondary heat sink for the beyond-design-basis ELAP event.

Procedure ECA-0.0, "Loss of AC Power", directs operators to perform an extended RCS cooldown after the accumulators have been isolated. Operators will depressurize the SGs to less than 150 psig and lower RCS temperature to less than 350 °F within 24 hours of the initiating event. This will meet the guidance promulgated in Westinghouse Technical Bulletin (TB) 15-1, "Reactor Coolant System Temperature and Pressure Limits for the No. 2 RCP Seal" to protect the integrity of the #2 RCP seal.

The licensee calculates that the SAFW DI water storage tank inventory will be depleted after approximately 24 hours of operation, at which time the core cooling strategy will enter Phase 2.

3.2.1.1.2 Phase 2

In Phase 2, an indefinite supply of water to the SGs is assured by deploying a portable, diesel-driven FLEX pump to refill the SAFW DI water storage tank from Lake Ontario. Non-robust sources of clean water, such as the CST, will be used if available, but the lake (via the discharge canal) is the credited source. During the audit process, the licensee noted that the water chemistry of Lake Ontario would have minimal effect on long-term heat transfer in the SGs, and would be augmented by a mobile water treatment system as soon as it became available in Phase 3. The SAFW pump, powered by the SAFW DG, will continue to inject to the SGs. This is the primary Phase 2 core cooling strategy.

An alternate Phase 2 core cooling strategy is to use one of two portable diesel-driven FLEX pumps to inject to the SGs via a protected connection point on the SAFW system, should the SAFW pumps become unavailable. The FLEX pump can take suction either from the SAFW DI tank or the discharge canal. The existence of a single connection point, rather than a primary and alternate connection, for using the FLEX pump to inject to the SGs is identified by the licensee as an alternative to the guidance in NEI 12-06. In the FIP, the licensee justifies this by pointing to the "multiple and diverse methods" available to supply the SGs using the SAFW pumps in the primary strategy: either SAFW pump has sufficient capacity to fulfill the heat removal function for both SGs simultaneously, and either pump can supply both SGs via its own discharge header and the other pump's discharge header, using either of two different cross-connection paths which are located in different buildings.

3.2.1.1.3 Phase 3

The Phase 3 strategy for core cooling is essentially the same as the Phase 2 strategy, supplemented by equipment furnished by the NSRC. Natural circulation in the RCS will continue, with heat removal accomplished by feeding the SGs using either an SAFW pump or the FLEX pump. An NSRC water treatment system will be deployed as soon as it becomes available, so that raw water from the lake can be treated before it is injected into the SGs.

3.2.1.2 RCS Makeup Strategy

3.2.1.2.1 Phase 1

Under ELAP conditions, RCS inventory will tend to diminish gradually due to leakage through RCP seals and other leakage points. Furthermore, the initial RCS cooldown starting at 2 hours into the event would result in a significant contraction of the RCS inventory, to the extent that the pressurizer would drain and a vapor void would form in the upper head of the reactor vessel. As is typical of operating PWRs, prior to implementing the Phase 2 FLEX strategy, Ginna does not have a fully robust capability for active RCS makeup. However, passive injection from the nitrogen-pressurized accumulators would occur as the RCS is depressurized below the accumulator cover gas pressure, which would result in the addition of borated coolant to the RCS. As discussed further below, the licensee has determined that (1) sufficient reactor coolant inventory would be available throughout Phase 1 to support heat transfer to the SGs via natural circulation without crediting the active injection of RCS makeup, and (2) according to the core operating history specified in NEI 12-06, a sufficient concentration of xenon-135 should exist in the reactor core to ensure subcriticality throughout Phase 1, considering the planned cooldown profile.

Procedure ECA-0.0 directs operators to isolate or vent the accumulators before continuing the RCS cooldown past the point at which nitrogen gas could be injected into the RCS. As noted above, per the licensee's primary strategy, the initial cooldown that begins in Phase 1 will be stopped when SG pressure reaches 360 psig, which the licensee calculates will prevent injection of the accumulator cover gas into the RCS. The NRC staff confirmatory calculations concur that this setpoint should have adequate margin to prevent injection of the nitrogen cover gas during an analyzed ELAP event. Procedure ECA-0.0 further includes a contingency strategy to feed the SGs with lower-pressure pumps, which may require additional depressurization to obtain sufficient flow for core decay heat removal. In this case, ECA-0.0 would direct SG depressurization to a pressure of 290 psig. This value is in a range that is typical for Westinghouse plants with three or four RCS loops; however, it is relatively low for a two-loop Westinghouse plant, which typically has a different accumulator design and configuration. Confirmatory ideal gas calculations performed during the audit by the NRC staff showed that, while nitrogen cover gas injection from the accumulators would not be predicted at an SG pressure of 290 psig using best-estimate parameters, little margin would exist to accommodate long-term containment heatup. Furthermore, a scenario with more limiting accumulator parameters within the range allowed by the Ginna Technical Specifications would allow essentially no margin for containment heatup. Therefore, if the SG pressure control point of 290 psig is used, then isolating or venting the accumulators in a timely manner following the restoration of electrical power would provide increased confidence that potential adverse consequences of nitrogen injection into the RCS (e.g., including interruption of natural circulation flow in the RCS and impedance of vapor condensation) can be avoided for the analyzed ELAP event.

3.2.1.2.2 Phase 2

In order to maintain sufficient borated inventory in Phase 2, the licensee states that a high-pressure, positive-displacement (75 gpm at 1500 psig) RCS injection pump will provide RCS makeup via connections on the safety injection lines. RCS injection will commence no later than 8 hours into the ELAP with loss of normal access to the UHS event. The primary pump is installed in the SAFW building and will be powered by the SAFW DG; an alternate portable FLEX pump with the same capacity is diesel-driven, and would be deployed outside the SAFW building. The portable RCS injection pump would connect via hoses at points on the suction and discharge lines of the installed pump. Both pumps would take suction from the RWST and discharge to the same SI line connections. Another alternate strategy would be to re-power the "B" charging pump (with a capacity of 60 gpm) from the SAFW DG using temporary power cables. The B charging pump already has a suction line to the RWST. This re-powering of installed plant equipment is acceptable to the staff. The licensee stated that the RWST, which is the robust water source used by both primary and alternate strategies, has a minimum volume of 300,000 gallons of borated water, enough for over 60 hours of continuous injection at the maximum rate, which extends beyond the duration of Phase 2.

3.2.1.2.3 Phase 3

In Phase 3, the RCS makeup strategy is a continuation of the Phase 2 strategy, supplemented as needed with equipment provided by the NSRC. At the depressurized condition, the required

RCS injection rate for the analyzed ELAP event is expected to be less than the maximum pumping capacity. As a result, the RWST inventory is expected to last well into Phase 3. Prior to depleting the water volume of the RWST, a mobile boration skid from the NSRC will be aligned to provide indefinite makeup to the RCS; its preferred water supply would be the SAFW DI water storage tank. As discussed above, the DI water storage tank would be replenished from any available on-site source of demineralized water, and if necessary from Lake Ontario through the NSRC water treatment system and portable diesel-driven FLEX pumps. Portable diesel-driven pumps from the NSRC would provide backup to the Ginna FLEX pumps.

3.2.2 Variations to Core Cooling Strategy for Flooding Event

The licensee's FIP states that the SAFW DI water storage tank, the SAFW DG and the SAFW pumps are fully protected from an external flood. The licensee also states that all equipment responsible for RCS makeup and the associated connection points are protected during a beyond-design-basis external flooding event. Both the portable diesel-driven FLEX SG injection pump and portable RCS injection pump are protected from a flood, but not deployable for the approximately 10 hours that the flood is calculated to persist. The staff noted that the FLEX SG injection pump would only need to be deployed within the first 10 hours of the event if the SAFW DG or both SAFW pumps should fail during Phase 1, which would represent a random failure of pre-installed, robust equipment that is beyond the analyzed ELAP scenario posited by NEI 12-06. If the portable RCS injection pump is not deployable during the first 10 hours of the event, the staff notes that the installed FLEX RCS injection pump or repowered installed normal charging pump should be available to provide redundant means for RCS makeup and boration; furthermore, sufficient margin exists for the analyzed ELAP event that establishing RCS injection following recession of the flood at 10 hours should also be acceptable. In addition, the probable maximum flood (PMF) would be extreme regional precipitation, which would be preceded by days of warning time. Ginna's high water flood plan (ER-SC.2, "High Water Flood Plan") directs operators to move portable FLEX equipment and trailers to higher ground as contingency actions in advance of the flooding event.

Therefore, there are no significant variations necessary to support the core cooling and RCS inventory strategies for a flooding event.

3.2.3 Staff Evaluations

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

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

In the FIP, Section 3.4.1 states that an SAFW DG will power the SAFW pumps taking suction from the SAFW DI water storage tank to provide cooling water to the steam generators in the event that the TDAFW pump or CST are unavailable. The licensee indicated that the SAFW pumps are manually realigned to take suction from the SAFW DI water storage tank and manually realigned to be fed power from the new SAFW DG. The SAFW pump flow is manually controlled using a local throttle valve to maintain steam generator level as communicated to the local operator by operators in the control room. The NRC staff noted that the SAFW building houses the SAFW system, both of which were designed to Seismic Category I, per UFSAR Table 3.2-1. During its audit, the staff reviewed engineering document ECP-13-00421, "DDSAFW Project Standby Auxiliary Feedwater Building Annex," and noted that the SAFW Annex, which houses the SAFW DG, is also a robust structure. In the UFSAR, Section 3.3.3.3.8 discusses the tornado missile protection for the SAFW system including portions of the discharge piping on one train that is not missile protected. The UFSAR also discusses the availability of an existing cross-connect such that the other SAFW train, which is fully tornado missile protected, can provide sufficient feedwater flow to both steam generators. During its audit, the licensee indicated that the SAFW Annex is flood protected and is designed to ensure the building remains functional during a flooding event. The licensee also confirmed that the SAFW building exterior door will be replaced with one that can withstand flooding and tornado wind and missiles. Thus, the staff finds the SAFW system and SAFW Building/Annex are robust and are expected to be available at the start of an ELAP event consistent with NEI 12-06, Section 3.2.1.3. In the FIP, Section 9 indicates that operators will be procedurally directed to enter the SAFW Building/Annex to take local actions to initiate and control SAFW flow and initiate alternate RCS injection during an ELAP event, which is consistent with the performance attributes in NEI 12-06, Table D-1. The staff's evaluation of the robustness and availability of FLEX connection points for the FLEX SG makeup pump is discussed in SE Section 3.7.3.1. Equipment operation during loss of heating and ventilation during an ELAP event will be addressed in SE Section 3.9.

In the FIP, Sections 3.3 and 3.4.2 indicate that local-manual operation of the SG ARVs is credited to remove decay heat as directed by operators in the control room. In the UFSAR, Section 10.3.2.5 states that the ARVs are Seismic Category I as part of the main steam line pressure boundary and that the piping and restraints necessary to ensure the valves function after a seismic event are also Seismic Category I. In the UFSAR, Section 10.3.2.3 indicates that the ARVs are located in the Intermediate Building (Seismic Category I structure per UFSAR Table 3.2-1). Although the Intermediate Building is a Seismic Category I structure, the licensee identified that the concrete block walls surrounding the building must be reinforced to ensure they can withstand a seismic event and withstand tornado wind loads and missiles such that the ARVs will not be damaged. In the FIP, Section 3.4.2 states that engineering document ECP-14-000727, "Harden Masonry Walls Surrounding Cable Tunnel Entrance to Protect Vital Instrumentation Following a Seismic Event or Tornado," involves erecting a structural frame on the Intermediate Building north concrete wall and attaching steel plates to this frame. The staff noted that this modification should ensure the ARVs are not damaged following a seismic or tornado event and will be available during an ELAP event. During the staff's audit, the licensee confirmed that the ARVs are not susceptible to flooding concerns. Thus, the staff finds the ARVs housed in the Intermediate Building are robust and are expected to be available during an ELAP event consistent with NEI 12-06, Section 3.2.1.3. Personnel habitability during an ELAP event is addressed in SE Section 3.9.

The Phase 1 core cooling FLEX strategy relies on the SAFW DI water storage tank as the water source for the SAFW pumps. The Phase 2 core cooling FLEX strategy relies on a portable diesel-driven FLEX pump with suction from Lake Ontario via the discharge canal to refill the SAFW DI water storage tank as the continued suction source for the SAFW pumps. This portable diesel-driven FLEX pump can also be used to directly inject into the steam generators with suction from Lake Ontario via the discharge canal or the SAFW DI water storage tank. The Phase 3 core cooling FLEX strategy relies on Lake Ontario via the discharge canal, in conjunction with a mobile water treatment system delivered by the NSRC. The staff's evaluation of the robustness and availability of the SAFW DI water storage tank and Lake Ontario via the discharge canal for an ELAP event is discussed in SE Section 3.10.1.

In the FIP, Section 4.6 indicates that the Phase 1 RCS inventory control FLEX strategy uses the alternate RCS injection system with injection into the RCS cold leg via the safety injection (SI) lines. The alternate RCS injection pump, which is permanently installed in the SAFW building, takes suction from the RWST and discharges into the RCS cold leg, via the SI "A" and "B" headers. A trailer-mounted diesel-driven RCS injection FLEX pump is provided as a redundant pump to the permanently installed pump. The licensee stated that hose connections provide the ability to connect the portable RCS injection FLEX pump to the hard-piped alternate RCS injection system. An additional alternate injection strategy has been developed by the licensee to repower charging pump 'B' from the SAFW DG to inject from the RWST to the RCS via the charging system regenerative heat exchanger.

Regarding the permanently installed alternate RCS injection system, the NRC staff noted it is located in the SAFW building, which is a Seismic Category I structure per UFSAR Table 3.2-1. The staff also noted that the SI piping, which is routed through the auxiliary building and containment, is Seismic Category I per UFSAR Table 3.2-1. The staff finds the alternate RCS injection system and SI piping is robust and is expected to be available during an ELAP event consistent with NEI 12-06, Section 3.2.1.3. The staff's evaluation of the robustness and availability of the FLEX connection point for the portable FLEX RCS injection pump is discussed in SE Section 3.7.3.1. Equipment operation with loss of heating and ventilation during an ELAP for the alternate RCS injection pump is discussed in SE Section 3.9.

Regarding charging pump 'B', the staff noted that the charging pumps and associated discharge piping are Seismic Category I per UFSAR Table 3.2-1. In the UFSAR, Section 3.6.2.5.1.8 states that the charging pumps are located in the basement of the auxiliary building (Seismic Category I) in a concrete room. In the UFSAR, Section 2.4.7 indicates that the auxiliary building is not subject to external flooding as the flood protection protects to a flood level of 273.8 feet (plant elevations are measured relative to mean sea level). Thus, the staff finds the charging pump 'B' and associated piping housed in the auxiliary building are robust and are expected to be available during an ELAP event consistent with NEI 12-06, Section 3.2.1.3. Equipment operation during loss of heating and ventilation during an ELAP event for charging pump 'B' is discussed in SE Section 3.9.

The Phase 1 RCS inventory control FLEX strategy relies on injection from the passive SI accumulators for RCS inventory control and long-term sub-criticality. The licensee's sequence of events timeline in its FIP indicates that no FLEX RCS makeup is needed prior to 8 hours; thus, the licensee's strategy does not rely upon any other plant SSCs. The Phase 2 RCS inventory control FLEX strategy relies on the use of the RWST as the borated water source. The Phase 3 RCS inventory control FLEX strategy relies on Lake Ontario via the discharge canal in conjunction with a mobile boration unit and water treatment system delivered by the NSRC. The staff's evaluation of the robustness and availability of the SI accumulators, the RWST and Lake Ontario via the discharge canal for an ELAP event is discussed in SE Section 3.10.2.

3.2.3.1.2 Plant Instrumentation

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

- SG Pressure
- SG Level (narrow range)
- RCS Hot Leg Temperature
- RCS Cold Leg Temperature
- RCS Pressure (wide range)
- Core Exit Thermocouple
- Pressurizer Level
- Reactor Vessel Level Indication System
- Source Range Detectors
- RWST Level
- DC Bus Voltage

These instruments are initially powered by vital station batteries. In Phase 2, the protected battery chargers are powered by the 1-MW SAFW DG (primary strategy), or by a 100-kW FLEX DG (alternate strategy). If the normal power supply to instrumentation is lost, procedure FSG-7, "Loss of Vital Instrumentation or Control Power", identifies instrumentation to take local readings of necessary parameters, along with guidance to repower instruments for necessary parameters at the instrument racks if field wiring is intact. If the field wiring is not intact, operators will be able to obtain readings at the appropriate containment penetration.

3.2.3.2 Thermal-Hydraulic Analyses

As identified in the licensee's FIP, Ginna's timeline for mitigating the analyzed ELAP event was developed based on plant-specific thermal-hydraulic analyses that were performed using the RELAP5 / MOD3.3 Patch 03 code. During the onsite audit, licensee calculation RWA-1323-003, "Ginna RELAP5 ELAP Analysis for Mode 1," was assessed by NRC staff. The staff recognized that some assumptions in Ginna's calculation appear conservative, most notably the assumed initial RCS leakage rate. However, the NRC staff also identified a number of potential nonconservatisms in the calculation. For instance, a SG depressurization terminus of 260 psig was assumed in the analysis, whereas the primary mitigating strategy in procedure ECA-0.0 would direct that SG depressurization be halted at 360 psig. Thus, the analysis would overestimate the accumulator inventory injected and tend to underestimate RCS leakage at the depressurized condition, both of which would tend to overestimate the available coping time. The licensee's plant-specific calculational method further did not consider the potential for a long-term increase in the RCS leakage rate due to hydrothermal corrosion degradation impacts on the RCP seal faceplates (discussed further in following section of this evaluation). Full resolution of these issues and a thorough review of the licensee's plant-specific analytical modeling techniques during the onsite audit was not feasible. As a result, the NRC staff could not endorse the conclusions of the licensee's plant-specific calculation and instead focused its attention on the Pressurized-Water Reactor Owners Group's (PWROG's) generic code calculations for Westinghouse plants.

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

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

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

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

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

The calculated results from WCAP-17601-P were subsequently analyzed further by the PWROG, and estimated times to enter reflux cooling were documented in PWROG-14027-P. The applicable time to reflux cooling for a two-loop Category 1 plant calculated in PWROG-14027-P is 16.3 hours. However, the NRC staff noted that the time to reflux determined in PWROG-14027-P did not consider the potential for increased leakage due to seal faceplate degradation that could occur in an ELAP event due to the loss-of-seal cooling. This phenomenon is discussed in greater detail in the subsequent section of this evaluation. Accordingly, the NRC staff performed confirmatory calculations to determine the expected impact. On the basis of these calculations, the NRC staff concluded that providing RCS makeup by approximately 13 hours into the event would maintain adequate natural circulation flow in the RCS. The licensee's strategy to provide at least 60 gpm of RCS makeup by 8 hours into the event conservatively satisfies this time constraint. Moreover, the licensee's FIP states that it is likely that charging to the RCS could commence earlier than 8 hours into the event, if appropriate based on reactor vessel level and/or pressurizer level.

Therefore, based on the evaluation above, the NRC staff concludes that application of the PWROG's generic analytical approach to Ginna, as modified to account for expected RCP seal leakage and other plant-specific parameters, should appropriately determine the sequence of events for reactor core cooling, including time-sensitive operator actions, and evaluate the required equipment to mitigate the analyzed ELAP event, including pump sizing and cooling water capacity.

3.2.3.3 Reactor Coolant Pump Seals

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

The two RCPs at Ginna are Westinghouse Model 93 pumps, and use standard three-stage Westinghouse seal packages. As noted in Section 3.2.3.2, the licensee's mitigating strategy was developed based on the results of a plant-specific thermal-hydraulic analysis performed with the RELAP5/MOD3.3 code to determine the time at which makeup would be required to maintain adequate natural circulation flow in the RCS. The plant-specific analysis assumed a leakage rate at nominal post-trip cold leg conditions (i.e., 2250 per square inch absolute (psia) and 550 °F) of 25 gpm for each RCP, plus an additional 11 gpm of operational leakage from the RCS (i.e., total initial leakage rate of 61 gpm). As noted above, these leakage rates are higher than the leakage assumed in the ELAP analysis in WCAP-17601-P. Furthermore, the plant-specific leakage rates remain higher than the values in WCAP-17601-P following RCS depressurization, as both the licensee's plant-specific analysis and the generic NOTRUMP analysis predict that seal leakage will decrease according to the critical flow correlations modeled in the applicable thermal-hydraulic codes. However, as noted in the previous section of this evaluation, the NRC staff's evaluation of the licensee's mitigating strategy for core cooling and reactor coolant inventory did not rely upon the licensee's plant-specific RELAP5 calculation because, among other reasons, it did not use a representative terminal pressure for the RCS cooldown and it did not address the potential for hydrothermal corrosion to result in long-term leakage rate increases.

Therefore, to assess the effectiveness of Ginna's strategy for providing RCS makeup to maintain adequate natural circulation flow, the staff based its evaluation upon the generic thermal-hydraulic analysis performed with the NOTRUMP code, as documented in WCAP-17601-P and PWROG-14064-P. In accordance with analysis and testing documented in WCAP-10541-P, Revision 2, "Westinghouse Owners Group Report, Reactor Coolant Pump Seal Performance Following a Loss of All AC Power," the ELAP analysis in WCAP-17601-P assumed a leakage rate at nominal post-trip cold leg conditions (i.e., 2250 psia and 550°F) of 21 gpm for each of the four RCPs, plus an additional 1 gpm of operational leakage. In the WCAP-17601-P analysis, both seal and operational leakage were assumed to vary according to the critical flow correlation modeled in the NOTRUMP code as the reactor was cooled down and depressurized.

Subsequent assessments of RCP seal leakage behavior under ELAP conditions by industry analysts and NRC staff identified several issues with the original treatment of seal leakage from standard Westinghouse seal packages. These concerns are documented in Westinghouse Nuclear Safety Advisory Letter (NSAL) 14-1, dated February 10, 2014, including (1) the initial post-trip leakage rate of 21 gpm does not apply to all Westinghouse pressurized-water reactors due to variation in seal leakoff line hydraulic configurations, (2) seal leakage does not appear to decrease with pressure as rapidly as predicted by the analysis in WCAP-17601-P, and (3) some reactors may experience post-trip cold leg temperatures in excess of 550 °F, depending on the lowest main steam safety valve lift setpoint. To address these issues, the PWROG performed additional analytical calculations using Westinghouse's seal leakage model (i.e., ITCHSEAL). These calculations included (1) benchmarking calculations against data from RCP seal leakage testing and (2) additional generic calculations for several groups of plants (categorized by similarity of first-stage seal leakoff line design) to determine the maximum leakage rates as well as the maximum pressures that may be experienced in the first-stage seal leakoff line piping.

PWROG-14015-P, Rev. 2, "No. 1 Seal Flow Rate for Westinghouse Reactor Coolant Pumps Following Loss of All AC Power - Task 2: Determine Seal Flow Rates" provides much greater detail for the expected seal leakage values expected during a loss of all ac power compared to the generic information provided in NSAL 14-1. Ginna is considered a "Category 1" plant within PWROG-14015-P Revision 2. The category signifies the seal leak-off line piping configuration that was analyzed within the document to summarize the expected leak rates for that configuration. Categorization of the different plants is documented within PWROG-14008-P.

The NRC staff requested that the licensee confirm that applicable portions of the first-stage seal leakoff line piping can withstand the maximum pressure experienced during an ELAP event. According to generic calculations performed by Westinghouse using the ITCHSEAL code, Category 1 plants (such as Ginna) would be expected to experience choked flow at the flow-measurement orifice in the first-stage seal leakoff line, even after completion of the initial RCS cooldown. Therefore, to support application of the generic Category 1 leakage rates, it is necessary for the licensee to demonstrate that a rupture in the pressure boundary of leakoff line piping or components upstream and inclusive of the flow orifice would not occur at Ginna. The licensee informed the NRC staff that the applicable portions of the leakoff line piping and components can tolerate pressures greater than or equal to RCS design pressure (i.e., 2500 psia) at a fluid temperature of 568 °F. Thus, the licensee's analysis concluded that the functionality of the first-stage seal leakoff lines should not be challenged during an analyzed ELAP event and the calculated leakage rates should be applicable to Ginna.

In support of beyond-design-basis mitigating strategy reviews, the NRC staff performed an audit of the PWROG's generic effort to determine the expected seal leakage rates for Westinghouse RCPs under loss-of-seal-cooling conditions. A key audit issue was the capability of Westinghouse's ITCHSEAL code to reproduce measured seal leakage rates under representative conditions. Considering known testing and operational events according to their applicability to the thermal-hydraulic conditions associated with the analyzed ELAP event, the benchmarking effort focused on comparisons of ITCHSEAL simulations to data from WCAP-10541-P that documents an RCP seal leakage test performed in the mid-1980s at Électricité de France's Montereau facility. Comparisons of analytical results to the Montereau data indicated that, while the ITCHSEAL code could not simultaneously obtain good agreement with respect to RCS pressure, the leakage rate simulated by ITCHSEAL could be tuned to reproduce the measured seal leakage rate data. Subsequent to the benchmarking effort, data from an additional RCP seal leakage test at the Montereau facility that had not been documented in WCAP-10541-P was brought to the staff's attention. The leakage rate during this test was significantly higher than that of the test in WCAP-10541-P that had been used to benchmark the ITCHSEAL code. However, conservative margin was identified in the ITCHSEAL analyses (e.g., PWROG-14015-P, PWROG-14027-P), which the staff determined should offset the potential for increased leakage rates observed in the additional Montereau test.

In conjunction with the revised seal leakage analysis that Westinghouse performed for the first-stage seal, as described above, the PWROG's generic effort also sought to demonstrate that the second-stage seal will remain fully closed during the ELAP event. If the second-stage seal were to open, additional leakage past the second-stage seal could add to the first-stage seal leakoff line flow that has been considered in the licensee's evaluation. Previous calculations documented in WCAP-10541-P indicated that second-stage seal closure could be maintained under the set of station blackout conditions and associated assumptions analyzed therein. Recent calculations performed by Westinghouse and AREVA in support of PWR licensees' mitigating strategies indicated that both vendors also expected the second-stage seals essentially to remain closed throughout the ELAP event, even when the RCS is cooled down and depressurized in accordance with a typical strategy. Contrary to these analytical calculations, two recent RCP seal leakage tests performed as part of AREVA's seal development program (discussed further below) have indicated that the second-stage seals could open and remain open under ELAP conditions. This unexpected phenomenon occurred near the end of the tests and could not be fully understood and evaluated by the vendors or NRC staff, based upon the limited data available. While considering these limitations, the staff observed that the opening of the second-stage seal did not appear to result in an increase in the total rate of leakage measured during the two AREVA tests.

On March 3, 2015, Westinghouse issued Technical Bulletin (TB) 15-1, "Reactor Coolant System Temperature and Pressure Limits for the No. 2 Reactor Coolant Pump Seal." Through TB 15-1, Westinghouse communicated to affected customers that long-term integrity of Westinghouse-designed second-stage RCP seals could not be supported by the available analysis, and recommended that affected plants execute an extended cooldown of the RCS to less than 350 °F and 400 psig by 24 hours into the ELAP event. Second-stage seal integrity appears necessary to ensure that leakage from Westinghouse-designed RCP seals can be limited to a rate that can be offset by the FLEX equipment typically available for RCS injection under ELAP conditions. As noted above, the mitigating strategy documented in Ginna's FIP does satisfy Westinghouse's TB 15-1 recommendation.

The seal leakoff analysis discussed above assumes no failure of the seal design, including the elastomeric o-rings. During the audit review, the licensee stated that not all installed RCP seal o-rings at Ginna are the high-temperature-qualified 7228-C type: the "B" RCP has some o-rings of the earlier 7228-B design. Unlike subsequent designs, 7228-B and earlier o-rings were not specifically qualified to withstand extended exposure to the maximum temperatures that could be experienced by Ginna and many other PWRs during a loss-of-seal-cooling event. In its review of the impact of these 7228-B o-rings with respect to the beyond-design-basis ELAP event, the NRC staff considered the following relevant information provided during the audit: (1) 7228-B o-rings have been qualified for a temperature reasonably close to the maximum temperature applicable to Ginna for an extended period of time, (2) the licensee intends to initiate the RCS cooldown without delay, (3) the 7228-B o-rings are installed at locations that were shown in WCAP-10541-P, Revision 2, not to be limiting for o-ring qualification, and (4) the licensee's intent henceforth to use only o-rings qualified for the maximum temperatures applicable to Ginna during an ELAP event. Based on these factors, the staff's audit review concluded that o-ring failure for Ginna during a beyond-design-basis ELAP event would not be expected.

During the audit review, the licensee confirmed that, following the loss of seal cooling that results from the ELAP event, seal cooling would not be restored. The NRC staff considers this practice appropriate because it prevents thermal shock, which, as described in NRC Information Notice 2005-14, "Fire Protection Findings on Loss of Seal Cooling to Westinghouse Reactor Coolant Pumps," could lead to increased seal leakage.

In addition, the NRC staff audited information associated with the more recent RCP seal leakage testing performed by AREVA. The AREVA testing showed a gradual increase in the measured first-stage seal leakage rate, which post-test inspection and analysis tied to hydrothermal corrosion of silicon nitride (likely assisted by flow erosion). Silicon nitride ceramic is used to fabricate the first-stage seal faceplates currently in operation in Westinghouse-designed RCP seals, including those at Ginna. This material degradation phenomenon would not have been present in the Montereau testing because that test article's faceplates were fabricated from aluminum oxide (consistent with the seals of actual Westinghouse-designed RCPs of that era). However, hydrothermal corrosion of silicon nitride became an audit focus area because the test data indicates that the long-term seal leakage rate could exceed the values assumed in the licensee's analysis. Academic research reviewed by the industry and NRC staff associated with this general phenomenon indicates that the corrosion rate is temperature dependent. The NRC staff understands that the PWROG is currently working to address the potential for this phenomenon to result in gradually increasing leakage rates from Westinghouse-style RCP seals.

From the limited information available regarding the recent AREVA tests, as well as several sensitivity calculations performed by the NRC staff during the audit, the NRC staff concluded that (1) the leakage rate for silicon-nitride RCP seals may be lower initially than had been predicted analytically by the PWROG's generic analysis using ITCHSEAL, (2) the RCP seal leakage rate during Phase 2 and/or Phase 3 of the ELAP event may increase beyond the long-term rate predicted analytically by the PWROG, and (3) certain aspects of the seal behavior observed in the AREVA tests did not appear consistent with the expected behavior based on models and theory that formed the basis for the WCAP and PWROG reports discussed above.

Based on these observations, the NRC staff estimated the potential effect of hydrothermal corrosion on the RCP seal leakage rate for Ginna, considering in particular the following relevant plant-specific considerations:

- Ginna has a relatively low minimum main steam safety valve lift setpoint and, furthermore, prior to the initial RCS cooldown, plans to use the SG ARVs to slightly reduce the RCS temperature approximately half an hour into the event, both of which tend to reduce the rate of hydrothermal corrosion,

- as is typical for a Westinghouse two-loop plant, following the initial RCS cooldown, the RCS cold-leg temperature will remain slightly higher than Westinghouse three- and four-loop plants (e.g., approximately 440 °F versus 420 °F), which leads to a higher corrosion rate during this period,

- while Ginna has to consider leakage from two RCPs, it has an RCS makeup capacity that is greater than that typically employed by Westinghouse three- and four-loop plants, and

- within 24 hours of the ELAP event initiation, the licensee plans to cool the RCS cold leg to 350 °F or below, which should terminate the hydrothermal corrosion reaction and halt the gradual increase in leakage from the RCP seals.

The licensee's FIP states that RCS makeup would be initiated within 8 hours at a flow rate of 75 gpm (60 gpm if the repowered charging pump is used). This flow capacity significantly exceeds the total rate of RCS leakage expected following RCS depressurization for the analyzed ELAP event, even considering the potential impacts of hydrothermal corrosion. Thus, implementation of the licensee's mitigating strategy would lead to the RCS being refilled with liquid to the desired level control point, thereby assuring that adequate core cooling will be maintained via natural circulation. According to the NRC staff's estimate for the analyzed ELAP event, the inventory in the RWST should supply reactor inventory needs for an extended period (e.g., approximately 6 days). Subsequently, if additional RCS makeup is required from FLEX equipment to support indefinite coping, the staff expects that the flow capability of the NSRC-supplied mobile boration unit should be sufficient to compensate for ongoing RCS leakage that may occur during the analyzed ELAP event.

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

3.2.3.4 Shutdown Margin Analyses

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

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

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

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

During the audit, the NRC staff reviewed the licensee's shutdown margin calculation. According to the FIP, borated water from the RWST will be injected into the RCS no later than 8 hours into the event. The licensee's shutdown margin analysis conservatively determined that the injection of borated coolant should begin by 14 hours into the event to ensure that recriticality can be avoided as the core xenon concentration decays away. The calculation of the time for initiating RCS boration was based upon the conservative assumption of an initial RCS temperature of 350 °F. The licensee further determined the required rate of injection to maintain the reactor subcritical by considering the boration rate necessary to counterbalance the rate of reactivity increase due to xenon decay. The licensee calculated that a minimum RCS makeup rate of 9 gpm of borated water from the RWST, in conjunction with RCS letdown via the reactor vessel head vent, would provide sufficient capacity to maintain the reactor subcritical. The licensee's analysis considered several cases, which varied the assumed values for accumulator injection volume and RCS leakage. According to this method, the licensee calculated that 20,239 gallons of RWST water, which is borated to a minimum concentration of 2750 ppm, would be necessary to borate the RCS to a concentration that would ensure adequate shutdown margin at 350 °F in the worst-case scenario. Administrative controls ensure that this volume will remain valid for future core designs. This volume is well within the 300,000-gallon approximate usable volume in the RWST.

Toward the end of an operating cycle, when the RCS boron concentration reaches its minimum value, some PWR licensees may need to vent the RCS to ensure that their FLEX strategies can inject a volume of borated coolant that is sufficient to satisfy shutdown margin requirements in cases where minimal RCS leakage occurs. During the audit, the licensee discussed Ginna's capability to conduct RCS venting in the case that letdown from the RCS is necessary. The licensee stated that, in this case, operators would follow the direction of FSG-8 to open the reactor vessel upper head vent valves; in the event that head vent valves are not available (which would constitute a random equipment failure not assumed in ELAP analysis) the procedure directs operators to lower RCS pressure using a power-operated relief valve (PORV). The procedure states that a PORV should only be used if no other means to depressurize the RCS is available. The licensee indicated that the head vent path would be opened in response to high pressurizer pressure or level, and closed again on indication of low pressure level, or if the RCS injection pump fails.

The licensee's FIP notes several key aspects of its shutdown margin analysis that satisfy and in some cases conservatively surpass endorsed regulatory guidance, including:

- Zero RCS leakage through the RCP seals is assumed, which maximizes the required boron injection.
- Limiting core conditions are assumed with regard to power history, time-in-life, initial RCS boron concentration, and xenon concentration.

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

- The required timing and quantity of borated makeup should consider conditions with no RCS leakage and with the highest applicable leakage rate.

- Adequate borated makeup should be provided either (1) prior to the RCS natural circulation flow decreasing below the flow rate corresponding to single-phase natural circulation, or (2) if provided later, then the negative reactivity from the injected boric acid should not be credited until one hour after the flow rate in the RCS has been restored and maintained above the flow rate corresponding to single-phase natural circulation.

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

During the audit review, the licensee confirmed that Ginna will comply with the August 15, 2013, position paper on boric acid mixing, including the conditions imposed in the staff's corresponding endorsement letter.

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

3.2.3.5 FLEX Pumps and Water Supplies

In the FIP, Section 3.6 states that engineering analysis DA-ME-15-005 predicts the performance of the portable diesel-driven FLEX pump when feeding the steam generators with the suction aligned to Lake Ontario. The licensee stated that its analysis predicts that the pump is capable of delivering 232 gpm split to both generators (116 gpm each) if the steam generators are at 305 psia. The licensee explained that 305 psia was selected as the steam generator target pressure after approximately 6 hours of effective SAFW flow per RWA-1323-003, Ginna RELAP5 ELAP Analysis for Mode 1. The staff noted that DA-ME-15-005 accounted for use of different suction sources, hose paths, and frictional losses to determine adequate performance criteria for the portable diesel-driven FLEX pump providing make-up to the steam generators. The credited water source for Phase 2 and 3 during an ELAP event to support core cooling is Lake Ontario. In addition, this calculation determined that available net positive suction head

(NPSH) based on vendor supplied pump curves exceeds the required NPSH to accomplish the FLEX core cooling strategies.

During its audit, the staff noted that the portable RCS injection FLEX pump is a belt driven triplex positive displacement pump with a 100 HP motor that can provide a maximum discharge flow and pressure of approximately 78 gpm at 1585 psi, per ECP-14-000169-015-7B-01, "Alternate RCS Injection Pump Capability." The licensee also determined through a hydraulic assessment, which considered flow resistance through valves and hoses, that this pump with suction from the RWST is capable of supporting the FLEX RCS inventory strategy. The staff noted that in order for the portable RCS injection FLEX pump to use the full contents of the RWST a booster pump is required once the RWST reaches a certain level. The licensee determined in DA-ME-15-005 that the FLEX booster pump is sized adequately even if 75 gpm of charging was used when the RWST reaches its lowest level, which is not an expected condition, since the RCS will have been cooled down and depressurized.

Based on its review, the NRC staff concludes that the licensee has demonstrated that its portable diesel-driven SG injection FLEX pump, portable RCS injection FLEX pump and portable FLEX booster pump are capable of supporting the licensee's FLEX strategies if implementation is performed as described by the licensee.

3.2.3.6 Electrical Analyses

The licensee's FIP defines strategies capable of mitigating a simultaneous loss of all ac power and loss of normal access to the UHS resulting from a BDBEE by providing the capability to maintain or restore core cooling. The licensee's electrical strategy is the same for RCS inventory control, core cooling, containment and SFP cooling, except as noted in Sections 3.3.4.4 and 3.4.4.4 of this SE. Furthermore, the electrical coping strategies are the same for all modes of operation.

The NRC staff reviewed the licensee's FIP to determine whether the FLEX strategies, if implemented appropriately, should maintain or restore core cooling, containment, and spent fuel pool cooling following a BDBEE. As part of its review, the NRC staff reviewed conceptual electrical single-line diagrams, summaries of calculations for sizing the FLEX diesel and turbine generators and station batteries, and summaries of calculations that addressed the effects of temperature on the electrical equipment credited in the FIP as a result of loss of heating, ventilation, and air conditioning (HVAC) during an ELAP as a result of a BDBEE.

According to the licensee's FIP, the Ginna operators would declare an ELAP following a loss of offsite power, loss of all emergency DGs, and the loss of any alternate ac power with a simultaneous loss of normal access to the UHS. In its FIP, the licensee assumes that this determination can be made within 1 hour after the onset of an ELAP with loss of normal access to the UHS event.

During the first phase of the ELAP event, the licensee's FLEX mitigation strategy involves relying on installed plant equipment and onsite resources, such as the use of a pre-staged 1 MW FLEX DG, installed Class 1E station safety-related batteries, vital inverters, and the Class 1E dc distribution system to provide support to instrumentation for monitoring parameters and support to controls for SSCs used to maintain the key safety functions (reactor core cooling, RCS inventory control, and containment integrity). The 1 MW SAFW FLEX DG is located in the

SAFW Annex and its electrical distribution system is completely independent, and physically separated from the plant electrical distribution system except at the connection to the manual transfer switches. The safety-related batteries are located in the control building on the lower level, which is a Seismic Category I structure. The batteries are therefore protected from the applicable extreme external hazards. This equipment is considered robust and protected with respect to applicable site external hazards since they are located within safety-related, Seismic Class 1 structures. Procedure ECA-0.0, "Loss of All AC Power," Revision 4 and FLEX Support Guideline (FSG)-4, "ELAP DC Bus Load Shed/Management," Revision 0, directs operators to conserve dc power during the event by stripping nonessential loads. The plant operators would commence stripping, or load shedding, dc loads within 1 hour after the occurrence of an ELAP with loss of normal access to the UHS event. The licensee expects load shedding to be completed within 20 minutes after initiation of load shedding. This action will ensure the functional capability of the vital station batteries to at least 8 hours after the event to allow battery charging to be initiated using the permanently installed 1 MW SAFW FLEX DG or the backup 100 kW portable FLEX DG. The 125 Vdc safety-related batteries at Ginna consist of two battery banks (Battery A and Battery B). The safety-related batteries are GNB NCN-21 that are rated for 1408 ampere-hours at an 8 hour discharge rate to 1.81 V per cell.

During the onsite audit, NRC staff reviewed dc coping calculations, DA-EE-97-069, "Sizing of Vital Batteries A and B," Revision 6, DA-EE-2001-028, "Vital Battery 8 Hour Capacity," Revision 1, and DA-EE-99-047, "125 VDC System Loads and Voltages," Revision 1, which verified the capability of the dc system to supply the required loads during the first phase of the Ginna FLEX mitigation strategy plan for an ELAP as a result of a BDBEE. The licensee's analysis identified the required loads and their associated ratings (amperage and minimum voltage) that would be shed to ensure battery operation for at least 8 hours.

During Phase 2, the licensee strategy includes repowering one or more of the protected battery chargers for the 125 Vdc batteries within 8 hours using the 1 MW SAFW FLEX DG to ensure vital instrumentation remains powered. A portable 100 kW, 480 Vac, 3-phase FLEX DG is available to be connected to one or more of the protected battery chargers for the 125 Vdc batteries to ensure vital instrumentation remains powered as an alternate. The 100 kW FLEX DG will be transported to outside the SAFW Annex overhead door or the east outside entrance to the Technical Support Center (TSC). The 1 MW SAFW FLEX DG and the portable 100 kW FLEX DG have integral diesel fuel tanks capable of 9 and 19 hours full load fuel supply, respectively.

The NRC staff reviewed the licensee's Phase 2 FLEX generator analysis and procedures EDOC-MISC-2013-0044, "DDSAFW Project: Electrical Scope," Revision 1, FSG-4, "ELAP DC Bus Load Shed/Management," Revision 0, FSG-5, "Initial Assessment and Flex Equipment Staging," Revision 1, conceptual single line diagrams, and the separation and isolation of the FLEX DGs from the Class 1E equipment. Based on the NRC staff's review, the minimum required Phase 2 loads for the 1 MW SAFW FLEX DG and 100 kW FLEX DG is 747 kW and 77 kW, respectively. Furthermore, the licensee's Phase 2 electrical strategy ensures that the safety-related battery chargers will be energized prior to the batteries depleting below minimum acceptable voltage.

For Phase 3, the licensee plans to continue the Phase 2 coping strategy with additional assistance provided from offsite equipment/resources. The offsite resources that will be provided by the NSRC include two 1 MW 4160 Vac 3-phase turbine generators (TGs), one 1

MW 480 Vac 3-phase TG, and a 4160 Vac distribution panel (including cables and connectors). The 4160 Vac TGs are capable of supplying approximately 1 MW each, and the licensee's plan is to operate them in parallel to provide approximately 2 MW total. Based on the licensee's analysis EDOC-MISC-2015-0042, "Fukushima FLEX Phase 3 Electrical Support Evaluation," Revision 0, the minimum required loads equate to 750 kW. Sufficient margin exists between the calculated loading and the capacity of the 4160 Vac TGs to ensure that the minimum required loads can function as expected. The capacity of the NSRC-supplied 480 Vac TG is equivalent to the capacity of the 1 MW 480 Vac SAFW FLEX DG. Therefore, the NRC staff finds that the Phase 3, 4160 Vac and 480 Vac TGs will have adequate capacity to supply power to the electrical loads (same as Phase 2) to maintain or restore core cooling, SFP cooling, and containment indefinitely following an ELAP.

Based on its review, the NRC staff finds that the plant batteries used in the strategy should have sufficient capacity to support the licensee's strategy, and that the FLEX DGs and turbine generators that the licensee plans to use 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 RCS inventory during an ELAP event consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.3 Spent Fuel Pool Cooling Strategies

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

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. 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.

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.

Ginna has one SFP, which is a Seismic Category I design, reinforced-concrete structure located in the west end of the auxiliary building.

3.3.1 Phase 1

In the FIP, Section 7 states that the Phase 1 SFP cooling FLEX strategy uses the SFP level instrumentation installed in response to Order EA-12-051 to monitor the SFP water level. Water addition is not required before the end of Phase 1; thus, there are no required actions for Phase 1. The staff noted that deployment of hoses to support SFP cooling strategies and opening a vent pathway for the SFP would be accomplished early in the ELAP event as directed by FSGs.

3.3.2 Phase 2

In the FIP, Section 7 also indicates that the Phase 2 SFP cooling FLEX strategy maintains adequate level in the SFP to protect the stored spent fuel and limit radiation dose to personnel near the SFP; thus, multiple strategies for establishing a diverse means of SFP makeup are provided in its FSG.

The primary SFP makeup strategy is accomplished using a portable diesel-driven FLEX pump taking suction from Lake Ontario via the discharge canal with a non-collapsible suction hose. The discharge hose is routed and tied-down to the edge of the SFP and sufficient flow will be established to recover and maintain SFP level.

An alternate SFP makeup strategy is accomplished using the same portable diesel-driven FLEX pump but with the discharge hose routed to Blitz fire nozzles located within 75 feet of the SFP to establish spray in order to recover and maintain SFP level. Another alternate SFP makeup strategy is accomplished by connecting the discharge hose to a flanged connection point at V-8662 in the SFP cooling system located in the auxiliary building basement, which allows for a fill path without accessing the SFP walkway. Ventilation of the generated steam is accomplished by opening doors in the auxiliary building and canister preparation building, as well as the auxiliary building tornado dampers.

3.3.3 Phase 3

FIP Section 7 states that the same strategies employed in Phase 2 can be employed in Phase 3 using FLEX equipment or NSRC 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) SFP cooling system is intact, including attached piping.

Based on the licensee's calculation on habitability on the SFP refuel floor and information in the FIP, boiling begins at approximately 5 hours during a full core offload with an initial SFP temperature of 150 ^{0}F and SFP water level in the normal range (between 276'-1.5" and 277'). The licensee determined that it would take approximately 45 hours with those initial conditions for pool water level to drop to a level requiring the addition of makeup to maintain sufficient radiation protection for personnel (Level 2 in Section 4.1 below). The staff noted that guideline FSG-11, "Alternate SFP Makeup and Cooling," provides cautions to the operators regarding steam from SFP boiling and radiation levels should SFP level drop below 258'. In addition, the sequence of events timeline in the FIP indicates that 9 hours into the ELAP event operators will be dispatched to set up for SFP makeup. Therefore, based on the scenarios and the cautions identified in the FSGs, the staff finds it reasonable that operators can safely enter the area of the SFP and deploy FLEX equipment.

In the FIP, Section 7 describes that the Phase 1 SFP cooling strategy does not require any anticipated actions. However, the licensee does establish a ventilation path to cope with temperature, humidity and condensation from evaporation or boiling of the SFP. The operators are directed by guideline FSG-5 to manually open overhead doors in the auxiliary building and canister preparation building to establish a vent path.

The licensee's Phase 2 and Phase 3 SFP cooling strategy involves use of the portable FLEX pump (or NSRC-supplied pump for Phase 3), with suction from the Lake Ontario via the discharge canal, to supply water to the SFP. The staff's evaluation of the robustness and availability of FLEX connections points for the FLEX pump is discussed in Section 3.7.3.1 below. Furthermore, the staff's evaluation of the robustness and availability of Lake Ontario via the discharge canal for an ELAP event is discussed in Section 3.10.3.

3.3.4.1.2 Plant Instrumentation

In its FIP, the licensee stated that the instrumentation for SFP level will meet the requirements of Order EA-12-051. Furthermore, the licensee stated that these instruments will have initial local battery power and the capability for channel LT-311 to be powered from the SAFW DG. The NRC staff's review of the SFP level instrumentation, including the primary and back-up channels, the display to monitor the SFP water level and environmental qualifications to operate reliably for an extended period are discussed in Section 4 of this SE.

3.3.4.2 Thermal-Hydraulic Analyses

FIP Section 7 and UFSAR Table 9.1-6 indicate that with a full core offload and initial SFP temperature of 150 °F, the time to reach 212 °F (boiling) in the SFP is about 5 hours with an associated boil-off rate of about 53 gpm. In the UFSAR, Sections 9.1.2.2 and 9.1.2.6 state that the SFP contains approximately 255,000 gallons of water and the top of the fuel assemblies is approximately 26 feet below the surface of the water. The licensee stated that with a boil-off rate of 53 gpm and approximately 6,352 gallons per foot of SFP water level it will take approximately 2 hours to boil off 1 foot of SFP water level, and therefore about 40 hours to boil down to the Level 2 setting of 257' discussed in Section 4.1 below, where there may start to be significant increases in the radiation levels around the SFP.

The staff concludes that based on the lower SFP heat load during power operations (because there will not be a full core offload) a flowrate of less than 53 gpm is required to maintain adequate level in the SFP to protect the stored spent fuel and limit exposure to personnel.

Based on the evaluation above, the NRC staff finds that the licensee has provided a thorough analysis that considered the maximum design basis SFP heat load for the site consistent with NEI 12-06, Section 3.2.1.6.

3.3.4.3 FLEX Pumps and Water Supplies

As described in FIP Section 7, the SFP cooling strategy relies on a FLEX pump to provide SFP makeup during Phase 2. In the FIP, Section 7 also describes the hydraulic performance criteria (e.g., flow rate, discharge pressure) for the FLEX Pump. The staff noted that the performance criteria of a FLEX pump supplied from an NSRC for Phase 3 would allow the NSRC pump to fulfill the mission of the onsite FLEX pump if the onsite FLEX pump were to fail. As stated in the FIP, a SFP makeup rate of 53 gpm meets or exceed the maximum SFP makeup requirements as outlined in SE Section 3.3.4.2.

The staff noted that engineering analysis DA-ME-15-005, "FLEX RHR/CCW/SW Hydraulic Model," predicts the portable diesel-driven FLEX pump performance providing makeup to the SFP with the suction aligned to Lake Ontario, which is the credited water source for Phase 2 and 3 during an ELAP event. The licensee stated that its analysis predicts the pump is capable of delivering 53 gpm to the SFP and 232 gpm split to both generators (116 gpm each). The staff noted that this calculation accounted for use of different suction sources, hose paths, frictional losses to determine adequate performance criteria for the portable diesel-driven FLEX pump providing make-up to the steam generators. This calculation determined that available NPSH exceeds the required NPSH from vendor-supplied pump curves so that the pump should be able to accomplish the FLEX SFP inventory control strategy.

The staff noted that NEI 12-06, Table D-3, states, in part, that the performance attributes for SFP cooling include a minimum spray rate of 200 gpm per unit to the pool or 250 gpm per unit if overspray occurs. The licensee acknowledged that it did not perform a hydraulic analysis to demonstrate that its FLEX pumps can provide a minimum spray rate of 200 gpm to the pool or 250 gpm if overspray occurs. The licensee indicated that its SFP is not subject to seismically induced failures that can lead to a rapid draining of the SFP. The staff noted this is an alternative approach to NEI 12-06 due to the reliance on an evaluation to demonstrate that the SFP cannot drain as a result of a seismic event in lieu of the recommended performance attributes discussed in NEI 12-06, Table D-3, for SFP spray. The NRC staff approved this alternative in Section 3.14.5.

3.3.4.4 Electrical Analyses

The licensee's FIP defines strategies capable of mitigating a simultaneous ELAP and loss of normal access to the UHS resulting from a beyond-design-basis external event (BDBEE) by providing the capability to maintain or restore SFP cooling (the licensee's strategy for SFP cooling uses the same electrical strategy as for maintaining or restoring core cooling and containment functions). Furthermore, the electrical coping strategies are the same for all modes of operation.

The NRC staff performed a comprehensive analysis of the licensee's electrical strategies, which includes the SFP cooling strategy. The NRC staff's review is discussed in detail in Section 3.2.3.6.

3.3.5 Conclusions

The NRC staff concludes that the licensee has methods for SFP makeup stated in NEI 12-06, Table D-3, with the capability for a flow rate exceeding the boil-off rate based on a conservative plant-specific analysis of the fuel's decay heat. However, as discussed in Section 3.3.4.3 above, the staff concludes that the licensee's capability does not fully meet the conditions of NEI 12-06, but does meet the requirements of Order EA-12-049. The NRC staff finds that this is an acceptable alternative to NEI 12-06. Refer to Section 3.14.5 for additional information.

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, with an approved alternative, and should adequately address the requirements of the order.

3.4 Containment Function Strategies

The industry guidance document, NEI 12-06, Table 3-2, provides some examples of acceptable approaches for demonstrating the baseline capability of the containment strategies to effectively maintain containment functions during all phases of an ELAP event. One such approach is for a licensee to perform an analysis demonstrating that containment pressure control is not challenged.

In accordance with NEI 12-06, the licensee performed a containment evaluation, RWA-1403-001, "GOTHIC FLEX Containment Analysis," Revision 0, which was based on the boundary conditions described in Section 2 of NEI 12-06. The calculation concludes that, even with the licensee taking no mitigating actions related to removing heat from the containment for at least 72 hours, the containment parameters of pressure and temperature remain well below the respective design parameters of 60 psig and 286 °F documented in UFSAR Table 3.11-1. From its review of this containment evaluation, the NRC staff noted that the required actions to maintain containment integrity and required instrumentation functions have been developed, and are summarized below.

Eventual containment cooling and depressurization to normal values may utilize off-site equipment and resources during Phase 3 if onsite capability is not restored.

3.4.1 Phase 1

In the FIP, Section 6.4 states containment temperature and pressure are expected to remain below design limits for at least 72 hours. For Mode 1, the analysis shows that with no operator actions, containment pressure will slowly increase to less than 20 psig over 72 hours and containment temperature will slowly increase to 220 °F over the same 72 hours. Since 20 psig is below the containment design pressure of 60 psig (UFSAR Table 3.11-1) and 220 °F is below the containment design temperature of 286 °F (UFSAR Table 3.11-1), no mitigation actions are necessary to maintain or restore containment cooling during Phases 1 or 2.

3.4.2 Phase 2

In the FIP, Section 6.6 states that no mitigation actions are necessary or planned to maintain or restore containment cooling during Phase 2 for Modes 1 through 4. Containment temperature and pressure are expected to remain below design limits for at least 72 hours; however, containment status will be monitored.

3.4.3 Phase 3

In the FIP, Section 6.7 states that for Modes 1 through 4, to minimize impacts on instrument operation in containment, actions can be taken during Phase 3 to maintain containment pressure less than 20 psig. At approximately 35 hours from the start of the ELAP event, equipment provided from an NSRC is available to power one or more containment recirculation fans (CRFs) and supply cooling water from Lake Ontario to one or more CRF coolers (CRFCs). RWA-1403-001 shows that one CRF and associated CRFC placed in service at 35 hours will reduce containment pressure and temperature. Procedure ECA-0.0, "Loss of All AC Power," directs performing FSG-12, "Alternate Containment Cooling," to restore containment cooling using NSRC-supplied equipment. The licensee stated that the NSRC equipment will be used if containment temperature is greater than 200 °F or containment pressure is greater than 15 psig.

3.4.4 Staff Evaluations

3.4.4.1 Availability of Structures, Systems, and Components

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

3.4.4.1.1 Plant SSCs

In the UFSAR, Section 3.8.1.1.1 states that the reactor containment structure is a reinforced-concrete vertical right cylinder with a flat base and a hemispherical dome. The containment structure is 99 feet high to the spring line of the dome and has an inside diameter of 105 feet.

The cylindrical reinforced concrete walls are 3 feet 6 inches thick, and the concrete hemispherical dome is 2 feet 6 inches thick. The concrete base slab is 2 feet thick with an additional thickness of concrete fill of 2 feet over the bottom liner plate. The containment cylinder is founded on rock (sandstone) by means of post-tensioned rock anchors, which ensure that the rock then acts as an integral part of the containment structure. The hemispherical dome is reinforced concrete designed for all moments, axial loads, and shears resulting from the loading conditions described in this section. The staff noted that being a Seismic Category I structure, the containment has been designed to maintain its function following a safe shutdown earthquake (SSE).

In the UFSAR, Section 3.8.1.1.1 also states that the containment provides a minimum free volume of approximately 997,000 cubic feet. The addition of mass and energy to the containment atmosphere during an ELAP event is driven by the assumed, initial leakage rate of 61 gpm (25 gpm per seal at 2250 psia plus 10 gpm worst case technical specification identified leakage plus 1 gpm worst case technical specification unidentified leakage). The staff noted that the relatively small amount of heat and mass being added to the containment atmosphere coupled with the very large net free volume of the containment results in a slow-moving response. As stated in SE Section 3.4.1, the licensee's calculation shows that even with no mitigating actions being taken to remove heat from the containment, the containment parameters of pressure and temperature remain well below the respective design limits of 60 psig and 286 °F in excess of 72 hours.

In the UFSAR, Section 6.2.2.1.2.1 states that the containment recirculation fan cooling system, which consists of four CRFC units, each including motor, fan, cooling coils, moisture separators and high efficiency particulate air filters, duct distribution system, and instrumentation and controls, are designed as Seismic Category I. Thus, the staff finds the containment recirculation fan cooling system is robust and is expected to be available to support an ELAP event consistent with NEI 12-06, Section 3.2.1.3. The staff noted that the containment analysis shows there is an extensive amount of time before any containment heat removal action would be required following an ELAP-initiating event and the expected arrival of offsite resources could also restore other available methods of containment heat removal.

3.4.4.1.2 Plant Instrumentation

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

Guideline FSG-7, "Loss of Vital Instrumentation or Control Power," implements a strategy to take a field (local) reading of containment pressure at a containment pressure transmitter using a pressure test gauge, along with guidance to repower a containment pressure instrument if field wiring is intact. PT-945, a containment pressure transmitter, is located on the middle level of the auxiliary building and is therefore protected from tornado or missile damage. The sensing line for PT-945 would be available to attach a pressure gage and take local readings in accordance with FSG-7.

3.4.4.2 Thermal-Hydraulic Analyses

During the audit process, the NRC staff reviewed analysis RWA-1403-001, "GOTHIC FLEX Containment Analysis," Revision 0. In this calculation, the licensee utilized the Generation of Thermal-Hydraulic Information for Containments (GOTHIC) version 8.0 code to model the containment response to an ELAP for Modes 1 and 5, and benchmarked the results against previous LOCA analyses. The only additions of heat and mass to the containment atmosphere under ELAP conditions are the heat loads from the reactor coolant system and main steam system (e.g., from the surfaces of hot equipment and the leakage of reactor coolant from the RCP seals). Specifically, Case 1 (which is the bounding case for Mode 1 operation) of the calculation evaluated the containment response with an initial leakage of 61 gpm (25 gpm per seal at 2250 psia plus 10 gpm worst case technical specification identified leakage plus 1 gpm worst case technical specification unidentified leakage).

Using the input described above, the containment peak pressure at the end of the 72-hour period before a mitigation action was taken in the analysis was calculated to be less than 20 psig and the temperature rose to less than 220 °F. These values are still far below the UFSAR design parameters of 60 psig and 286 °F, so the licensee has adequately demonstrated that there is significant margin before a limit would be reached.

3.4.4.3 FLEX Pumps and Water Supplies

In the FIP, Section 6.4 states that the containment temperature and pressure are expected to remain below design limits for at least 72 hours. The licensee also stated that for Mode 1, RWA-1403-001, "GOTHIC FLEX Containment Analysis," Revision 0, demonstrated that with no operator actions, the containment pressure will slowly increase to less than 20 psig over 72 hours and containment temperature will slowly increase to 220 °F over the same 72 hours. Since 20 psig and 220 °F is below containment design pressure and temperature of 60 psig and 286 °F (UFSAR Table 3.11-1), the licensee determined that no mitigation actions are necessary to maintain or restore containment cooling during Phases 1 or 2.

Thus, the staff noted that the licensee's containment integrity strategies do not rely on the use of FLEX pumps and water sources for maintaining containment pressure or temperature below the design limits for at least 72 hours, at which time off-site resources should be available to initiate containment cooling.

In the FIP, Section 6.7 states that during Phase 3, equipment provided from an NSRC can be available to power one or more CRFs and supply cooling water from Lake Ontario to one or more CRFCs. Guideline FSG-12, "Alternate Containment Cooling," provides guidance to restore containment cooling using NSRC-supplied equipment to repower CSFs and supply water to CRFCs if containment temperature is greater than 200 °F or containment pressure is greater than 15 psig.

3.4.4.4 Electrical Analyses

The licensee performed a containment evaluation based on the boundary conditions described in Section 2 of NEI 12-06 to determine the temperature and pressure increase in the containment resulting from an ELAP as a result of a BDBEE. Based on the results of the evaluation, the licensee developed required actions to ensure maintenance of containment integrity and required instrumentation function. For Phase 1 and 2, the licensee concluded that no actions were required as part of their strategy, aside from monitoring containment pressure. Containment temperature and pressure are expected to remain below design limits for at least 72 hours. Therefore, actions to reduce containment temperature and pressure and to ensure continued functionality of the key parameters will not be required immediately.

The Phase 3 coping strategy is to use the 4160 Vac TGs provided by the NSRC to repower containment recirculation fans within 35 hours to reduce containment pressure and temperature. The NRC staff reviewed the licensee's analysis EDOC-MISC-2015-0042, "Fukushima FLEX Phase 3 Electrical Support Evaluation," Revision 0, conceptual single line electrical diagrams, the separation and isolation of the FLEX TGs from the Class 1E EDGs, and procedures that direct operators how to align, connect, and protect associated systems and components. Based on its review of the licensee's analysis, the NRC staff confirmed that two 1 MW 4160 Vac TGs will provide sufficient capacity and capability to supply the necessary loads following an ELAP to maintain core cooling and containment. Refer to Section 3.2.3.6 above for additional electrical analysis.

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. NEI 12-06 directed licensees to proceed with evaluating external hazards based on currently available information. For most licensees, this meant that the OIP used the current design basis information for hazard evaluation. Coincident with the issuance of Order EA-12-049, on March 12, 2012, the NRC staff issued a Request for Information pursuant to Title 10 of the *Code of Federal Regulations* Part 50, Section 50.54(f) [Reference 19] (hereafter referred to as the 50.54(f) letter), which requested that licensees reevaluate the seismic and flooding hazards at their sites using updated hazard information and current regulatory guidance and methodologies. Due to the time needed to reevaluate the hazards, and for the NRC to review and approve them, the reevaluated hazards were generally not available until after the mitigation strategies had been developed. The NRC staff has developed a proposed rule, titled "Mitigation of Beyond-Design-Basis Events," hereafter called the MBDBE rule, which was published for comment in the Federal Register on November 13, 2015 [Reference 57]. The proposed MBDBE rule would make the intent of Orders EA-12-049 and EA-12-051 generically applicable to all present and future power reactor licensees, while also requiring that licensees consider the reevaluated hazard information developed in response to the 50.54(f) letter.

The NRC staff requested Commission guidance related to the relationship between the reevaluated flooding hazards provided in response to the 50.54(f) letter and the requirements for Order EA-12-049 and the MBDBE rulemaking (see COMSECY-14-0037, Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards") [Reference 47]. The Commission provided guidance in an SRM to COMSECY-14-0037 [Reference 20]. 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 damage 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 37], 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, Revision 0, and the related industry guidance in NEI 12-06, Revision 0. The hazard reevaluations may also identify issues to be entered into the licensee's corrective action program consistent with the OIPs submitted in accordance with Order EA-12-049.

As discussed above, licensees are reevaluating the site seismic and flood hazards as requested in the NRC's 50.54(f) letter. After the NRC staff approves the reevaluated hazards, licensees will use this information to perform flood and seismic mitigating strategies assessments (MSAs) per the guidance in NEI 12-06, Revision 2, Appendices G and H [Reference 58]. The NRC staff endorsed Revision 2 of NEI 12-06 in JLD-ISG-2012-01, Revision 1 [Reference 54]. 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. Licensees will submit the MSAs for NRC staff review.

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

3.5.1 Seismic

In its FIP, the licensee stated that seismic hazards are applicable to the site. As stated in UFSAR Section 2.5.2.2, 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 the numbers above, is often used as a shortened way to describe the hazard.

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

3.5.2 Flooding

In its FIP the licensee stated that Ginna is a "wet" site, which means that portions of the plant are below the design-basis flood level. UFSAR Section 2.4.2.1 states that the plant is protected from flooding from Lake Ontario by a breakwater with a top elevation of 261 feet above mean sea level (ft msl). The source of the event that leads to the design-basis flood level of elevation 273.8 ft msl is an extreme regional precipitation event which floods Deer Creek (a stream running alongside the plant) to that height, resulting in the probable maximum flood (PMF). The UFSAR states that the main plant area and buildings are at elevation 270 ft msl, and that the equipment required for safe plant shutdown is protected to 273.8 ft msl. The warning time would be days and the persistence of the flooding onsite would be about 10 hours. Thus, Ginna screened in for assessing external flooding impact.

The current design-basis for local intense precipitation (LIP), as discussed in Section 2.4.2.2 of the UFSAR, evaluates flooding to a height of 254.5 ft msl at the screen house, which is the limiting location, and concludes that the LIP will not affect safety-related equipment.

With regard to internal flooding sources, in its FIP the licensee stated that failure of non-seismically qualified tanks in the auxiliary building could cause flooding in the auxiliary building subbasement where the residual heat removal (RHR) pumps are located. However, RHR pumps are not used in the initial FLEX response. The licensee stated that the intermediate building, SAFW building, SAFW building annex, containment, and control building do not have non-seismically qualified water sources that could cause internal flooding following a seismic event.

With regard to potential impact of ground water in-leakage, during the audit the licensee described that dewatering pumps and hoses have been purchased for removing accumulated water from structures required for deployment of FLEX strategies. Their use is prescribed within procedure ER-SC.2.

In its FIP, the licensee stated that Ginna is not impacted by failure of a non-seismically robust downstream dam.

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

3.5.3 High Winds

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

The screening for high wind hazards associated with hurricanes should be accomplished by comparing the site location to NEI 12-06, Figure 7-1, from 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, Rev. 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, Rev. 1.

In its FIP, regarding the determination of applicable extreme external hazards, the licensee stated that the site is located at 43°16.7' north latitude and 77°18.7' west longitude. In NEI 12-06 Figure 7-2, Recommended Tornado Design Wind Speeds for the 1E-6/year Probability Level, indicates the site is in region 2, where the recommended 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. Using the guidance of NEI 12-06, Section 7.3.1, the licensee should apply the plant's design basis for high wind hazards.

In its FIP, the licensee also stated that per Figure 7-1 of NEI 12-06, Ginna has a 1 in 1 million chance per year of a hurricane induced peak-gust wind speed of 120 mph. As this is less than 130 mph, the site does not need to assess the impact of extreme straight winds.

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

3.5.4 Snow, Ice, and Extreme Cold

As discussed in NEI 12-06, Section 8.2.1, all licensees 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.

In its FIP, regarding the determination of applicable extreme external hazards, the licensee stated that Ginna is located at latitude 43°16.7'N and longitude 77°18.7'W. Ginna is located above the 35th parallel; thus, the capability to address hindrances caused by extreme snowfall with snow removal equipment is provided. As stated in UFSAR Section 2.3.2.2, the extreme minimum temperature appropriate to the Ginna site is 2 °F (equaled or exceeded 99 percent of the time). The measured minimum temperature for the site region is -16 °F, which occurred in February 1961. Ginna is located within the region characterized by NEI 12-06, Figure 8-2, as ice severity level 5.

As stated in UFSAR Section 2.3.2.2, mean annual snowfall in the site region is approximately 86 inches. In the site area, a maximum monthly snowfall occurred in February 1958 and totaled 72.6 inches. The maximum measured snow depth on the ground for the site region is 48 inches. Highly localized effects operate to produce snowfalls in the Lake Ontario "snow belt" along the southern and eastern shores of the lake.

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

3.5.5 Extreme Heat

In the section of its FIP regarding the determination of applicable extreme external hazards, the licensee stated that, as per NEI 12-06 Section 9.2, all sites are required to consider the impact of extreme high temperatures. As stated in UFSAR Section 2.3.2.2, the extreme maximum temperature appropriate to the Ginna site is 91 °F (equaled or exceeded 1 percent of the time). Per the UFSAR, the measured maximum temperature for the site region is 100 °F, which occurred in June 1953.

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

3.5.6 Conclusions

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

3.6 Planned Protection of FLEX Equipment

3.6.1 Protection from External Hazards

In its FIP, the licensee described that it is proposing an alternative approach to NEI 12-06 for protection of FLEX equipment as stated in Section 5.3.1 (seismic,) Section 7.3.1 (severe storms with high winds), and Section 8.3.1 (impact of snow, ice and extreme cold). This alternative approach will be to store the necessary FLEX equipment ("N" set) in fully robust buildings and the backup (N+1) set of equipment in a commercial building. For all hazards scoped in for the site, the FLEX equipment will be stored in a configuration such that no one external event can reasonably fail the site FLEX capability (N).

Specifically, in its FIP the licensee stated that all "N" equipment used to mitigate post ELAP events are either permanently installed in a robust structure and properly anchored, capable of resisting BDBEE, or are portable equipment anchored in place in robust armored Sea Vans which can resist flooding, seismic forces, and tornado winds/missiles.

The "N+1" equipment provides a portable means of providing redundant or diverse means of accomplishing post-ELAP functions. Designated N+1 equipment is stored in a commercial building analyzed in accordance with the American Society of Civil Engineers standard ASCE 7-10, Minimum Design Loads for Buildings and Other Structures, that protects the equipment from weather hazards, but which does not have sufficient separation from the robust structure housing "N" equipment to preclude simultaneous damage from a tornado.

There is also certain equipment used to support post-ELAP functions. This equipment consists of a tow truck, a debris remover, two hose trailers, and two fuel trailers. This support equipment is stored in areas which are separated from each other by the width of a site-specific tornado (1040 feet), accounting for the prevailing tornado path for the region (southwest to northeast).

The licensee's alternative approach is discussed in Section 3.14.2, below. Provision of at least N+1 sets of portable on-site equipment stored in diverse locations or in structures designed to reasonably protect from applicable BDBEEs provides some assurance that N sets of FLEX equipment will remain deployable to assure success of the FLEX strategies.

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

3.6.1.1 Seismic

In addition to the information stated in Section 3.6.1, above, in its FIP the licensee also stated that large portable FLEX equipment are secured, as appropriate, to protect them during a seismic event, and stored equipment and structures were evaluated and protected from seismic interactions, as appropriate, to preclude interaction during a seismic event that could cause damage to the equipment.

3.6.1.2 Flooding

Ginna is a "wet" site which means that portions of the plant are below the design basis flood level. In its FIP, the licensee stated that all "N" equipment used to mitigate post ELAP events are either permanently installed in a robust structure and properly anchored, capable of resisting BDBEE, or are portable equipment anchored in place in robust armored Sea Vans which can resist flooding, seismic forces, and tornado winds/missiles.

In its FIP, Exelon stated it will meet all of the requirements in NEI 12-06 Section 6.2.3.1 for the external flood hazard.

3.6.1.3 High Winds

In its FIP, the licensee stated that, consistent with NEI 12-06, Section 7.3.1.1.a., the structural walls and roof of the new "robust structure" housing the "N" set of FLEX mitigation equipment were designed to the Regulatory Guide 1.76 tornado wind speed and suite of tornado missiles. However, the building's entranceway and openings (e.g., as needed for ventilation) are designed to withstand the plant's design basis tornado (i.e., 132 mph wind speed) and tornado missile spectrum. The NRC staff find this acceptable because, as discussed in Section 3.5.3 above, the NEI 12-06 guidance is to apply the plant's design-basis for high wind hazards.

In its FIP, the licensee stated that any stored mitigation equipment exposed to the wind would be adequately tied down to prevent it from being damaged or becoming airborne.

3.6.1.4 Snow, Ice, Extreme Cold and Extreme Heat

With regard to extreme cold temperatures, in its FIP the licensee stated that storage of FLEX equipment would account for the fact that the equipment will need to function in a timely manner. The equipment would be maintained at a temperature within a range to ensure its likely function when called upon. For example, by storage in a heated enclosure or by direct heating (e.g., jacket water, battery, engine block heater, etc.).

In its FIP, the licensee stated it will meet all of the requirements in NEI 12-06 Section 9.3.1 for impact of high temperatures.

3.6.2 Reliability of FLEX Equipment

Section 3.2.2 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 multiple strategies to accomplish a function, in which case the equipment associated with each strategy does not require an additional spare.

In its FIP, the licensee describes the FLEX "N" and "N+1" equipment and their functions. A table in the FIP lists all the major components by the served safety function, applicable external hazard(s), and their connection points.

The FIP also describes certain equipment used to support post-ELAP functions. This equipment consists of a tow truck, a debris remover, two hose trailers, and two fuel trailers. This support equipment is stored separate from each other in areas which are separated by the width of a site-specific tornado (1040 feet), accounting for the prevailing tornado path for the region (southwest to northeast).

In its FIP, the licensee also proposes an alternative approach to the N+1 requirement applicable to hoses and cables as stated in Section 3.2.2 of NEI 12-06. This is discussed in Section 3.14.3, below.

Based on the number of portable FLEX pumps, FLEX DGs, and support equipment identified in the FIP and during the audit review, the NRC staff finds that, if implemented appropriately, the licensee's FLEX strategies include a sufficient number of portable FLEX pumps, FLEX DGs, and equipment for RCS makeup and boration, SFP makeup, and maintaining containment consistent with the N+1 recommendation in Section 3.2.2 of NEI 12-06.

3.6.3 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, with certain approved alternatives to NEI 12-06 as discussed in Section 3.14, and should adequately address the requirements of the order.

3.7 Planned Deployment of FLEX Equipment

In its FIP, the licensee stated that plant procedures identify primary and alternate deployment routes for Phase 2 portable FLEX equipment and specify the deployment path maintenance and availability requirements. There is no planned movement or deployment of equipment that specifically requires electrical power, so no power supply strategy is required. Any required movement of gates, doors, fences, etc. can be performed by manual action. In-plant storage areas are uniquely identified to ensure equipment is available at all times to support the associated FLEX strategy. Identification of FLEX equipment, connections, and storage locations is with labels of black lettering on a green background to highlight the unique uses for this equipment and facilities.

3.7.1 Means of Deployment

In its FIP, the licensee stated that the site has a large payloader vehicle, as well as a large pickup truck with a snow plow, to remove debris caused by a BDBEE. Each vehicle also has equipment to check for live wires in downed power lines. Each vehicle is also equipped with a pintle hitch, which can be used to transport mitigation equipment, such as the 100 kW DG, the portable satellite trailer, the FLEX pumps, the fuel trailers, the hose trailers, and the air compressors to their deployment points. There is also an electric trailer caddy, capable of moving any of the FLEX mitigation equipment, stored in a robust structure.

3.7.2 Deployment Strategies

As described in the Ginna UFSAR Section 2.5.3, two on-site slopes whose failures may be of safety concern are a known condition. The results of the slope analyses performed by the NRC staff during the Systematic Evaluation Program show that the factors of safety against slope failure under both static and earthquake loading conditions are less than unity, indicating that these slopes are not stable. At the first slope, northwest of the turbine building and inside the plant protected area, there is no structure nor equipment located within or adjacent to the slope except the roadway which encircles the power block. Therefore, the failure of that slope would not pose any safety concern but might close the section of the road near the turbine building. The road is not needed for the deployment of FLEX equipment. The second slope, east of the screen house, is sufficiently removed from any required safety-related equipment. Thus, its failure would not be a safety concern.

With regard to FLEX deployment after a seismic event that may impact the identified unstable slopes, in its FIP the licensee stated that a soil liquefaction analysis was performed to ensure FLEX equipment could be deployed down the paths to reach the pumping location at the discharge canal following a seismic event. The following conclusions from the analysis are noted:

- Liquefaction is not a concern for the large majority of the soil samples tested.
- The slopes to the west and east remain serviceable following an earthquake with no liquefaction concern.
- The roadway at the toe of the west slope remains serviceable.

For the FLEX implementation project (deployment path, not structures), based on conclusions from the analysis and information provided by the licensee during the audit the NRC staff finds it is reasonable to assume that these slopes are the bounding case during a seismic event considering the site's topographic profile. Localized liquefaction of soils on the deployment path will not have a substantial effect due to:

- Of the reviewed soil samples, limited soil samples were noted to be capable of liquefaction.
- There are no large loads (structures or bridges) located on deployment paths (universal stress field).
- The soil is confined (flat areas with no slopes to fail).
- If liquefaction occurs during a seismic event, some soil strength will be regained over time following the event.

Debris removal vehicles may be utilized to negate effects of liquefaction and transit the deployment path due to their large tire size.

In its FIP, the licensee stated that during a flood, access to the UHS (Lake Ontario) will be temporarily unavailable due to floodwater on site. Flooding reevaluation results show that the persistence of the flood is approximately 10 hours. Ginna has installed a 160,000 gallon SAFW DI water storage tank, which has adequate inventory for approximately 24 hours of heat removal. This tank is protected from all events (seismic, tornado and flood), and will be used for decay heat removal from the reactor core until the UHS is available.

To provide water from Lake Ontario once any flood water recedes, in its FIP the licensee described that a diesel-driven FLEX pump stored in the SAFW annex will be used (the +1 pump is stored in the "L" building). Associated hoses are stored on trailers. The pumped water is used to refill the SAFW DI water storage tank which supplies makeup for the SGs. The FLEX pump and hose trailer are moved to west of the SH with suction for the pump from Lake Ontario via a non-collapsible suction hose. Discharge hoses are run up the east side roadway to a distribution manifold. In addition, the manifold allows branch lines to be laid into the AB to provide makeup to the SFP.

In the area of the discharge canal there are multiple locations to place a FLEX pump suction hose into the discharge canal to provide makeup to the SAFW DI water storage tank or SGs if the preferred area (by the grating) is blocked.

FLEX suction hoses have a strainer installed on the end of the hose. Each strainer has approximately 3.7 times the surface area of the non-collapsible suction hose. Strainer perforation diameter is 3/8". There are 19 holes per row and 50 rows around the diameter of the strainer, giving an approximate surface area of 105 square inches (in^2). Non-collapsible suction hoses are 6" diameter giving a surface area of approximately 28 in^2. There are two suction strainers available. In the unlikely event that one becomes clogged there would be a brief interruption to shut down the pump, swap strainers, and restart the pump. Monitoring of pump flow and pressure would indicate a possible clogged suction strainer.

In its FIP, the licensee stated that frazil ice has occurred in the past at the Ginna intake structure. The intake structure is not credited for FLEX. Frazil ice at the suction of hoses dropped into the discharge canal for FLEX or NSRC pumps is reasonably expected to not be a concern requiring special equipment for the following reasons:

- Frazil ice blockage has been managed effectively at Ginna by accelerating and decelerating the water going through the intake structure by changing level in the SH. This agitation has historically been effective at disrupting the frazil ice and re-establishing normal flow rates. For FLEX pumps, the length of hose dropped into the discharge canal is short enough to allow operators to physically agitate the hose to disrupt frazil ice if it were to occur. Alternatively, the FLEX pumps have variable speed engines and discharge valves that could be used to accelerate/decelerate flow similar to the intake structure strategy.

- Frazil ice has occurred at Ginna during late night hours. Operators would be cognizant of the potential for frazil ice during extreme cold conditions and cognizant of the potential vulnerability during late night hours. Margin is available in the FLEX response times and integrated flows/heat removal associated with FLEX pumps and NSRC pumps to accommodate brief periods of flow degradation from FLEX and NSRC pumps for frazil ice management.

Ginna is a wet site and in its FIP the licensee describes activities for deployment of portable equipment during flooding: Plant procedure ER-SC.2 identifies two severity levels that exist with respect to external flooding: Level 1 and Level 2. The symptoms or triggers that initiate a Level 1 flooding condition are as follows: (1) 5 inches of rain over a 24-hour period forecasted in the next 3 days; (2) Shift Manager discretion. The symptoms that initiate a Level 2 flooding condition are as follows: (1) forecasted rainfall of 10 inches or more within the next 24 hours; (2) lake level rises to a level of 252 ft., as noted in the discharge canal and a continued rise is observed or expected; (3) flooding of Deer Creek reaches the access road bridge handrail; (4) wave action causes water splashing over the discharge canal wall or pushes water over the armor stone; (5) flooding of the SH or TB basement; (6) Shift Manager discretion.

Per procedure ER-SC.2, during a Level 1 flooding condition, personnel are dispatched to place FLEX dewatering pumps in the following areas: AB/RHR subbasement; inside engineered barriers in the TB basement near the emergency diesel generator (EDG) rooms and inside engineered barriers in the TB basement near the battery rooms. The 100 KW portable FLEX DG will be staged on the TB operating floor as a source of power for the dewatering pumps. Additionally, in accordance with ER-SC.2, personnel are to move portable FLEX equipment (2 diesel-driven portable FLEX pumps and portable FLEX fuel transfer pump) and trailers to high ground (southwest of the engineering building, or at the high integrity container storage facility, or another location approved by engineering personnel). It should be noted that these are contingency actions and are not credited as FLEX strategies. Credited FLEX equipment consists of the doors and seals of the battery rooms, AHR, and the EDG rooms. No flooding of the AB is anticipated during the PMF.

In its FIP, the licensee states that the required flood barriers used by Ginna are stored immediately adjacent to the openings in which they are to be installed. Additional barriers were purchased for defense-in-depth protection of the EDG rooms and the battery rooms. These are not required to mitigate a flood, and are stored in a storage building on-site.

3.7.3 Connection Points

3.7.3.1 Mechanical Connection Points

Core Cooling

Primary Connection Point

In the FIP, Section 3.6 states the FLEX strategy uses a portable diesel-driven FLEX pump with suction from the SAFW DI water storage tank, or Lake Ontario, to supply the steam generators should the SAFW pumps become unavailable. The staff noted that the portable diesel-driven FLEX pump is connected to the SAFW system via a hose connection point in the SAFW building. As discussed in SE Section 3.2.3.1.1 the SAFW system and SAFW building/annex are robust and protected from applicable external hazards. The staff noted that the discharge of the portable diesel-driven FLEX pump is on the existing cross-connect between the SAFW 'C' and 'D' pumps as shown in FIP Figure 2. The staff noted that the discharge connection point and injection path are robust such that they are protected from applicable external hazards and should be available during an ELAP event consistent with NEI 12-06, Section 3.2.2.

Alternate Connection Point

In the FIP, Section 2.3 proposes an alternative approach to NEI 12-06, Section 3.2.2 and Table D-1, for having primary and alternate injection points to the steam generators for the portable diesel-driven FLEX pump. The licensee stated that its alternative approach is to have one discharge connection point for the portable diesel-driven FLEX pump and that an alternate injection point is not planned due to the multiple and diverse methods of delivering water to the steam generators using the SAFW pumps powered by the SAFW DG.

The licensee stated that only one of the two existing SAFW pumps ('C' or 'D'), located in the SAFW building, is needed for the decay heat removal function and either of these pumps is capable of being powered by the SAFW DG. The licensee explained that either SAFW pump can be aligned to feed both steam generators through their discharge headers and one of two normally isolated cross-connects (one cross-connect is located in the SAFW building and the other cross-connect is located in the auxiliary building). The staff noted that ECP-14-000749, "Standby AFW Cross-Tie (Fukushima)," implemented an SAFW cross-connect modification in the auxiliary building to ensure that SAFW flow can be provided downstream of potentially damaged (from a tornado) SAFW piping. In the UFSAR, Section 3.3.3.3.8 provides additional information regarding the existing cross-connect piping between SAFW Pump 'C' and 'D' and discharge piping vulnerabilities to tornado missiles.

The staff noted that the performance attributes for two injection points through separate divisions/trains was to provide flexibility and diversity so that at least one connection point should be available for applicable external hazards. Instead of an alternate connection point for the portable pump, the licensee's FLEX core cooling strategy provides flexibility and diversity by including three pumps (portable diesel-driven FLEX pump, SAFW 'C' and SAFW 'D' pump) that can provide feedwater to both generators through diverse flow paths via the two cross-connects. The staff finds the lack of an alternate connection point for the portable diesel-driven FLEX pump is an acceptable alternative to NEI 12-06, as the licensee has demonstrated compliance with the order and the licensee's strategy offers flexibility and diversity in the form of multiple pumps and diverse injection paths via cross-connects to maintain or restore core cooling.

RCS Inventory Control

Primary Connection Point

In the FIP, Section 4.6 states that a trailer-mounted diesel-driven RCS injection FLEX pump is being provided as a redundant pump to the permanently mounted alternate RCS injection pump in the SAFW building. The licensee stated that hose connections are provided to connect the portable RCS injection FLEX pump to the hard-piped alternate RCS injection system to take suction from the RWST and discharge to a hose connection with its flow path to either or both of the safety injection lines (Train A or Train B). The staff noted the discharge connection point is located in the SAFW building/annex, which is protected from all applicable external hazards as discussed in SE Section 3.2.3.1.1. The staff noted that the permanently mounted alternate RCS injection FLEX pump discharge connection point and injection paths are robust such that they are protected from applicable external hazards and should be available during an ELAP event, which is consistent with NEI 12-06, Section 3.2.2.

Alternate Connection Point

In the FIP, Section 4.6 states an additional alternate strategy for RCS injection has been developed. This alternate strategy of injecting borated water into the RCS involves repowering charging pump 'B' with the SAFW DG using temporary power cables and manually lining up to inject from the RWST to the RCS using the installed charging line to the RCS through the regenerative heat exchanger.

The staff noted that the licensee's FLEX RCS inventory control strategies involves using the SAFW DG to power the permanently mounted alternate RCS injection pump located in the SAFW building with its discharge into either or both the safety injection 'A/B' lines. In addition, the licensee has the capability to use a portable diesel-driven RCS injection FLEX pump with the same injection path as the permanently mounted alternate RCS injection pump through the safety injection 'A' and 'B' lines.

The NRC staff noted that the performance attributes for two injection points through separate divisions/trains was to provide flexibility and diversity so that at least one connection point should be available for applicable external hazards. The staff noted the licensee's FLEX RCS inventory control strategy includes three pumps (permanently mounted alternate RCS injection pump, portable diesel-driven RCS injection FLEX pump and charging pump 'B') and multiple injection flow paths (via safety injection 'A' or 'B' lines or via the charging line through the regenerative heat exchanger) in order to provide sufficient borated water to the RCS.

SFP Inventory Control

Primary and Alternate Connection Points

In NEI 12-06, Table D-3, states, in part, that the baseline capabilities for SFP cooling include makeup via hoses on the refueling floor, spray capability via portable monitor nozzles from refueling floor and makeup via connection to SFP cooling piping or other alternate location.

In the FIP, Section 7.6 states that the primary SFP makeup strategy is accomplished using the portable diesel-driven FLEX pump (which also supplies the SGs when needed) taking suction from Lake Ontario with the discharge hose routed to the edge of the SFP and tied down. Furthermore, the licensee states that an alternate SFP makeup strategy is accomplished using this portable diesel-driven FLEX pump with the discharge hose routed to Blitz fire nozzles located within 75 feet of the SFP to establish SFP spray. An additional alternate strategy is accomplished by using this portable diesel-driven FLEX pump with the discharge hose routed to a flanged connection point at valve V-8662 on the SFP cooling system. This valve is located in the auxiliary building basement and allows for a fill path at other than the SFP walkway. The staff noted that the connection points and hose deployment paths are located in the auxiliary building, which is a Seismic Category I structure and protected from tornado wind and missiles. In addition, as discussed in SE Section 3.7.2, the licensee expects floodwaters to recede within 10 hours of the initiating event and makeup to the SFP is not required until at least 21 hours into the ELAP event (FIP sequence of events, Action Item 20); thus, floodwaters do not impact operators from implementing the SFP cooling FLEX strategies. Thus, the staff finds the available connection points in the licensee's SFP cooling FLEX strategies are consistent with NEI 12-06, Table D-3, and are protected from applicable external hazards.

3.7.3.2 Electrical Connection Points

Electrical connection points are applicable during all three phases of Ginna's mitigation strategies for a BDBEE. During Phase 1, the licensee plans to power the SAFW pump motors in the SAFW building using the permanently installed SAFW 480 Vac FLEX DG. The normal safety-related bus feed to the SAFW pumps will be isolated by manual disconnect switches which are mechanically linked to the connection switch feed from the SAFW DG, preventing any possible back feed to the safety-related bus. If the SAFW DG were to fail, which is not required to be postulated by the guidance in NEI 12-06, the licensee will utilize a portable diesel-driven FLEX pump as an alternate method of feeding the SGs after reducing the pressure in the SGs.

For Phase 2, the licensee developed a primary and alternate strategy to supply power to the vital battery chargers. The primary strategy is to power one or more of the protected vital battery chargers for the 125 Vdc batteries from the SAFW DG to ensure vital instrumentation remains powered. The normal bus feed to the 125 Vdc battery chargers will be isolated by a manual disconnect switch rated for fault current. Temporary cables will run from the SAFW DG connections in the SAFW annex to a portable distribution panel or to a distribution panel in the waste gas compressor (WGC) room. Cables from the portable distribution panel can be routed to one battery charger on each train. Cables from the distribution panel in the WGC room can be routed to breakers on motor control center (MCC) C and MCC D to power one battery charger for each train. The alternate strategy is to power one or more of the protected battery chargers for the 125 Vdc batteries from the portable 100 kW FLEX DG. This alternate strategy will use two methods to power the battery chargers similar to those used by the SAFW DG. First, the 100 kW FLEX DG will be transported to outside the SAFW annex overhead door to power the distribution panel in the WGC room. Temporary cables will be routed from the 100 kW FLEX DG to a junction box in the SAFW annex to feed the distribution panel in the WGC room and from the distribution panel in the WGC Room to battery charger breakers for each train on MCC C and MCC D. Second, the 100 kW FLEX DG could be transported to the east outside entrance to the TSC to power the portable distribution panel. Temporary cables will be routed from the 100 kW FLEX DG to the portable distribution panel and from the portable distribution panel to one battery charger on each train. Guideline FSG-4 provides guidance for ensuring proper phase rotation and following color coded convention when connecting FLEX cables to the battery charger breakers before attempting to power equipment from the SAFW annex and 100 kW FLEX DGs.

For Phase 3, two NSRC 4160 Vac 1 MW TGs will be connected to an NSRC 4160 Vac distribution center to re-energize the 4160 Vac essential bus. The NSRC distribution center will be connected to the Ginna 4160 Vac switchgear. The preferred deployment location for the two NSRC 4 kV and the one NSRC 480 Vac TGs is outside the auxiliary building overhead door #28. Guideline FSG-5 provides guidance for ensuring proper phase rotation and following color coded convention when connecting FLEX cables to 4160 Vac bus 16. In its FIP, the licensee stated that connections are available to supply the 480 Vac vital buses from the NSRC 480 Vac TG, but there are no explicit steps provided in the FSGs when the equipment is a duplicate.

3.7.4 Accessibility and Lighting

In its FIP, the licensee described that fixed battery-powered emergency lighting units are provided in safety-related areas and other areas which contain fire hazards to facilitate emergency operations, manual fire-fighting, and access to and egress from each designated fire area. The lighting units are 8-hour rated, but are not seismically qualified. In addition to the fixed lighting systems, portable battery-powered hand lights are provided. Safe shutdown panels are located in several areas of the plant. The lighting at the safe shutdown areas has been determined to be sufficient to perform all required safe shutdown tasks.

This determination was made by a lighting survey conducted in conjunction with 10 CFR 50 Appendix R compliance efforts. The control room (CR) 125 Vdc emergency lighting system comes on for loss of ac power and is not load shed during a FLEX event. The CR emergency lighting fixtures are fed from either the A or B station batteries. In the event of loss of either battery there is a transfer switch in the CR by which the operators can manually switch the emergency lighting feed from one train to the other. Should loss of either battery occur in the emergency lighting mode, an 8-hour-rated emergency light fixture located near the transfer switch should remain functional to provide sufficient lighting to perform the transfer. The 125 Vdc power supply up to the point of termination at the emergency lighting fixtures is Class 1E and Seismic Category I. The emergency lighting fixtures are standard fixtures. A prototype fixture has been seismically tested in accordance with the Institute of Electrical and Electronics Engineers (IEEE) standard IEEE-344-1975 to ensure continued operation of the fixtures in the event of an earthquake. In addition, an analysis of the seismically reinforced suspended ceiling has been performed to ensure that the ceiling, including the normal and emergency lighting fixtures, does not create a hazard to CR personnel or safety-related equipment during a seismic event.

Lighting in the SAFW annex building is automatically powered from the SAFW DG when the DG is in operation. Initial lighting in the main SAFW building will be from 8-hour Appendix R battery-powered lighting, with portable flood lights being available to be deployed. The door to the SAFW annex can be opened to help with lighting in the main SAFW building.

There are flashlights and hard hat lights, along with large quantities of batteries, stored in robust protected locations.

3.7.5 Access to Protected and Vital Areas

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

3.7.6 Fueling of FLEX Equipment

In the FIP, Section 8.3.5.1 describes the licensee's refueling strategy that consists of using two 990-gallon towable fuel trailers. The licensee explained that refueling times and actions were incorporated into the timelines for its staffing study and determined that all tasks were able to be accomplished with the available personnel. The fuel oil tank for the SAFW DG is 660 gallons and with a complete refill of this tank, the licensee stated that 330 gallons of fuel oil would remain in the fuel trailers to support an operating FLEX Pump (171 gallons working capacity) and 100 KW DG (144 gallons working capacity). Fuel oil will be drawn from the fuel oil storage tanks using small engine driven pumps discharging to the refueling trailers.

During the audit, the staff noted that the licensee's analysis, DA-ME-14-003, "Fukushima Fuel Consumption Analysis," determined the fuel oil consumption for Phase 1 and Phase 2 equipment. The staff noted the licensee's analysis incorporated conservative assumptions such as all pieces of FLEX equipment would be operating simultaneously at full load, unless justified, for a duration of 72 hours from the start of the event and the consumption of an additional 1000 gallons to account for miscellaneous equipment. In addition, FIP Section 2.1.2 states that there are two refueling tank trailers with each containing 990 gallons of diesel fuel oil that were not considered in the fuel oil consumption analysis. The licensee determined that the minimum amount of diesel fuel oil and gasoline that are required to power FLEX equipment for 72 hours is 9,010 gallons of diesel fuel oil and 68.2 gallons of gasoline. During the staff's audit, the licensee stated that gasoline-powered equipment that supports FLEX strategies are for defense in depth and additional support and are not part of the "N" set of equipment.

FIP Section 8.3.5.1 indicates that there are two safety-related fuel oil storage tanks and two non-safety-related fuel oil storage tanks that can support the licensee's FLEX strategies. The non-safety-related fuel oil storage tanks A and B have a working capacity of 18,000 gallons in each tank, with a minimum storage volume administratively maintained between the two tanks of 19,936 gallons. The safety-related fuel oil storage tanks A and B contain at least 5,000 gallons each as required by Technical Specifications in Modes 1 to 4.

During its audit, the staff noted in DA-ME-14-005, "Reasonable Protection Evaluation of Offsite Fuel Storage Tanks," that the licensee assessed the non-safety-related fuel oil storage tanks, which are outside the plant protected area, for reasonable protection against applicable external hazards. The licensee determined that components within the valve house may be damaged as a result of external hazards; however, damage to the valve house does not prevent the licensee from accessing the manway and nozzles to draw fuel oil from these tanks. In addition, the licensee determined that revisions to its flood preparation procedures were needed to cut and cap the vent lines for these tanks to prevent flood waters from potentially entering. In the FIP, Section 8.3.5.1 states that for the external flood, plugs are inserted into the vent lines to prevent flood water from entering the tanks, as described in procedure ER-SC.2, High Water (Flood) Plan. The staff noted that the licensee has procedural activities to sample and test fuel oil quality from the non-safety-related fuel oil storage tanks in procedure CH-S-BULK-FO, "Sampling Off-Site Diesel Fuel Oil Bulk Storage Tanks," Rev. 00500. Based on the licensee's evaluation and revised procedure, the staff finds that the fuel oil contained in the non-safety-related fuel oil storage tanks A and B are reasonably protected and can be expected to be available to support the licensee's FLEX strategies.

In the UFSAR, Section 8.1.4.1 indicates that the all electrical systems and components (e.g., underground safety-related fuel oil storage tanks that support operation of the emergency diesel generators) vital to plant safety, including the emergency diesel generators, are designed as Seismic Category I and designed so that their integrity is not impaired by the maximum potential earthquake, wind storms or floods. Furthermore, the staff noted that the quality of the fuel oil in these tanks are maintained by the licensee's Technical Specifications. Thus, the staff noted that the underground safety-related fuel oil storage tanks A and B are robust and will be available to support the licensee's FLEX strategies.

Based on the amount of fuel oil needed to support the licensee's FLEX strategies, the staff finds there is sufficient volume in the safety-related fuel oil storage tanks to support at least 72 hours after the start of the ELAP event. Furthermore, the licensee has demonstrated that fuel oil from non-safety-related tanks are reasonably protected as an additional supply of fuel oil. Thus, the staff finds the amount of fuel oil available at the licensee's site is adequate to support its FLEX strategies until fuel oil can be replenished from off-site.

In the FIP, Section 8.3.5.1 states that operators will monitor equipment operation and refuel FLEX equipment, as necessary. Furthermore, FLEX pumps, the FLEX 100 KW DG and the SAFW DG all have fuel gages installed to aid operators in monitoring. The licensee stated that FSG-5, "Initial Assessment and Flex Equipment Staging," provides guidance for establishing a diesel fuel source and refueling means. Specifically, FSG-5, Attachment G, "Refueling the Fuel Tank Trailers," provides the guidance for filling the fuel tank trailers from the non-safety-related diesel fuel oil storage tanks or from the safety-related fuel oil storage tanks.

3.7.7 Conclusions

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, with approved alternatives, and should adequately address the requirements of the order.

3.8 Considerations in Using Offsite Resources

3.8.1 Ginna SAFER Plan

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

There are two NSRCs, located near Memphis, Tennessee and Phoenix, Arizona, established to support nuclear power plants in the event of a BDBEE and operated by the SAFER team. 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 23], 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. In its FIP, the licensee stated that it has established contracts with SAFER to participate in the process for equipment delivery from the NSRCs as specified in the Ginna SAFER plan.

The NRC staff noted that the licensee's SAFER Response Plan contains (1) SAFER control center procedures, (2) NSRC procedures, (3) logistics and transportation procedures, (4) staging area procedures, which include travel routes between staging areas to the site, (5) guidance for site interface procedure development, and (6) a listing of site-specific equipment (generic and non-generic) to be deployed for FLEX Phase 3.

3.8.2 Staging Areas

In general, up to four staging areas for NSRC-supplied Phase 3 equipment are identified in the SAFER plans for each reactor site. These are a Primary (Area C) and an Alternate (Area D, if available) which are offsite areas (within about 25 miles of the plant) utilized for receipt of ground transported or airlifted equipment from the NSRCs. From staging areas C and/or D, the SAFER team will transport the Phase 3 equipment to the staging area B for interim staging prior to it being transported to the final location in the plant (Staging Area A) for use in Phase 3. For Ginna, the alternate staging area D is not used. Staging area C is located on Rochester International Airport property as depicted in Figure 8 in the FIP. Staging area B would be located in the plant contractor parking lot (as it is currently named), as well as the area to the west, as depicted in Figure 7 of the FIP. Staging area A consists of multiple areas for portable equipment staging as depicted in Figure 6 of the FIP.

Use of helicopters to transport equipment from staging area C to staging area B is recognized as a potential need within the Ginna 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 Ginna, ventilation providing cooling to occupied areas and areas containing FLEX strategy equipment will be lost. Per the guidance given in NEI 12-06, FLEX strategies must be capable of execution under the adverse conditions expected following a BDBEE resulting in an 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 several loss of ventilation analyses to assess the potential impacts of temperatures expected in specific areas related to FLEX implementation to ensure the environmental conditions remain acceptable for personnel habitability and within equipment qualification limits.

The key areas identified for all phases of execution of the FLEX strategy activities are the control room (CR), vital battery rooms, and standby auxiliary feedwater room (SAFW building/annex). The licensee evaluated these areas to determine the temperature profiles following an ELAP with loss of normal access to the UHS event.

For the control room, the licensee performed DA-ME-15-012, "FLEX HVAC for Control Room and Battery Rooms," Revision 1, using Mathcad 14.0 to predict cooling needs for the CR during ELAP conditions. By placing one 3500 cubic foot per minute (cfm) blower in service within 8 hours the CR temperature is predicted to be maintained below 120 °F and reduced to 105 °F by 72 hours. Based on temperatures remaining below 120 °F (the temperature limit, as identified in NUMARC-87-00, for electronic equipment to be able to survive indefinitely), the staff finds that the equipment in the CR will not be adversely impacted by the loss of ventilation as a result of an ELAP event.

The Ginna safety-related batteries are manufactured by GNB. The licensee's analysis, DA-ME-15-012, states that the temperature in the battery rooms remains less than 120 °F. Analyses by the battery vendor, NLI, show that the batteries are capable of performing their function up to 120 °F, however, periodic monitoring of electrolyte level would be necessary to protect the battery since the battery may gas more at higher temperatures. The licensee plans to restore normal battery room ventilation when the batteries are charging during Phase 2 and 3. One HVAC system supplies battery rooms A and B. Guideline FSG-4 provides guidance for restoring normal battery room ventilation. Guideline FSG-5 provides guidance for using portable ventilation fans in the battery rooms during extreme high temperature conditions when normal battery room ventilation isn't available. For extreme outside temperature conditions (100 °F), the licensee's analysis shows that by using portable ventilation fans with 400 cfm or 2900 cfm flow, the battery room temperatures will remain less than 120 °F or 105 °F, respectively. Based on its review of the licensee's battery room assessment, the NRC staff finds that the safety-related batteries should perform their required functions at the expected temperatures as a result of loss of ventilation during an ELAP event.

The staff noted that the SAFW building/annex houses the following permanently installed equipment that support the licensee's FLEX strategies: the SAFW pumps, the alternate RCS injection pump and the SAFW DG. In the FIP, Section 8.2.3 states that RWA-1433-001, "Ginna Standby Auxiliary Feedwater Room Heat-Up Analysis," Revision 0, documents the SAFW building/annex temperature response for FLEX cases for key components within the structure. The licensee stated that the SAFW pumps and the alternate RCS injection pump depend on ambient cooling. The staff noted that early in the ELAP event the licensee's ECA-0.0 procedure directs the use of ATT-5.5, "Attachment SAFW with Suction from DI water storage tank during SBO," Revision 3, to establish SAFW ventilation by blocking open doors and starting ventilation fans, which are powered by the SAFW DG. Based on the expected temperature response in the SAFW building/annex, the blocking open of doors and the repowering of existing ventilation fans, the staff noted that adequate ventilation is provided to the equipment in the SAFW building/annex to ensure equipment operability during an ELAP event.

In the FIP, Section 8.3.8 states that the design temperature specifications for the control unit of the portable 100 KW DG indicate a temperature range of minus 40 °F to 158 °F with an engine derate indicated for ambient temperatures greater than 122 °F. For the FLEX pump diesel engine, there is no maximum ambient temperature indicated in the specifications; however, there is a recommendation to reduce load on the engine if the operating (coolant) temperature is greater than 234 °F.

3.9.1.2 Loss of Heating

In the FIP, Section 8.2.3 states that a GOTHIC model analysis, RWA-1433-00, of the SAFW annex interior temperatures determined that additional heating must be provided to maintain temperatures above 40 °F to prevent water from freezing. As a result, a 15 kW electric heater was installed in the SAFW annex, which is thermostatically controlled to maintain room temperatures above that required and can be powered from the SAFW DG during an ELAP event. In addition, ECP-13-000995, "DDSAFW Annex Building – Mechanical Scope" installed heat tracing on the SAFW DI water storage tank sample lines, tank suction piping, tank return piping, and recirculation piping, to support operation of the SAFW system. The licensee stated that this heat trace can be powered by the SAFW DG. The licensee also stated that the SAFW DI water tank recirculation pump and the DI water tank heater can maintain tank water temperature above 40 °F and can be powered by the SAFW DG during an ELAP event. Based on the installation of electric heaters and heat trace and the availability of the recirculation pump and tank heater, the staff noted that the contents in the SAFW DI water storage tank will not be affected during extreme cold conditions and loss of heating during an ELAP event.

The RWST is the suction source to the alternate RCS injection pump to support FLEX RCS inventory control strategies. In the UFSAR, Section 6.3.2.2.3 indicates the maximum boric acid concentration within the RWST is approximately 1.75 weight percent boric acid. At 32 °F the solubility limit of boric acid is 2.2 percent; therefore, the concentration of boric acid in the RWST is well below the solubility limit at 32 °F. The licensee stated that boron precipitation in the RWST is not a concern because CALC-2014-0006 determined that the auxiliary building would remain above freezing during extreme cold conditions. Based on the expected temperature response in the area of the RWST and the boric acid concentration within the tank, the staff noted that the contents in the RWST will not be affected during extreme cold conditions and loss of heating during an ELAP event.

In the FIP, Section 8.3.8 states that its FLEX strategies include freeze protection by creating continuous flow paths such that freezing of vulnerable FLEX equipment (i.e. hose, pumps, etc.) will not occur. In addition, portable FLEX pumps and associated hoses can be drained when not in use to prevent freezing. The licensee also stated that the diesel-driven FLEX pumps, the portable RCS injection FLEX pump, the air compressors, and the FLEX 100 kW DG are all equipped with engine block heaters and battery tenders. The staff noted that FSG-5, Attachment C, "Additional Strategies for Extreme Weather Conditions," provides guidance to drain FLEX pumps and hoses or maintain flow in the FLEX pump to prevent freezing.

The battery rooms are located on the lower level of the control building and they are normally maintained at approximately 71-77 °F. Guideline FSG-4 provides guidance for restoring normal battery room ventilation which should maintain temperature in the battery rooms above 60 °F if duct work is intact and circulate warm air back to the battery rooms. If duct work is not intact then battery room dc-powered fans might have to be throttled or stopped and a small portable fan limiting airflow to 400 cfm will be used to maintain battery room temperatures. Mathcad 14.0 analysis, DA-ME-15-012, supports the licensee's action to maintain battery room temperatures during extreme cold temperatures. Based on its review of the licensee's battery room assessment, the NRC staff finds that the safety-related batteries should perform their required functions at the expected temperatures as a result of loss of heating during an ELAP event.

3.9.1.3 Hydrogen Gas Control in Vital Battery Rooms

The staff reviewed Ginna calculation, DA-EE-99-068, "Vital Battery Room Hydrogen Analysis," Revision 3, to verify that hydrogen gas accumulation in the 125 Vdc vital battery rooms will not reach combustible levels while HVAC is lost during an ELAP. Off-gassing of hydrogen from batteries is only a concern when the batteries are charging. The licensee stated in its FIP that under worse case conditions, without ventilation, the 0.8 percent normal hydrogen concentration limit would not be exceeded until 28.9 hours and that the unacceptable hydrogen concentration limit of 2 percent would not be exceeded until 73.3 hours, with the batteries being charged. Guideline FSG-4, "ELAP DC Bus Load Shed/Management," provides guidance for starting normal battery room ventilation (dc powered vent fans) after establishing temporary power to the station battery chargers and also directs using temporary battery room ventilation if required. Guideline FSG-5, "Initial Assessment and FLEX Equipment Staging," Revision 1, directs using portable fans for battery room ventilation.

Based on its review of the licensee's calculation and battery room ventilation strategy, the NRC staff concludes that hydrogen accumulation in the safety-related battery rooms should not reach the combustibility limit for hydrogen (4 percent) during an ELAP because the licensee plans to establish normal battery room ventilation or provide portable ventilation during Phase 2.

3.9.2 Personnel Habitability

3.9.2.1 Control Room

In the FIP, Section 8.2.3 states DA-ME-15-012, "FLEX HVAC for Control Room and Battery Rooms," used Mathcad 14.0 to predict heating and cooling needs for the control room during ELAP conditions. The licensee stated that its calculation determined that for extremely cold conditions, two 1500-Watt heaters placed in service by 8 hours post-event to keep the control room above 40 °F for 72 hours. In addition, for extremely hot conditions, one 3500 cfm blower placed in service by 8 hours post-event is predicted to keep the control room below 120 °F for 72 hours. The staff noted that FSG-5, Attachment C, "Additional Strategies for Extreme Weather Conditions," provides guidance to deploy heaters and the blower consistent with the results of the calculation. Based on the licensee's guidance for deployment of temporary blower and heaters, and the expected temperature response in the control room, the staff noted that it is reasonable that the control room will remain habitable during an ELAP event.

3.9.2.2 Spent Fuel Pool Area

Based on the licensee's calculation on habitability on the SFP refuel floor and information in FIP Section 7, boiling begins at approximately 5 hours with a full core offload in the SFP with an initial SFP temperature of 150 °F and SFP water level in the normal range (between 276'-1.5" and 277'). The licensee determined that it would take approximately 45 hours with those initial conditions for pool water level to drop to a level requiring the addition of makeup to maintain sufficient radiation protection for personnel (Level 2 in Section 4.1 below). The staff noted that FSG-11, "Alternate SFP Makeup and Cooling," provides cautions/warnings to the operators regarding steam from SFP boiling and radiation levels should SFP level drop below 258'. In addition, the sequence of events timeline in the FIP indicates that nine hours into the ELAP event operators will be dispatched to set up for SFP makeup. Therefore, based on the heat loads during non-outage scenarios, and cautions identified in its FSGs, the staff finds it reasonable that operators will be able to safely enter the area of the SFP and deploy FLEX equipment.

In the FIP, Section 7 indicates that the Phase 1 SFP cooling strategy does not require any anticipated actions. However, the licensee does establish a ventilation path to cope with temperature, humidity and condensation from evaporation or boiling of the SFP. The operators are directed per FSG-5 to manually open overhead doors in the auxiliary building and canister preparation building to establish a vent pathway.

3.9.2.3 Other Plant Areas

SAFW Building/Annex

In the FIP, Section 9 states that the local actions taken in the SAFW building/annex are the initiation and control of SAFW flow, initiation of RCS injection, and monitoring of SFP level. FIP Section 8.2.3 states that RWA-1433-001, "Ginna Standby Auxiliary Feedwater Room Heat-Up Analysis," Revision 0, documents the SAFW building/annex temperature response for FLEX cases for key components within the structure. The staff noted that early in the event the licensee's ECA-0.0 procedure directs the use of ATT-5.5, "Attachment SAFW With Suction From DI Water Storage Tank During SBO," Revision 3, to establish SAFW ventilation by blocking open doors and starting ventilation fans, which are powered by the SAFW DG. Based on the expected temperature response in the SAFW building/annex, blocking open of doors, and the repowering of ventilation fans in the SAFW building/annex, the staff noted that it is reasonable that this area will remain habitable for operators during an ELAP event.

Intermediate Building

In the FIP, Section 9 states that the SG ARVs located in the intermediate building must be locally controlled during an ELAP event. FIP Section 8.2.3 states that a GOTHIC calculation, ECP-10-000301, has been performed for the ARV area and the results under a station blackout scenario indicate that with doors S37F, S44F, and SD/55 opened within 15 minutes, the steady-state ambient temperature for the area is 117 °F. The licensee also performed Calculation RWA-1316-001, "FLEX Intermediate Building GOTHIC Heat Up Analysis," which documents the information above. The licensee stated that operator safety concerns with habitability in the ARV area resulted in a caution statement at the beginning of ECA-0.0, which states "Due To Potentially Extreme Environmental Conditions, Caution Should Be Used When Entering The Intermediate Bldg For Local Actions." Furthermore, the licensee indicated that ice vests are available from freezers in diverse locations at the site. In addition, the staff noted that ECA 0.0 provides direction for security personnel to open S37F, S44F, and SD/55 to enhance cooling. Based on the expected temperature response in the area of the ARVs, procedural guidance to open door S37F, S44F, and SD/55 to enhance cooling in the ARV area, and availability of ice vests to operators, the staff noted that it is reasonable that this area will remain habitable for operators during an ELAP event.

Auxiliary Building

In the FIP, Section 9 states that when initiating alternate RCS injection four manual valves must be manipulated within the auxiliary building. In addition, hoses are deployed to the edge of the SFP, or, alternatively, to valve 8662 for SFP makeup within the auxiliary building. FIP, Section 7.6 states that calculation CALC-2014-0006, "Auxiliary Building Environmental Conditions during ELAP," evaluated the temperature response of auxiliary building areas (which includes the SFP area) in response to a loss of forced ventilation during an ELAP. As a result of the calculation, the licensee determined that compensatory actions are required to maintain the auxiliary building within acceptable temperatures. The staff noted that FSG-5, "Initial Assessment and FLEX Equipment Staging," initiates action to provide vent paths by manually opening overhead doors and tornado dampers in the auxiliary building and the canister preparation building. Based on the resulting temperature response in the auxiliary building and guidance to open overhead doors, the staff noted that it is reasonable that the auxiliary building will remain habitable for operators during an ELAP event.

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 Steam Generator Make-Up

Phase 1

In the FIP, Section 3.4.3 states that the SAFW DI water storage tank is a flat bottom, stainless steel deionized water tank and is procedurally maintained with a minimum water level to ensure 24 hours of water supply is available for core cooling and heat removal during Phase 1.

Regarding, the seismic and flooding hazard, the licensee stated that the SAFW DI water storage tank was qualified to the SSE, and that it is not buoyant when filled and exposed to flood waters. In addition, the tank discharge is routed to flood protected areas; thus, staff finds the tank is robust with respect to the seismic and flooding hazard.

In the UFSAR, Section 2.3.2 indicates that the design-basis tornado wind velocity is 132 miles per hour (mph) and the normal ground snow load is 40 lb/ft^2. During its audit, the staff reviewed Calculation 175180-000-SP-CL-00001, Design Calculations for (1) 36' Diameter x 34'-9" High DRT, and confirmed that the licensee designed the SAFW DI water storage tank for 132 mph wind loads and for snow loads of 84 lb/ft^2. Regarding the high wind and snow loads, the staff finds the tank's design is consistent with or exceeds the current licensing basis; thus, the tank is robust with respect to the high wind hazard and snow loads.

Regarding the extreme cold hazard, FIP Section 3.4.3 states the SAFW DI water storage tank is insulated and has a tank heater that will continuously maintain the tank temperature. The licensee also explained that the tank heater is capable of being powered by the SAFW DG that is relied upon for its FLEX strategies. Thus, the staff finds that the tank is robust with respect to the extreme cold hazard.

During its audit, the staff reviewed Calculation 12574-1, "Analysis of Tornado Generated Missiles Impacting a Water Storage Tank," and noted that the SAFW DI water storage tank was evaluated for two sets of missiles. These missiles included the utility pole and steel rod identified in UFSAR Section 3.3 and the missiles identified in Regulatory Guide 1.76 (i.e., automobile, pipe and small steel spheres). The licensee's calculation performed a finite-element analysis to determine the response of the tank based on the impact from these missiles. Based on the calculation, the tank experienced plastic deformation (denting) for all missiles considered and penetration of the tank was not predicted. In addition, FIP Section 3.4.3 states that nozzles to the tank are provided with localized protection from tornado missiles with barriers and surrounding buildings. Based on the protection provided to the nozzles and the finite-element analysis performed, the staff finds the SAFW DI water storage tank is robust with respect to tornado missiles.

The sequence of events timeline in the FIP indicates that at 9 hours into the ELAP event operators are dispatched to refill the SAFW DI water storage tank. Furthermore, after 24 hours into the event refilling of the SAFW DI water storage tank should commence by taking suction from Lake Ontario and discharging through a fill connection at the tank. During its audit, the staff noted an analysis, DA-ME-14-020, "Deionized Water Tank Inventory Requirements", Rev. 0, was performed that determined approximately 152,000 gallons of water would be needed to support 24 hours of core cooling.

If implemented appropriately and consistent with the FIP, the licensee should have an adequate source of water available during Phase 1 core cooling. In addition, the licensee's strategy should provide sufficient time for operators to deploy and stage Phase 2 FLEX equipment.

Phase 2

In the FIP, Section 3.6 states that the licensee will monitor the SAFW DI water storage tank level so that it can be refilled with a portable diesel-driven FLEX pump discharging to a fill connection on the tank. The licensee indicated that the credited suction source for the portable diesel-driven FLEX pump is Lake Ontario via the discharge canal. However, if non-credited higher quality water sources are available, such as the condenser hotwell or the outside condensate storage tank, the licensee will use those first.

In the FIP, Section 2.1.1 states that the site is located on the south shore of Lake Ontario and the lake water levels are regulated by the Moses-Saunders power dam in Massena, NY. The licensee confirmed that failure of a non-seismically robust downstream dam (i.e., the Moses-Saunders power dam) would not have an adverse effect on its FLEX strategy. Thus, the staff finds the licensee has addressed NEI 12-06 Section 5.3.2, Consideration 3 and Section 5.3.3, Consideration 4, associated with the impact of a failure of a not-seismically-robust downstream dam.

As previously noted, the licensee is accessing Lake Ontario via the discharge canal. In the UFSAR, Table 3.2-1 indicates that the service water system and screen house are Seismic Category Class 1; thus, the staff finds that accessing Lake Ontario via the discharge canal is robust with respect to the seismic hazard.

The staff noted that severe storms with high winds, including wind-generated missiles, external flooding and extreme high heat does not impact the available water volume in Lake Ontario. The staff noted that the suction hose of the portable diesel-driven FLEX pump will have a detachable suction strainer submerged below the surface of the water in the discharge canal; thus, debris resulting from a high wind event or external flood should not affect the licensee's use of Lake Ontario. Thus, the staff finds Lake Ontario via the discharge canal should be available to support the licensee's FLEX strategies during an ELAP event that results from these external events.

In the FIP, Section 8.3.3 states that potential icing over the discharge canal could be effectively managed by on-site personnel using available equipment. The licensee explained that if the ice is thin then it could be broken using readily available lengths of piping or boards. Furthermore, options for accessing the discharge canal if the ice is thick include, but are not limited to, use of the debris remover to break up the ice, accessing the water in the Screen House bays, or accessing the water in the discharge tunnels via removal of manways. The licensee also stated that frazil ice at the discharge canal is not expected to be a concern for the reasons given in Section 3.7.2 above. In addition, the staff noted that the minimum available water in the SAFW DI water storage tank is sufficient for a minimum of 24 hours; thus, access to the discharge canal is not immediately needed during an ELAP event. The staff noted that the available options to address potential icing over the discharge canal are adequate; thus, the staff finds the licensee has addressed NEI 12-06 Section 8.3.2, Consideration 3, associated with the UHS being affected by extreme low temperatures due to ice blockage or formation of frazil ice.

If implemented appropriately and consistent with the FIP, the licensee should have an adequate source of water available during Phase 2 core cooling. In addition, the licensee's strategy should provide sufficient time for off-site resources from the NSRC to arrive and begin deploying and staging Phase 3 FLEX equipment.

Phase 3

In the FIP, Section 3.7 states that to refill the SAFW DI water storage tank, any existing source of demineralized water on site will be preferentially used until the NSRC water treatment system arrives. The licensee also stated that when the NSRC water treatment system arrives, water will be pumped from Lake Ontario via the discharge canal through the water treatment system to the SAFW DI water storage tank. Alternatively, water can be pumped from Lake Ontario via the discharge canal through the water treatment system directly into the steam generators via the SAFW system connection point. The staff noted that Section 7 of the licensee's SAFER response plan, CC-GI-118-1001, "SAFER Response Plan for R. E. Ginna Nuclear Generating Station," Revision 0, identifies a water treatment system will be delivered by the NSRC to support Phase 3 FLEX strategies. The staff noted that with the water volume available in Lake Ontario and the use of the NSRC water treatment system, the licensee has an indefinite amount of demineralized/purified water for injection in the steam generators for decay heat removal.

If implemented appropriately and consistent with the FIP, the licensee should have an adequate source of water available during Phase 3 core cooling.

3.10.2 Reactor Coolant System Make-Up

Phase 1

In the FIP, Sections 2 and 4 indicate that borated water from the safety injection (SI) accumulators will be injected for RCS inventory control and long-term sub-criticality. In the UFSAR, Table 3.2-1 indicates that the SI accumulators and associated piping to the RCS are Seismic Category I components. In addition, UFSAR Section 3.5.1.3.1.2 indicates that the SI accumulators are located inside the containment building; thus, SI accumulators are protected from high winds, tornado-generated missiles and external flooding. The staff finds the SI accumulators are robust with respect to applicable external hazards and should be available to support the licensee's FLEX strategies during an ELAP event.

If implemented appropriately and consistent with the FIP, the licensee should have an adequate source of water available during the Phase 1 RCS inventory control and makeup. The licensee's sequence of events timeline in the FIP indicates that no FLEX RCS makeup is needed prior to 8 hours; thus, the licensee's strategy should provide sufficient time for operators to deploy and stage Phase 2 FLEX equipment.

Phase 2

In the FIP, Section 4.6 states that to maintain RCS inventory control and long term subcriticality, the RWST is used as the borated water source. The licensee stated that the RWST is a flat bottom, stainless steel tank located in the auxiliary building. In the UFSAR, Section 3.8.2.1.1.1 indicates that the auxiliary building and the RWST are Seismic Category I Structures. Furthermore, UFSAR Section 2.4.7 indicates that the auxiliary building will not be subject to external flooding. In the UFSAR, Section 3.3.5.7 states that backdraft dampers were installed in the auxiliary building north wall to eliminate the effects of differential pressures associated with the tornadoes. In addition, UFSAR Section 3.3.3.3.1 indicates an analysis of missile effects (utility pole and steel rod) and wind pressure effects due to a 188-mph tornado, was performed, with acceptable results, for the RWST. Furthermore, during its audit, the staff noted that the licensee assessed the RWST in Calc No. 13318-2, "Missile Impact Evaluation of Ginna Refueling Water Storage Tank," for the four missiles (telephone pole, steel rod, schedule 40 pipe, automobile) in a total of 20 locations. A finite-element analysis of the impact was performed using the LS-DYNA code for each missile and in all instances, the evaluation determined that the tank experiences plastic deformation (denting) and that penetration of the tank does not occur. Therefore, the staff finds the RWST is robust with respect to applicable external hazards and is available to support the licensee's FLEX strategies as a borated water source.

If implemented appropriately and consistent with the FIP, the licensee should have an adequate source of water available during the Phase 2 RCS inventory control and makeup.

Phase 3

In the FIP, Section 5.7 states that to refill the SAFW DI water storage tank, any existing source of demineralized water on site will be preferentially used until the NSRC water treatment system arrives. Once the NSRC water treatment system arrives, water will be pumped from Lake Ontario via the discharge canal through the water treatment system to refill the SAFW DI water storage tank. The licensee also stated that prior to depleting the RWST inventory, boron and a mobile boration unit supplied from the NSRC can be utilized to provide an indefinite source of borated water for Phase 3 boron control and RCS injection. The staff noted that Section 7 of the licensee's SAFER response plan (CC-GI-118-1001, "SAFER Response Plan for R. E. Ginna Nuclear Generating Station," Revision 0) identifies a mobile boration unit, which includes bags of boron, to be delivered by the NSRC to support its Phase 3 FLEX strategies. The staff noted with the water quantity available in Lake Ontario and the use of the NSRC boration unit and water treatment system, the licensee has a sufficient amount of borated water for injection into the RCS.

If implemented appropriately and consistent with the FIP, the licensee should have an adequate source of water available during the Phase 3 core cooling.

3.10.3 Spent Fuel Pool Make-Up

Phases 1 through 3

As discussed in SE Section 3.3, during Phase 1 the strategy will be to monitor SFP level to ensure adequate level. FIP Section 7.6 indicates that to support the multiple SFP strategies a portable diesel-driven FLEX pump will take suction from Lake Ontario via the discharge canal. As previously discussed in SE Section 3.10.1, Lake Ontario via the discharge canal is robust with respect to the applicable external hazards and the water volume available in Lake Ontario in conjunction with the NSRC water treatment system provides the licensee with a sufficient amount of demineralized water for SFP makeup.

If implemented appropriately and consistent with the FIP, the licensee should have an adequate source of water available during the Phase 2 and 3 SFP cooling and makeup.

3.10.4 Containment Cooling

Phase 1 through 3

As discussed in SE Section 3.4, the licensee's Phase 2 Containment Integrity strategies do not rely on the use of FLEX pumps and water sources for maintaining containment pressure or temperature below the design limits for at least 72 hours off-site resources arrive. In the FIP, Section 6.7 indicates that with Phase 3 equipment Lake Ontario via the discharge canal can be used to supply one or more of the Containment Recirculation Fan Coolers. In this SE, Section 3.10.1 discusses the availability of Lake Ontario via the discharge canal during an ELAP event.

Thus, the staff noted that in Phases 1 and 2, no external source of water is needed for maintaining containment pressure or temperature below the design limits for an extended period of time until off-site resources arrive.

3.10.5 Conclusions

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

3.11 Shutdown and Refueling Analyses

Order EA-12-049 requires that licensees must be capable of implementing the mitigation strategies in all modes. In general, the discussion above focuses on an ELAP occurring during power operations. This is appropriate, as plants typically operate at power for 90 percent or more of the year. When the ELAP occurs with the plant at power, the Ginna mitigation strategy initially focuses on the use of the SAFW pumps to add water to the SGs 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, as described in its FIP, shows that following a full core offload to the SFP, about 45 hours are available to implement makeup before boil-off results in the water level in the SFP dropping far enough to cause a significant increase in radiation levels in the SFP operating area, 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 the SGs are not available for natural circulation cooling of the RCS, another strategy must be used for decay heat removal from the reactor core. On September 18, 2013, NEI submitted to the NRC a position paper entitled "Shutdown/Refueling Modes" [Reference 38], which described methods to ensure plant safety in those shutdown modes. By letter dated September 30, 2013 [Reference 39], the NRC staff endorsed this position paper as a means of meeting the requirements of the order.

The position paper provides guidance to licensees for reducing shutdown risk by incorporating FLEX equipment in the shutdown risk process and procedures. Considerations in the shutdown risk assessment process include maintaining necessary FLEX equipment readily available and potentially pre-deploying or pre-staging equipment to support maintaining or restoring key safety functions in the event of a loss of shutdown cooling. The NRC staff concludes that the position paper provides an acceptable approach for demonstrating that the licensees are capable of implementing mitigating strategies in shutdown and refueling modes of operation. In its FIP, the licensee informed the NRC staff of its plans to follow the guidance in this position paper. During the audit process, the NRC staff observed that the licensee had made progress in implementing this position paper, primarily through the development of guidance document FSG-14, "Shutdown RCS Makeup," and procedure AP-ELEC.4, "Loss of All AC Power While on Shutdown Cooling."

Based on the information above, the NRC staff concludes that the licensee is developing 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

In its FIP, the licensee stated that it utilized industry developed guidance from the PWROG, EPRI, and NEI task team to develop site specific procedures or guidelines to address the criteria in NEI 12-06. These procedures and/or guidelines support (not replace) the existing symptom-based command and control strategies in the current Emergency Operating Procedures (EOPs). Clear criteria for entry into FSGs ensures that FLEX strategies are used only as directed for BDBEE conditions, and are not used inappropriately in lieu of existing procedures. The existing command and control procedure structure is used to transition to Severe Accident Management Guidelines (SAMGs) if FLEX mitigation strategies are not successful.

FLEX strategies in the FSGs were evaluated for integration with the appropriate existing procedures. As such, FLEX strategies are implemented in such a way as to not violate the basis of existing procedures. Where FLEX strategies rely on permanently installed equipment, such as the new SAFW DG, changes were made to the Abnormal Operating Procedures (AOPs) and EOPs, as appropriate. The FSGs are controlled under the site procedure control program.

The existing hierarchy for operating plant procedures remains relatively unchanged:

- ECA-0.0, "Loss of All AC Power," provides actions to respond to a loss of all AC power.
- New procedure AP-ELEC.4, "Loss of All AC Power while on Shutdown Cooling," provides actions to respond to a complete loss of all ac power while on shutdown (RHR) cooling.
- ECA-0.0 and AP-ELEC.4 are the entry points for ELAP with loss of normal access to the UHS events. FSGs are entered from ECA-0.0, AP-ELEC.4 and if appropriate, other procedures.

In its compliance letter [Reference 18], the licensee stated that training for plant staff had been completed in accordance with an accepted training process as recommended in NEI 12-06, Section 11.6. In its FIP, the licensee stated that training programs and controls are implemented in accordance with the industry's Systematic Approach to Training.

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 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 40], which included EPRI Technical Report 3002000623, "Nuclear Maintenance Applications Center: Preventive Maintenance Basis for FLEX Equipment." By letter dated October 7, 2013 [Reference 41], 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 preventive maintenance procedures (PMs) were established and testing procedures developed with frequencies established based on type of equipment, original equipment manufacturer recommendations and considerations made within EPRI Technical Report 3002000623.

In conjunction with a proposed alternate approach for storage of FLEX equipment, the licensee will conduct periodic and corrective maintenance of some FLEX equipment with a shorter allowed outage time. This alternate approach is discussed in more detail in Section 3.14, below.

Based on the information above, the NRC staff finds that the licensee has adequately addressed equipment maintenance and testing activities associated with FLEX equipment because a maintenance and testing program has been established in accordance with NEI 12-06, Section 11.5.

3.14 Alternatives to NEI 12-06, Revision 0

In general, Ginna has more alternatives than the average plant. This is a result of the licensee's decision to develop a FLEX strategy which relies heavily on permanently installed equipment located in robust structures, such as the SAFW building and the SAFW building annex, which are directly adjacent to each other with interior access. Guidance document NEI 12-06 was written with the assumption that the FLEX equipment would be portable equipment located in a robust storage building which would be moved into place following the BDBEE. One site-specific factor that led Ginna to this approach is that the TDAFW pump and its water source (the CST) are not robust, and cannot be credited for the FLEX strategy. Therefore, Ginna needed to develop a FLEX strategy that would provide makeup to the SGs for core decay heat removal before the SGs boiled dry.

3.14.1 Permanently Installed FLEX (SAFW) DG with Auto Start

In its FIP, the licensee identified the use of the SAFW DG, permanently installed in the SAFW building annex, with an automatic start feature, as an alternative to NEI 12-06. The SAFW DG is used to power the SAFW pumps and RCS injection pump which are permanently installed in the SAFW building. In the ISE [Reference 16] the NRC staff had previously discussed the

SAFW DG as an alternative to NEI 12-06, Section 3.2.1.3, condition 2, which states "All installed sources of emergency on-site ac power and SBO [station blackout] alternate ac power sources are assumed to be not available and not imminently recoverable." However, the NRC staff noted that the SAFW DG is robust (protected from external events), and the licensee has stated that the SAFW DG will not be connected to the internal power distribution system, thereby alleviating the potential vulnerability of reliance on a common supporting system. During the onsite audit, the NRC staff also learned that the SAFW DG had an automatic start feature, which the staff was not previously aware of. The licensee addressed this feature in the FIP as follows:

> Proposed Alternative:
> In this alternate approach, upon loss of normal yard 12.47 KV power to the SAFW Building loads and D/G auxiliary load equipment (i.e., block heaters, engine battery, chargers, etc.) an automatic transfer switch (ATS) will automatically initiate a command to start the 1 MW FLEX D/G and, once stable, swap the source power from the normal yard power to the SAFW switchgear power and take on the loads connected to new panel ACPDPAF04 and, through it, to a new 120/208V Power Transformer (PXAF02) to supply new power panel ACPDPAF05.
>
> Basis for the alternative approach:
> The existing normal power to the SAFW pump motors is 480 VAC, 3-phase, 60 Hz power from safety-related Bus 14 and Bus 16. With implementation of modification ECP-12-000459, "DDSAFW Project Electrical Design and Installation," upon loss of normal bus power, the operators are able to manually transfer the power source to the SAFW pump motors from their normal power source to the 1 MW FLEX D/G via Class 1E manual transfer switches 43/PSF01A and 43/PSF01B. For use in emergencies, the Operators will start the D/G manually if it has not started prior to this time due to the loss of normal yard 12.47 KV power. With the generator bus voltage achieving a nominal 480 V within 10 seconds, the operator can then manually start the SAFW pumps and other FLEX loads. The newly installed D/G and electrical distribution system is completely independent, and physically separated from the plant electrical distribution system except at the connection to the Manual Transfer Switches. When normal yard power recovers, the automatic transfer switch is inhibited from transferring back to normal yard power until operator action is taken.
>
> Use of the 1 MW FLEX D/G to power the SAFW pumps as a FLEX strategy was previously accepted as an alternative approach to NEI 12-06 (ML14007A704) [the NRC's ISE]). While the D/G auto start feature was not identified prior to the ISE review, the auto start feature does not automatically power the SAFW pumps and other FLEX loads. The auto start feature is used to repower the 1 MW FLEX D/G auxiliary load equipment to maintain generator readiness for a BDBEE. Providing power to mitigation equipment from the 1 MW FLEX D/G must be performed manually as previously described. Exelon requests NRC Staff review and approval of this auto start feature as an acceptable alternative to the NEI 12-06 guidance.

The NRC staff considered the design features of the SAFW DG, especially its independence from other plant systems and structures, and finds that crediting the SAFW DG is an acceptable alternative to the NEI 12-06 guidance, and meets the requirements of the order.

3.14.2 Storage of Backup (N+1) Equipment in a Non-Robust Building

In its FIP, the licensee proposed an alternative approach to NEI 12-06 for protection of FLEX equipment as stated in Section 5.3.1 (seismic,) Section 7.3.1 (severe storms with high winds), and Section 8.3.1 (impact of snow, ice and extreme cold). In general, the guidance in NEI 12-06 is to store the backup (N+1) equipment in a robust storage location, such that it would be available following a BDBEE. The licensee has stored most of the N+1 equipment in a non-robust (commercial) building, called the L building. The licensee addressed this in the FIP as follows:

> Proposed Alternative:
>
> This alternate approach will be to store "N" sets of equipment in fully robust buildings and the +1 set of equipment in a commercial building. For all hazards scoped in for the site, the FLEX equipment will be stored in a configuration such that no one external event can reasonably fail the site FLEX capability (N).
>
> Basis for the alternative approach:
>
> To ensure that no one external event will reasonably fail the site FLEX capability (N), Exelon will ensure that N equipment is protected in robust buildings. To accomplish this, Exelon will develop procedures to address the unavailability allowance as stated in NEI 12-06 Section 11.5.3., (see Maintenance and Testing section below for further details). This section allows for a 90-day period of unavailability. If a piece of FLEX equipment stored in the robust building were to become or found to be unavailable, Exelon will impose a shorter allowed outage time of 45 days. For portable equipment that is expected to be unavailable for more than 45 days, actions will be initiated within 24 hours of this determination to restore the site FLEX capability (N) in the robust storage location and implement compensatory measures (e.g., move the +1 piece of equipment into the robust building) within 72 hours where the total unavailability time is not to exceed 45 days. Once the site FLEX capability (N) is restored in the robust storage location, Exelon will enter the 90-day allowed out of service time for the unavailable piece of equipment with an entry date and time from the discovery date and time.
>
> Maintenance and Testing
>
> - The unavailability of equipment and applicable connections that directly performs a FLEX mitigation strategy for core, containment, and SFP should be managed such that risk to mitigating strategy capability is minimized.
>   - 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.

- 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.
- The duration of FLEX equipment unavailability, discussed above, does not constitute a loss of reasonable protection from a diverse storage location protection strategy perspective.
- 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.

For NEI 12-06 Section 5.3.1, seismic hazard, Exelon will also incorporate these actions:

- Large portable FLEX equipment such as pumps and power supplies should be secured as appropriate to protect them during a seismic event (i.e., Safe Shutdown Earthquake (SSE) level).
- Stored equipment and structures will be evaluated and protected from seismic interactions to ensure that unsecured and/or non-seismic components do not damage the equipment.

For NEI 12-06 Section 7.3.1, severe storms with high winds, Exelon will also incorporate this action:

- To meet Section 7.3.1.1.a, either of the following are acceptable:
  - All required sets (N+1) in a structure(s) that meets the plant's design basis for high wind hazards, or
  - (N) sets in a structure(s) that meets the plant's design basis for high wind hazards and (+1) set stored in a location not protected for a high wind hazard.

For NEI 12-06 Section 8.3.1, impact of snow, ice and extreme cold, Exelon will also incorporate this action:

- Storage of FLEX equipment should account for the fact that the equipment will need to function in a timely manner. The equipment should be maintained at a temperature within a range to ensure its likely function when called upon. For example, by storage in a heated enclosure or by direct heating (e.g., jacket water, battery, engine block heater, etc.).

Exelon will meet all of the requirements in NEI 12-06 Section 6.2.3.1 for external flood hazard and Section 9.3.1 for impact of high temperatures.

The NRC staff notes that by letter dated December 10, 2015, NEI submitted guidance document NEI 12-06, Revision 2 (ADAMS Accession No. ML16005A625) to the NRC for review. By letter dated January 22, 2016 (ADAMS Accession No. ML15357A163), the NRC staff endorsed NEI

12-06, Revision 2. NEI 12-06, Revision 2, contains modifications which resulted in NRC acceptance of the storage of backup (N+1) equipment in a non-robust storage building. Section 11.5.4.b of NEI 12-06, Revision 2, contains the condition that if the site FLEX capability (N) is met, but not protected for all of the site's applicable hazards, then the allowed unavailability is reduced to 45 days (compared to the 90 day unavailability with any FLEX equipment unavailable, but with the FLEX capability (N) available and in a protected or diverse storage configuration). Although Ginna is evaluated to NEI 12-06, Revision 0, in this SE, the licensee has committed to follow the 45 day unavailability limit stated in NEI 12-06, Revision 2. Therefore, the NRC staff finds the Ginna storage configuration acceptable.

The NRC staff reviewed the licensee's proposal and finds that the methods used to ensure that the primary (N) set of equipment is available, with a reduction in allowed unavailability to 45 days if any N equipment is not protected for all of the site's applicable hazards, is an acceptable alternative to the NEI 12-06, Revision 0, guidance, and meets the requirements of the order.

3.14.3 Reduced Set of Hoses and Cables As Backup Equipment

In its FIP, the licensee took an alternative approach to the NEI 12-06 guidance for hoses and cables. In NEI 12-06, Section 3.2.2 states that in order to assure reliability and availability of the FLEX equipment required to meet these capabilities, the site should have sufficient equipment to address all functions at all units on-site, plus one additional spare, i.e., an N+1 capability, where "N" is the number of units on-site. Thus, a single-unit site would nominally have at least two portable pumps, two sets of portable ac/dc power supplies, two sets of hoses & cables, etc. Typically the hoses utilized to implement a FLEX strategy are not a single continuous hose but are composed of individual sections of a smaller length joined together to form a sufficient length. In the case of cables, multiple individual lengths are used to construct a circuit such as in the case of 3-phase power. The NEI, on behalf of the industry, submitted a letter to the NRC [Reference 48] proposing an alternative regarding the quantity of spare hoses and cables to be stored on site. The alternative proposed was that that either a) 10 percent additional lengths of each type and size of hoses and cabling necessary for the N capability plus at least one spare of the longest single section/length of hose and cable be provided or b) that spare cabling and hose of sufficient length and sizing to replace the single longest run needed to support any FLEX strategy. The licensee has committed to following the NEI proposal. By letter dated May 18, 2015 [Reference 49], the NRC agreed that the alternative approach is reasonable, but that the licensees may need to provide additional justification regarding the acceptability of various cable and hose lengths with respect to voltage drops, and fluid flow resistance. The NRC staff approves this alternative for Ginna as being an acceptable method of compliance with the order.

3.14.4 Single Injection Point For SG makeup

In its FIP, Exelon proposed an alternate approach to NEI 12-06 for having primary and alternate injection points to the SGs for the portable FLEX SG makeup pump, as specified by NEI 12-06, Section 3.2.2 and Table D-1. The licensee's alternative is to have only a single injection point for the portable FLEX pump used for SG makeup. The licensee addressed this in its FIP as follows:

Proposed Alternative:

This alternate approach will be to have one connection point for the portable FLEX S/G injection pump. The portable FLEX S/G injection pump is located in the SAFW Building Annex and will be staged outside of this building if used. There is one connection point for the portable FLEX S/G injection pump discharge hose, which is inside the SAFW Building. An alternate injection point is not planned due to the multiple and diverse methods of delivering water to the S/Gs using the SAFW pumps powered by the SAFW D/G using the previously accepted alternative approach to NEI 12-06.

Basis for the alternative approach:

Ginna has multiple and diverse methods to deliver water to the S/Gs from a SAFW pump powered by the SAFW D/G. Only one of the two SAFW pumps is needed for performing the heat removal function. Either SAFW pump is capable of being powered by the SAFW D/G and can be aligned to feed both S/Gs through their discharge headers and one of two normally isolated cross connections between their discharge headers. One cross connection is located in the SAFW Building and the other cross connection is located in the Auxiliary Building.

The multiple and diverse methods of delivering water to the S/Gs using a SAFW pump or a portable FLEX S/G injection pump meets the intent of NEI 12-06 Section 3.2.2 and Table D-1. Exelon requests NRC Staff review and approval of this alternative approach as an acceptable alternative to the NEI 12-06 guidance.

The NRC staff reviewed the licensee's proposal and finds that the available multiple and diverse methods of providing makeup to the SGs is an acceptable alternative to the NEI 12-06 guidance, and meets the requirements of the order. An additional discussion is provided in Section 3.7.3.1 of this SE.

3.14.5 Remove Requirement for SFP Spray

The licensee requested an alternative from NEI 12-06 Table D-3, which states that there should be three methods of adding water to the SFP, to ensure that the spent fuel assemblies located there have sufficient cooling. The three methods are makeup using a hose directly into the SFP; makeup using a connection to a SFP cooling piping or a similar system (which allows makeup while avoiding the need to go on the refueling floor, where habitability may be a concern); and makeup via water spray into the SFP. The licensee has the first two capabilities, but asked for an alternative to not have the spray capability. The NRC's position is that the spray is only needed if there is a potential for water to drain from the SFP. This position is stated in JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," Revision 1 [Reference 54].

By letter dated March 31, 2014, Exelon submitted its SHSR for Ginna to the NRC [Reference 22]. In the NRC staff review of the reevaluated seismic hazard [Reference 45], the staff concluded that a SFP evaluation was not required since the reevaluated seismic hazard level is bounded by the plant design-basis for frequencies between 1 and 10 Hz. Further, the licensee's reevaluated seismic hazard is acceptable to address other actions associated with NTTF Recommendation 2.1, "Seismic". In reaching this determination, the NRC staff confirmed the licensee's conclusion that the licensee's Ground Motion Response Spectrum (GMRS) for the Ginna site is bounded by the SSE for Ginna in the 1 to 10 Hz range, except for a narrow band exceedance between 9 and 10 Hz. As such, the NRC staff did not require any additional SFP evaluation at Ginna.

The NRC staff worked with industry to develop a method of predicting the susceptibility of a SFP to cracking. The primary input is the seismic stresses that the SFP was designed to survive compared to the seismic stresses from a seismic event that has some probability of occurring at the site. By letter dated February 23, 2016 [Reference 55], NEI submitted a request for the NRC staff to approve guidance for a SFP evaluation based on EPRI report 3002007148. EPRI 3002007148 is a generic study performed for nuclear power plants with low-to-moderate seismic ground motions (peak spectral accelerations less than 0.8g) to address the NRC 50.54(f) letter that requested a seismic evaluation of the SFP to consider all seismically induced failures that could lead to rapid draining. Based on the staff's assessment letter dated June 11, 2015 [Reference 45], the peak spectral acceleration for the licensee's SSE and Ground Motion Review Spectrum are less than 0.8g; thus, the staff finds that EPRI 3002007148 is applicable to the licensee's site. Section 3.3 of EPRI 3002007148 provides guidance on specific site parameters, structural parameters and non-structural parameters that a licensee should confirm on a site-specific basis to ensure that the report applies. The NRC staff endorsed the EPRI report as an acceptable method of performing seismic evaluations of SFPs in a letter dated March 17, 2016 [Reference 56]. During the audit, the licensee confirmed that Ginna met the site parameters in section 3.3 of the EPRI report to affirm that the report was applicable to the Ginna SFP and therefore Ginna was not susceptible to draining of the SFP.

The NRC staff reviewed the licensee's proposal and finds that the robust design of the SFP, the moderate seismic hazard at the site, and the available diverse methods of providing makeup to the SFP to compensate for boiloff justify deleting the requirement for SFP spray as an acceptable alternative to the NEI 12-06 guidance. The NRC staff concludes that the licensee has a strategy to maintain or restore SFP cooling that will prevent damage to the fuel following a BDBEE, which meets the requirement of the EA-12-049 order.

3.15 Conclusions for Order EA-12-049

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

4.0 TECHNICAL EVALUATION OF ORDER EA-12-051

By letter dated February 28, 2013 [Reference 24], the licensee submitted an OIP for Ginna in response to Order EA-12-051. By letter dated August 29, 2013 [Reference 25] the NRC staff sent a Request for Additional Information (RAI) to the licensee. The licensee provided a response by letter dated September 23, 2013 [Reference 26]. By letter dated December 5, 2013 [Reference 27], the NRC staff issued an Interim Staff Evaluation (ISE) and RAI to the licensee.

By letters dated August 27, 2013 [Reference 29], February 24, 2014 [Reference 30], August 26, 2014 [Reference 31], February 20, 2015 [Reference 32], and August 28, 2015 [Reference 33], the licensee submitted status reports for the Integrated Plan. The Integrated Plan describes the strategies and guidance to be implemented by the licensee for the installation of reliable SFP level instrumentation which will function following a BDBEE, including modifications necessary to support this implementation, pursuant to Order EA-12-051. By letter dated December 15, 2015 [Reference 35], the licensee reported that full compliance with the requirements of Order EA-12-051 was achieved.

The licensee has installed a SFP level instrumentation system designed by AREVA Americas, Inc. The NRC staff reviewed the vendor's SFP level instrumentation system design specifications, calculations and analyses, test plans, and test reports. The staff issued an audit report on September 15, 2014 [Reference 34].

The NRC staff performed an onsite audit to review the implementation of SFP level instrumentation related to Order EA-12-051. The scope of the audit included verification of (a) site's seismic and environmental conditions enveloped by the equipment qualifications, (b) equipment installation met the requirements and vendor's recommendations, and (c) program features met the requirements. By letter dated June 18, 2015 [Reference 17], the NRC issued an audit report on the licensee's progress. Refer to section 2.2 above for the regulatory background for this section.

4.1 Levels of Required Monitoring

The level instrumentation will provide the capability to monitor SFP level at the three distinct critical levels identified by NEI 12-02 guidance:

- Level 1 - Level adequate to support operation of the normal fuel pool cooling system. The minimum required level to provide adequate pump suction is 275'-11.5".
- Level 2 - Level adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck is 257'. This level provides substantial personnel radiation shielding that would allow implementation of local SFP make-up strategies for a beyond design bases event.
- Level 3 - Level where fuel remains covered and actions to implement make-up water addition should no longer be deferred is 251'-5", the highest point of any fuel rack seated in the SFP.

In its letter dated September 23, 2013 [Reference 26], the licensee stated that the Level 1 value is established at Ginna based on the low water level trip of SFP cooling pump B at 275'-11.5", which is approximately 2' below the top of the SFP and approximately 2' above the pump upper suction line, and is based on preventing air entrapment that may occur due to vortexing. The Level 1 elevation at the SFP pump B trip setpoint represents the higher of the two points described in the NEI guidance. Engineering analysis shows that for SFP pump B, with the SFP high and low suction valves open and SFP temperature at 212 °F, the required NPSH for the minimum flow rate is approximately 275'-11". The level at which reliable suction loss occurs due to uncovering of the coolant inlet pipe (274'-0") is lower than the elevation at which SFP pump B loses the required NPSH (275'-11.5") making the SFP Pump B trip setpoint the higher of the two points, and it was therefore selected for the Level 1 value. The normal water level in the SFP is between 276'-1.5" and 277'.

For Level 2, the licensee stated that the calculation indicates that water coverage of 5'-6" above the racks is sufficient to ensure dose rates around the SFP deck area meet the acceptance criterion of ≤ 100 millirem per hour (mrem/hr). The Level 2 value has been established at about 5'-7" above the fuel racks to provide some margin. The dose calculation assumes that there is no material stored above the SFP racks that contributes to the dose rate. If materials that can contribute to the dose rate are planned to be stored in the SFP in the future, additional analysis will be performed to determine the projected dose rate impact and the appropriate Level 2 value. The addition of irradiated materials to the SFP and any additional analysis will be controlled by a station procedure. In the same letter above the licensee provided a sketch depicting SFP instrumentation (SFPI) Level 1 designated as 275'-11.5", Level 2 designated as 257'-0", and Level 3 designated as 251'-5".

The NRC staff noted that Level 1 designation is above the pump upper suction line and adequate for normal SFP cooling system operation. This level also represents the higher of the two points described in NEI 12-02 for Level 1. For Level 2, the staff noted that the licensee used the second of the two options described in NEI 12-02 for Level 2. This method requires enough water level in the SFP to provide adequate radiation shielding to maintain personnel radiological dose levels within acceptable limits while performing local operations in the vicinity of the pool. Guidance document NEI 12-02 states that guidance for performing plant-specific shielding calculations considering the emergency conditions that may apply at the time and the scope of necessary local operations may be found in EPA-400, "Manual of Protective Actions Guides and Protective Actions for Nuclear Incidents". The NRC staff also noted that the licensee performed calculations in accordance with EPA-400 guidance to determine dose rates near the edge of the SFP with 5 ft. to 7 ft. of water above the top of the fuel racks, and found that the dose rate would be lower than 100 mrem/hr. The calculated dose rate and the use of procedures to control the addition of irradiated materials to the SFP is reasonable for the licensee to perform actions in the vicinity of the SFP to maintain total dose within regulatory limits. The Level 3 designation is the top of the fuel racks which is consistent with NEI 12-02.

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. Refer to Section 2.2 above for the requirements of the order in regards to the design features. Below is the staff's assessment of the design features of the SFP level instrumentation.

4.2.1 Design Features: Instruments

In its OIP, the licensee stated that the primary and backup instrument channels will consist of fixed components. The primary and backup instrument channels level sensing components will be located and permanently mounted in the SFP. The primary and backup instrument channel will provide continuous level indication over a minimum range of approximately 25 feet 7 inches from the high SFP level elevation of 277'-0" to the top of the spent fuel racks at elevation 251'-5". This continuous level indication will be provided by a guided wave radar system, through air radar system, or other appropriate level sensing technology that will be determined during the detailed engineering design phase of the project. Primary instrument channel level sensing components will be located in the southeast corner of the SFP. Backup instrument channel level sensing components will be located in the southwest corner of the SFP.

In its letter dated August 27, 2013 [Reference 29], the licensee further stated that the instrument channels will provide continuous level indication over a minimum range of about 25 feet 7 inches from the high SFP water level elevation of 277'-0" to the top of the spent fuel racks at elevation 251 '-5". The NRC staff noted that the measurement range will cover Levels 1, 2, and 3 as described in Section 4.1 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 letter dated August 27, 2013 [Reference 29], the licensee provided locations for the SFPI sensors, which will be located in the southeast and northeast corners of the SFP to minimize impact/interference with the SFP Bridge Crane as well as minimize length of waveguide to keep signal losses from the transmitter as low as possible.

In its letter dated September 23, 2013 [Reference 26], the licensee further stated that the waveguide will route from the southeast horn antenna to its level transmitter seismically mounted on the exterior east wall of the decontamination pit at the 276' elevation level, between the south block wall of the auxiliary building and the new fuel storage building's south wall. The waveguide from the northeast horn antenna will route to its level transmitter seismically mounted at the 276' elevation level, at the exterior SFP east wall directly under the stairwell leading from the spent fuel pool decking to the auxiliary building operating level. The northeast channel's level transmitter cabling will route into the adjacent cable tray 68 which penetrates down into the middle level. The cable will route in tray 68 for approximately 18 feet and then head south in conduit to the Chemical & Volume Control System (CVCS) Hold-Up Tank (HUT) room wall. The cable and conduit will then route into the eves HUT room opening between tanks 1 and 2 and run along the north interior wall into the waste gas compressor room. Inside the waste gas compressor room the cable and conduit will run along the north, then east, and then south walls to the new building penetrations made for the new Diesel Driven Auxiliary Feedwater (DDAFW) building. New buried conduit has been installed from these new penetrations through to the east wall of DDAFW building. This wall is also the west wall (shared wall) of the existing Standby Auxiliary Feedwater (SAFW). The cable and conduit will penetrate into the SAFW building (core bore) just south of the walkway between the buildings, and then run north on the west wall to the northwest corner of the building where the control panel will be mounted to the north wall approximately 10 feet east from the west wall. The southeast channel's level transmitter cabling will route in conduit northward along the exterior of the decontamination pit wall and into the new fuel storage building. The cabling and conduit will run 11.5 feet along the east concrete wall of the new fuel storage building and then into the middle level CVCS HUT 1 room through a new hole that will be bored into the operating floor. The cable and conduit will then run north along the west wall to the north wall where it will then run eastward and meet up with the other channel's conduit between the HUT room 1 and room 2 areas. The cable and conduit will run the rest of the way to its respective control panel in the same general area as the northeast channel's route. The southeast channel's control panel will be mounted just above the control panel for the northeast channel on the SAFW building's north wall.

The licensee's locations of the primary and backup level instruments for its SFP appears to be consistent with NEI 12-02. However, the NRC staff noted that sketches provided in letter dated September 23, 2013, show a portion of the two conduits running side by side on the Intermediate Floor (Elevation 253'-0") to the control panels. The staff had concerns regarding the routing of these two channels in accordance with the guidance on channel separation as described in NEI 12-02. In its letter dated February 24, 2014 [Reference 30], the licensee provided a response to the staff's concern, in which it stated that all equipment located in areas that are vulnerable to externally generated missiles (Auxiliary Building Operating Floor and SFP area) maintains physical channel separation of at least the width of the shortest side of the SFP. This provides for natural protection from a missile disabling both systems. Horn antenna and waveguide are mounted and routed at opposite sides of the SFP. The transmitter and conduit for its respective cabling that are located on the operating floor are also physically separated by at least the width of the shortest side of the SFP. Further, all cabling for each channel are routed in separate conduit and the transmitter and conduit for the southeast channel are located inside the new fuel storage building. Equipment located in the Intermediate Floor of the Auxiliary Building is not vulnerable to externally generated missiles that may result from damage to the structure over the SFP as the concrete Auxiliary Building Operating Floor provides protection from missiles that may result from damage to the structure over the SFP.

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

Based on the discussion 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

In its OIP, the licensee stated that mounting will be Seismic Class I. Installed equipment will be seismically qualified to withstand the maximum seismic motion considered in the design of the plant area in which it is installed. An evaluation of other hardware stored in the SFP will be conducted to ensure it will not create an adverse interaction with the fixed SFP instrument locations.

In its letter dated February 24, 2014 [Reference 30], the licensee stated that the sensor mount and the horn assembly mounts are qualified by calculation using the AISC 9th Edition design manual for steel construction. All anchorages are qualified using concrete anchor bolts and the manufacturer's design guide. The generic sensor calculation qualifies a simple C-channel steel section welded centrally on a 1/2 inch steel base plate. The base plate is anchored using four concrete anchor bolts. The generic sensor end support uses a generic seismic acceleration of 10g for the SSE, which is meant to encompass the seismic response spectra of all the locations where these mounts are installed. The calculation assumes a maximum height of support to be 15 inches off of the wall. All mounts using a smaller length of C-channel are qualified by comparison. Mounting of the SFP level transmitter wave guide at Ginna is addressed in calculation DA-ME-13-015, "Seismic Evaluation for SFP Level Indication Radar Guide Pipe and Supports". Piping shall be qualified as seismic category I in accordance with EWR 2512, "Design Criteria, Ginna Station Seismic Upgrade Program," and the pipe supports shall be qualified to loading conditions which bound those specified in EWR 2512. All electrical conduit supports are installed per GC-76.9, "Installation and Inspection of Electrical Equipment, Raceway and Electrical Supports," per the standard Impell conduit support drawing series. The Control Panel mounting assembly will be mounted to unistrut using the hardware specified in drawing 02-9209819D.

In its letter dated February 20, 2015 [Reference 32], the licensee further stated that ECP-13-000547 Form-015-7B-01 establishes installation criteria that all equipment installed at the SFP shall be mounted to retain its design configuration during and following the maximum seismic ground motion considered in the SFP structure. All electrical conduit supports are installed per GC-76.9 and per the standard Impell conduit support drawing series. The Control Panel mounting assembly is mounted to unistrut using the hardware specified in drawing 02-9209819D.

During the onsite audit, the licensee stated that all SFP level equipment was seismically mounted to existing concrete plant structures. Structural engineering reviewed all connection points to verify that the structural integrity was not impacted by the addition of SFP level components. Detailed installation instructions including where to mount components was provided with the plant modification package. All conduit/cable and the control panels were seismically mounted per the standard Impel drawing series (0950-072). These stations specific support drawings are used for mounting safety related and seismic equipment or conduit supports to existing concrete or steel plant structures. The horn and level transmitter supports were seismically mounted per Calculation 32-9221237, Revision 003 and Calculation 32-9208751, Revision 002.01. The waveguide supports were seismically mounted per DA-ME-13-015, Revision 000.

The NRC staff found the licensee adequately addressed the SFPI mounting requirements. The site-specific seismic analyses demonstrated that the SFP level instrumentation's mounting design is satisfactory to allow the instrument to function per design following the maximum seismic ground motion. The staff verified the licensee's responses by performing a walkdown and by reviewing the following:

- In Calculation 32-9221237, "Qualification for a Waveguide Type "A" Support and Horn Assembly for AREVA Spent Fuel Level Monitoring Instrumentation," Revision 003, the licensee stated that the waveguide support and horn end assembly with a horn cover are qualified provided the sloshing loads calculated are equal to or below 3.37 psi. This load bounds the maximum hydrodynamic loading anticipated at Ginna of 1.9 psi or less.

- Calculation 32-9208751, "for AREVA Spent Fuel Level Monitoring – Horn and Transmitter Support," Revision 002.01 uses SSE acceleration to calculate the waveguide support assembly.

- Calculation DA-ME-13-015, "Seismic Evaluation for SFP Level Indication Radar System Guide Pipe and Supports," Revision 000 states that the pipe support are structurally adequate under all the loading combinations, specified in "EWR 2512, Design Criteria, Ginna Station Seismic Upgrade Program," Revision 5. For evaluation of the supports, use of N-411 damping is conservative for peak SSE accelerations.

- Engineering Change Package ECP-13-000547, "Spent Fuel Pool Level Instruments," Revision 0001, Form 9, "Installation and Testing Instructions," states that the control panel shall be mounted as instructed to the unistrut, which shall conform to the generic support drawings 0950-072-1002 Sheet1, 0950-072-1000 and 0950-072-2000. Conduit and associated supports must be installed per Impel standard conduit support drawings.

Based on the discussion above, the NRC staff finds that the licensee's proposed mounting design appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of 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 augmented quality requirements, similar to those applied to fire protection equipment, will be applied to this project.

Based on the discussion above, the NRC staff finds that the licensee's proposed augmented quality assurance process, if implemented appropriately, appears to be consistent with NEI 12-02, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.4.2 Equipment Reliability

The NRC staff reviewed the AREVA SFP level instrumentation's qualification and testing during the vendor audit for temperature, humidity, radiation, shock and vibration, and seismic [Reference 34]. The staff further reviewed the anticipated Ginna's environmental conditions during the on-site audit [Reference 17].

4.2.4.2.1 Temperature, humidity, and radiation

In its OIP, the licensee stated that the primary and backup channels will be reliable at temperature, humidity, and radiation levels consistent with the SFP water at saturation conditions for an extended period. Saturation temperature at the bottom of the SFP assuming normal water level will be approximately 255 °F. Post-event temperature at sensors located above the SFP is assumed to be 212 °F. Post event humidity near and above the SFP is assumed to be 100 percent with condensing steam. Equipment will be qualified for expected conditions at the installed location assuming that normal power is unavailable and that the SFP has been at saturation for an extended period. Equipment located in the vicinity of the SFP will be qualified to withstand peak and total integrated radiation dose levels for its installed location assuming that post-event SFP water level is equal to the top of the spent fuel racks (Level 3) for an extended period of time. The equipment mounted in the new fuel storage area is at a lower elevation than the top of the SFP and the temperature is expected to be lower than the temperature above the SFP. The sensor and cables are relatively insensitive to temperature. Exposure of the electronics to temperatures above 150 °F may result in equipment failure.

For the temperature and humidity conditions at the locations the SFP level instrument is located, in its letter dated February 20, 2015 [Reference 32], the licensee stated that the postulated temperature and humidity in the spent fuel pool area that results from a boiling pool is 100 °C (212 °F) with saturated steam. The electronics in the SFP level sensor are rated for a maximum continuous duty temperature of 80 °C (176 °F) on the condition that the process temperature (that which the flange connection is in contact with) is no greater than 130 °C (266 °F). The sensor must be located away from the spent fuel pool in an area where the temperature is at or below the rated temperature. The SFP level sensors are located in the auxiliary building away from and at a lower elevation than the top of the SFP. An analysis of the auxiliary building environment, CALC-2014-0006, under the assumed worst case conditions with no power available to run HVAC systems, shows that the SFP level sensors will be subject to a maximum of 126.1 °F and a maximum wet bulb globe temperature of 127.5 °F. The process temperature at the flange connection is no greater than 212 °F. The SFP level instrumentation power control panel internal components are rated for a maximum temperature of at least 70 °C (158 °F). Allowing for 5 °C (9 °F) heat rise in the panel, the overall panel maximum ambient temperature for operation is 65 °C (149 °F). The power control panel enclosure is rated NEMA 4X and provides protection to the internal components from the effects of high humidity environments. The power control panel is located in the SAFW building with a maximum temperature of 120 °F for normal and accident conditions. Humidity conditions in the SAFW building will be bounded by outside air humidity.

For the radiological conditions at the locations the SFP level instrument is located, in its letter dated February 24, 2014 [Reference 30], the licensee stated that Calculation Change Notice ECP-13-000547-CN-005, "Address Maximum Dose at SFP Level Transmitter for Fukushima

Project," calculates that the total integrated dose (TID) is 772 rad at the SFP level transmitter with the SFP level at the top of the racks for 7 days and that the bounding dose rate is 4 rad/hour. With the additional shielding provided by the SFP wall, the TID would be significantly less. AREVA Document No. 51-9202556, "Qualification Analysis of VEGAPULS 62 ER Through Air Radar," states that the electronics for the SFP level instrumentation equipment must be located in an area that is shielded from the direct shine from the fuel, and bounce and scatter effects above the pool. For the purpose of this analysis, the radiation levels in the area do not exceed $1x10^3$ rad. Dose rates used for testing electronics using MIL-STD-883J are 50 rad/second or greater. During the onsite audit, the NRC staff reviewed Calculation CALC-2013-0001, "Ginna Spent Fuel Pool Area Dose Rates at Severely Reduced Water Levels," Revision 0. CALC-2013-0001 concluded that the TID over a 7 day period was calculated to be 772 rad, which is less than the 1000 rad that the equipment is qualified for.

The NRC staff found the licensee adequately addressed the equipment reliability of SFP level instrumentation with respect to temperature, humidity and radiation. The equipment qualification envelops the expected radiation, temperature, and humidity conditions during a BDBEE. The equipment environmental testing demonstrated that the SFP instrumentation should remain functional during the expected beyond-design-basis (BDB) conditions.

4.2.4.2.2 Shock and Vibration

In its letter dated February 24, 2014 [Reference 30], the licensee stated that the MIL-S-901D test consisted of a total of nine shock blows, three through each of the three principal axes of the sensor, delivered to the anvil plate of the shock machine. The heights of hammer drop for the shock blows in each axis were one foot, three feet and five feet. The SFP level indicator was energized and operating throughout the test. At the completion of each shock blow, in addition to visual inspection for evidence of physical damage and leakage, the level indicator was also checked for electrical malfunction. There was no apparent physical damage, leakage or electrical malfunction as a result of the shock blows. In addition to the MIL-S-901D testing, the VEGAPULS 62 ER sensor has been shock tested in accordance with EN 60068-2-27, (100g, 6 millisecond (ms)), ten shock blows applied along a radial line through the support flange. Test results document that the requirements were fulfilled. The MIL-STD-167-1 vibration test frequencies ranged from 4 Hz to 50 Hz with amplitudes ranging from 0.048" at the low frequencies to 0.006" at the higher frequencies. The potential vibration environment around the SFP and surrounding building structure might contain higher frequencies than were achieved in the testing discussed above. Additional testing of the VEGA PULS 62 ER sensor was performed in accordance with EN 60068-2-6 Method 204 (except for the 5g, 500 Hz test). Test results document that the testing requirement were met. This additional testing is considered to provide a stand-alone demonstration of the resistance to vibration of the VEGAPULS 62 ER sensor and further substantiates the results of the MIL STD-167-1 testing.

The NRC staff finds that the licensee adequately addressed the equipment reliability of SFP level instrumentation with respect to shock and vibration. The staff also reviewed the shock and vibration test report during the vendor audit and found it acceptable.

4.2.4.2.3 Seismic

For the equipment's seismic qualification, in its letter dated February 20, 2015 [Reference 32], the licensee stated that a seismic shake test was performed by AREVA to the requirements of

IEEE 344-2004 for elements of the VEGAPULS 62 ER through-air radar to levels anticipated to envelop most if not all plants in the U.S. The equipment qualified included the sensor, indicating and adjustment module, 62 display, power control panel, rotatable horn waveguide assembly, waveguide piping including standard and repair flanges, and pool end and sensor end mounting brackets. The brackets are considered to be the standard design. Modifications to the standard design for specific applications are qualified by analysis. The rotatable horn waveguide assembly can be provided in shorter cantilever lengths than the tested assembly. The shorter cantilever lengths are inherently more rigid than the tested lengths. Therefore, the seismic test results are considered to be also applicable to the shorter cantilever lengths. The seismic required response spectra (RRS) used for the testing was at 5 percent damping. This RRS is intended to envelop not only the seismic level for items mounted to building structure, but also the much higher levels that can be experienced for items mounted in or on cabinets due to the additional seismic amplification from cabinet resonances.

The waveguide piping between the horn end section and the sensor is supported by mounts provided and qualified by the customer. The seismic test configuration had 10'-7½" between supports for the waveguide piping with standard flanges and 6'- 3½" between supports for the waveguide piping with repair flanges. These distances represent the maximum allowable distances between supports to maintain seismic qualification. Flanges were located both centrally between supports and near one support to test both conditions. Therefore, flanges may be located at any point between the supports. Ginna calculation DE-ME-13-015, Assumption 5.8, documents that the vendor has qualified their standard bolted flange design seismically to a maximum span of 10'-7½". Ginna's design includes a maximum span of 14'-1". This is acceptable based on the low stress levels calculated within this design analysis and the significant difference of the response spectra for the Ginna auxiliary building 315' elevation (5g peak) compared to the EPRI TR-1 07330 response spectra (14g peak) used to qualify the waveguide components, a factor of safety (FS) of 2.8. Increasing the span by 33 percent is expected to increase the moment, and resulting stress levels, by a factor of 1.77, based on the beam equation for a uniform loading condition.

Additionally, an envelope of the response spectra for the 271' and 315' elevations in the auxiliary building is conservatively used. The response spectra for the 278' elevation is expected to be much closer to the 271' response spectra (1.2g peak, FS of 11.7), as the local ground elevation is 271' and SFP concrete structure extends from the 278' elevation down to bedrock. The significant increase in acceleration from the 271' to the 315' elevation is due to the transition of the structure from below grade concrete structure to above grade steel framed structure. Additional support is provided by straps which are not credited for the seismic qualification that are installed on the protective steel structures at the transfer slot. Although not credited, these straps will provide additional support for the waveguide pipe. Confirmatory analysis was conducted to verify these straps would not result in any elevated stress conditions.

An analysis of the combined maximum seismic and hydrodynamic forces on the cantilevered portion of the assembly exposed to the potential sloshing effects was performed in calculation 32-9221237. The waveguide Type "A" support and horn end assembly were evaluated for deadweight, seismic and sloshing loads. The sloshing loads calculated are equal to or below 3.37 psi and within allowable parameter limits. A sloshing force of 3.37 psi (does not include Dynamic Load Factor) will result in a maximum I.R. = 1.0 for the shear check on the waveguide pipe. Sloshing loads less than this are acceptable by comparison. All other interaction ratios for the support are less than 1.0. The Ginna owner's acceptance review documents that the Ginna specific horn assembly is shorter, therefore more rigid and stronger than Type "A" qualified within this calculation. Also, the smaller assembly will result in less deadweight, seismic and hydrodynamic loading on the waveguide flange, flange bolts and horn assembly support. Calculation 32-9221237, Attachment G-1, independently checks the qualification of the horn assembly with a sloshing load of 2 psi. As both the horn and support are shown to be rigid, it is appropriate to use zero period accelerations (ZPAs). The AREVA ZPAs (1g vertical and 2g horizontal) bounds the actual ZPAs anticipated at the SFP by greater than 2 times in any given direction. The qualified sloshing load is 3.37 psi. This load bounds the maximum hydrodynamic loading anticipated at Ginna of 1.9 psi or less. Two methods were used to calculate the sloshing loads. The first concluded the sloshing load at <1 psi, but conservatively did a check of the horn and support using 2 psi, and the second applied an alternate conservative method that bounded the sloshing load at 1.9 psi.

The NRC staff found the licensee adequately addressed the equipment reliability of SFP level instrumentation with respect to seismic qualifications. The equipment's seismic qualifications envelop the expected Ginna seismic condition during BDB event. The site-specific seismic analyses demonstrated that the SFP level instrumentation's mounting design is satisfactory to allow the instrument to function per design following the maximum seismic ground motion. The staff also reviewed the vendor's factory acceptance test reports and found the Ginna SFPI design and qualification process acceptable.

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 letter dated September 23, 2013 [Reference 26], the licensee stated that the two channels of the AREVA through-air radar SFP level measurement system meet the requirement for independence through separation by distance and electrical independence of one another. The horn antenna for each level instrument will be installed on the southeast and northeast corners of the SFP. This separation will be maintained for the routing of the stainless steel waveguide piping and each channel's sensor electronics. Wiring from the sensors and wiring to the control panels and displays for each channel will be routed in separate conduits to the SAFW building. The instrumentation power sources are provided with independent and battery backed-up supplies. Independence will be maintained throughout the entire channel. Therefore, failure of one power source will not result in a loss of both instrument channels.

For the normal power sources, in its letter dated February 24, 2014 [Reference 30], the licensee stated that each control panel will receive an independent non-safety related 120 Vac power feed. Power for the northeast channel's control panel will be from ACPDPAF02 (located in the southeast corner of the SAFW building), circuit 8. This panel is fed from MCC E, which is powered from bus 15. Power for the southeast channel's control panel will be from the planned ACPDPAF05 panel located in the new Diesel Driven Auxiliary Feedwater (DDAFW) building. This panel will be fed from the 12 kilovolts (kV) Sodus Line or KDG08 through breaker 52DI/SAFW as selected by automatic transfer switch 83/SAFW. Each control panel also contains an internal battery backup that is independent from the station's ac and dc distribution systems, which will ensure continued level indication on an SBO scenario by powering the indication in the SAFW building and on the PLISCOM. Since the new DDAFW building will not be available during the initial construction phase of this modification, power for the southeast channel's control panel will initially be fed from the same source (ACPDPAF02, circuit 8) as the northeast's channel. Once the new DDAFW building is completed, power for the southeast channel's control panel will be re-located.

During the onsite audit, the NRC staff reviewed the following documents:

- Drawing 03200-0102, "AC Power Distribution Panels One-Line Diagram," Revision 33
- Drawing 33013-2539, "AC System Plant Load Distribution One Line Wiring Diagram," Revision 28
- Drawing 33013-2722, "Residential AC Power Distribution Circuit One-Line Diagram," Sheet 4, Revision 16
- Drawing 33013-2722, "Residential AC Power Distribution Circuit One-Line Diagram," Sheet 1, Revision 38

The NRC staff found that the licensee adequately addressed the instrument channel independent including the power sources. The primary instrument channel is physically and electrically independent of the backup instrument channel. The instrument channels' physical separation is discussed in Subsection 4.2.2, "Design Features: Arrangement". With the licensee's proposed power arrangement, the electrical functional performance of each level measurement channel would be considered independent of the other channel, and the loss of one power supply would not affect the operation of other independent channel under BDB event 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 Design Features: Power Supplies

In its OIP, the licensee stated that the primary and backup channels will be powered from dedicated batteries and local battery chargers. The battery chargers for both channels will normally be powered from independent, non-safety-related, 120V ac power supplies. Minimum battery life of 72 hours will be provided. The battery systems will include provision for battery replacement should the battery charger be unavailable following the event. Spare batteries will be readily available. During the loss of normal power the battery chargers will be connectable to another 120 Vac power source. This will be from portable generators stored onsite or from generators deployed from off-site by the mitigating strategies resulting from Order EA- 12-049, at approximately 24 hours after the event.

In its letter dated September 23, 2013 [Reference 26], the licensee further stated that in the event of loss of primary power the instruments can be manually switched to backup power. The VEGAPULS has a self-contained battery (four standard C lithium cells) backup source which will support approximately 2.5 years with 30 minutes of operation per day, or > 300 hours of continuous operation. During this time, it supplies the power to the whole system, i.e., sensor electronics and the display, with a power consumption of < 0.5 Watts. The sizing of the battery back-up for each channel of the VEGAPULS 62ER is based on the ability to supply the sensor at full load (20 milliamps (mA)), and the level monitoring display, ensuring that the channel will be available to run reliably and continuously following onset of the BDB/ELAP event for at least seven days, with built-in margin. The sizing of the battery will be verified by calculation or test prior to installation. The self-contained battery system will be independent from existing station batteries.

During the onsite audit, the NRC staff inquired as to power restoration strategy following an ELAP and prior to the back-up battery depletion. In response, the licensee stated that the channel that is powered from the 12 kV Sodus off-site line is backed by the new SAFW DG. Upon loss of the Sodus line, the SAFW DG will automatically start and energize the bus that powers the level channel. In the event that the SAFW DG fails to start, the new NFPA-805 1MW diesel generator will start and energize the bus that powers that level channel.

The NRC staff noted that the licensee adequately addressed the staff's concern and verified the response by reviewing the following:

- Drawing 03200-0102, "AC Power Distribution Panels One-Line Diagram," Revision 33
- Drawing 33013-2539, "AC System Plant Load Distribution One Line Wiring Diagram," Revision 28
- Drawing 33013-2722, "Residential AC Power Distribution Circuit One-Line Diagram," Sheet 4, Revision 16
- Drawing 33013-2722, "Residential AC Power Distribution Circuit One-Line Diagram," Sheet 1, Revision 38

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

4.2.7 Design Features: Accuracy

In its letter dated September 23, 2013 [Reference 26], the licensee stated that the reference accuracy for the instrument defined by the manufacturer is ± 2 millimeters (mm) based on sensor horn without a waveguide using a metal target. However, with a waveguide and water as a target, accuracy under normal SFP level conditions has been demonstrated to be ± 1 inch based on tests performed by AREVA. This represents an accuracy of approximately 0.327% of the 25'-6" measurement range from normal SFP level to SFP Level 3. This is the design accuracy value that will be used for the SFP level instrument channels. The accuracy of the instrument channel is little affected under BDB conditions (i.e., radiation, temperature, humidity, post-seismic and post shock conditions). The stainless steel horn antenna and waveguide pipe that would be exposed to BDB conditions is largely unaffected by radiation, temperature and humidity other than a minor effect of condensation forming on the waveguide inner walls which will have a slight slowing effect on the radar pulse velocity. Testing performed by AREVA using saturated steam and saturated steam combined with smoke indicate that the overall effect on the instrument accuracy is minimal. The overall accuracy due at BDB conditions described above is conservatively estimated to not exceed ± 3 inches or 0.980 percent of the 25'-6" measurement range, which is within the required ± 1 foot described in NEI 12-02.

For the instrument accuracy performance after the loss of power, in its letter dated August 26, 2014 [Reference 31], the licensee stated that the vendor factory acceptance test demonstrated reliable operation of the SFP level instrumentation under normal conditions and under various simulated BDB test conditions (e.g. steam exposure). The accuracy performance values were also verified after a loss of power and subsequent restoration of power. The factory acceptance test and site acceptance testing verified that on a loss of the normal ac power supply that is expected to occur during an ELAP, power is automatically transferred to a battery backup within each of the primary and backup SFPLI power control panels and accuracy remains satisfactory. During the onsite audit, the NRC staff reviewed Factory Acceptance Test Report 66-9218244, "Through Air Radar Spent Fuel Pool Level Indication (SFPLI) Instrument Factory Acceptance Test (FAT) Report," Revision 000 and Site Acceptance Test Report 66-9221608, "Spent Fuel Pool Level Indication Site Acceptance Test Report," Revision 002 and found the tests were performed with satisfactory results.

The NRC staff finds that the licensee adequately addressed instrument channel accuracy. The order requires demonstrated that the instrument channels shall maintain their designed accuracy following a power interruption or change in power source without recalibration. The NRC staff finds that the licensee's proposed instrument accuracy is consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.8 Design Features: Testing

In its letter dated September 23, 2013 [Reference 26], the licensee stated that multi-point testing is enabled by means of a radar horn antenna capable of being rotated away from the SFP water surface and aimed at a movable metal target that is positioned at known distances from the horn. This allows checking for correct readings of all indicators along a measurement range and validates the functionality of the installed system. Since the two level channels are independent, a channel check tolerance based on the final design accuracy of each channel will be applied for cross comparison between the two channels. Functional checks will be performed on a regularly scheduled basis. The functional check includes visual inspection, verification of the instrument display reading, verification of proper power supply voltage, and testing of the battery backup on simulated loss of normal power. Multi-point calibration tests will also be made on a regularly scheduled basis. Functional testing will be performed within 60 days of a planned refueling outage considering normal testing schedule allowances and not to exceed more than once every 18 months. Calibration tests and functional checks will be incorporated into procedures as part of the plant surveillance program. Periodic functional tests will be scheduled to occur within 60 days of each planned refueling outage. The functional tests will verify that the readings for the primary and backup channels are consistent with the actual SFP level. The through-air radar instrument requires no regular preventative maintenance, except for routine replacement of the backup lithium battery cells in the control panel. This will be performed during regularly scheduled checks and testing.

The NRC staff found that the SFP level instrumentation is adequately designed to provide the capability for routine testing and calibration. 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. The NRC staff finds that the licensee's proposed SFP instrumentation design allows for testing consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.9 Design Features: Display

In its OIP, the licensee stated that remote indication will be provided in the SAFW building, which will be (a) promptly accessible to the appropriate plant staff, including during the occurrence of a SFP drain down event, (b) located outside of the area surrounding the SFP floor at an appropriate distance from the radiological sources resulting from an event impacting the SFP, (c) a structure that provides protection against adverse weather, and (d) located outside of any high radiation areas during normal operation.

In its letter dated August 26, 2014 [Reference 31], the licensee stated that depending on the specific BDB event, personnel will be dispatched to the SFP level display location in the SAFW building to establish SAFW flow to the SGs within 25 minutes of the initiating event. Once the priority of establishing flow to the SGs is achieved, personnel can then monitor SFP level on an intermittent basis to provide SFP level indication information to the control room operator. An access pathway to the SAFW building (among multiple available pathways) is expected to remain available following a seismic or tornado missile event. In slowly developing BDB events, personnel can be pre-staged at the SFP level display location. The SFP level display access times are based on engineering/operations judgment. During a postulated BDB event, only periodic monitoring of SFP level is required. The SAFW building environment is not affected by the environmental conditions associated with any SFP drain down scenario. Radio communications between personnel at the SFP level display and the control room will used to keep control room operators informed of SFP level.

During the onsite audit, the licensee further stated that the SAFW building is a robust, habitable structure. This structure will be in use within 35 minutes of the ELAP event, since it is connected to the SAFW annex, from which necessary operator actions are performed to mitigate the event. This time period is well before any significant loss of water from the SFP could occur. During the Ginna Station staffing study, transition to the SAFW annex from the control room was performed in two minutes. To account for darkness and potential debris, the credited transition time was doubled to four minutes.

The NRC staff found that the licensee adequately addressed the display requirements. If implemented properly, the displays will provide continuous indication of SFP water level. The displays are located in a seismically qualified building and the accessibility of the SAFW building following an ELAP event is considered acceptable.

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

4.3 Evaluation of Programmatic Controls

Order EA-12-051 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 the Systematic Approach to Training (SAT) will be used to identify the population to be trained and to determine both the initial and continuing elements of the required training. Training will be completed prior to placing the instrumentation in service. The NRC staff finds that the use of SAT to identify the training population and to determine both the elements of the required training is acceptable. The licensee's proposed plan to train personnel in the operation, maintenance, calibration, and surveillance of the SFPI and the provision of alternate power to the primary and backup instrument channels, including the approach to identify the population to be trained, is 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 procedures will be developed using guidelines and vendor instructions to address the maintenance, operation and abnormal response issues associated with the new SFP instrumentation.

During the onsite audit, the licensee provided a list of procedures as follows:

- Calibration Procedures CPI-LVL-310, "Calibration of SFP Level Northeast Channel Loop LT-310" and CPI-LVL-311, "Calibration of SFP Level Southeast Channel Loop LT-311" provide for Calibration and performance checks of Spent Fuel Pool level Instruments LT-310 and LT-311.

- Operational Procedure O-6.1, "Equipment Operator Rounds and Log Sheets," provides a Channel Check of level instruments LT-310 and LT-311.

- CC-AA-118, "Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program". This document describes the program for FLEX and SFPI for Exelon Nuclear.

- CC-GI-118, "Site Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program". This document describes the program for FLEX at Ginna Station. This procedure implements the corporate procedure CC-AA-118.

- A-52.12, "Nonfunctional Equipment Important to Safety". This procedure provides the means to monitor the operating status of equipment considered to be important to safety but not addressed by Technical Specification, which includes the SFP level indication equipment.

The NRC staff finds that the licensee adequately addressed the procedure requirements for the testing, surveillance, calibration, and operation of the primary and backup SFP level instrument channels. The NRC staff finds that the licensee's proposed procedures are consistent with NEI 12 02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.3.3 Programmatic Controls: Testing and Calibration

In its letter dated September 23, 2013 [Reference 26], the licensee stated the maintenance and testing of the SFP level instrumentation system will be incorporated into the normal station work control processes based on vendor recommendations for maintenance and periodic testing. The calibration and maintenance program will include testing to validate the functionality of each instrument channel within 60 days of a planned refueling outage considering normal testing scheduling allowances. In the event a channel of SFP level instrumentation is out of service for any reason, the out-of-service time will be administratively tracked with an action to restore the channel to service within 90 days. Functionality of the other channel will be confirmed via appropriate testing measures within the following 7 days and every 90 days thereafter until the non-functioning channel is restored to service. In the event that a channel cannot be restored to service within the 90 day period, expedited actions to restore the channel would be initiated and tracked via Ginna's corrective action program. If both channels are determined to be non-functional, Ginna will initiate appropriate compensatory actions within 24 hours. The expedited and compensatory actions will be defined in the applicable maintenance procedure.

In its letter dated August 26, 2014 [Reference 31], the licensee further stated that programmatic controls will be established to ensure the performance of periodic performance checks of the SFP level transmitters and indications, calibration of loop power supplies and current repeaters/isolators, and verification of computer response. Procedures CPI-LVL-310 and CPI-LVL-311 provide the instructions for calibration checks of SFP level instrumentation channels LT-310 and LT-311 respectively. Procedure O-6.1 directs the outside operator to log LI-310 and LI-311 SFP levels once per twelve hour shift. Minimum and maximum SFP level values are identified for operator action in O-6.1. The plant process computer system has alarms to notify control room operators when levels indicate off-normal values.

During the onsite audit, the NRC staff had concerns with the licensee's lack of information on the preventive maintenance (PM) program and compensatory actions for SFPLI unavailability. In response, the licensee stated that the instrument calibration check is performed per procedure CPI-LVL-310 (northeast channel) and CPI-LVL-311 (southeast channel). They are invoked by PMs P105831 and P105832, respectively. These PMs are performed every 1.5 years (every refueling outage [RFO] cycle) and are performed within 60 days of the start of the RFO. Ginna performs a single point calibration check. The calibration procedures also require replacement of the backup batteries, which is based on the vendor's recommendation. Operation Procedure O-6.1, "Equipment Operator Rounds and Log Sheets," provides a channel check of level instruments LT-310 and LT-311. Rounds are made in the SAFW pump room and SAFW annex once per shift with channel checks taken at the same time.

Compensatory actions for one or both instrument channels out of service and one of the instrument channels cannot be restored to functional status within 90 days are as follows:

# Channel(s) Out-of-Service	Required Restoration Action	Compensatory Action if Required Restoration Action not completed within Specified Time
1	Restore channel to functional status within 90 days (or if channel restoration not expected within 90 days, then proceed to Compensatory Action)	Immediately initiate the following actions: - Initiate an Issue Report to enter the condition into the Corrective Action Program. - Identify the equipment out of service time is greater than the specified allowed out of service time, develop and implement an alternate method of monitoring, determine the cause of the non-functionality, and the plans and schedule for restoring the instrumentation channel(s) to functional status.
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 the following actions: - Initiate an Issue Report to enter the condition into the Corrective Action Program. - Identify the equipment out of service time is greater than the specified allowed out of service time, develop and implement an alternate method of monitoring, determine the cause of the non-functionality, and the plans and schedule for restoring the instrumentation channel(s) to functional status.

The above requirements are being incorporated into the Exelon Fleet Procedure CC-AA-118 and will be incorporated into the Ginna FLEX/SFPI Program Document CC-GI-118, "Site Implementation of Diverse and Flexible Coping Strategies (FLEX) AND Spent Fuel Pool Instrumentation Program". In addition, this procedure will further reference Procedure A-52.12, "Nonfunctional Equipment Important to Safety," as the controlling document for requirements should SFP level indicators be out of service.

The NRC staff found that the licensee adequately addressed the staff's concern. The staff verified the responses by reviewing the following:

- Procedure CPI-LVL-310, "Calibration of SFP Level Northeast Channel Loop LT-310, " Revision 1
- Procedure CPI-LVL-311, "Calibration of SFP Level Southeast Channel Loop LT-311," Revision 1

- Procedure O-6.1, "Equipment Operator Rounds and Log Sheets," Revision 05700

The NRC staff found that the licensee adequately addressed necessary testing and calibration of the primary and backup SFP level instrument channels to maintain the instrument channels at the design accuracy. The testing and calibration are 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 is 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 December 15, 2015 [Reference 35], the licensee stated that it would meet the requirements of Order EA-12-051 by following the guidelines of NEI 12-02, as endorsed by JLD-ISG-2012-03. In the evaluation above, the NRC staff finds that, if implemented appropriately, the licensee has conformed to the guidance in NEI 12-02, as endorsed by JLD-ISG-2012-03. In addition, the NRC staff concludes that if the SFP level instrumentation is installed at Ginna according to the licensee's proposed design, it should adequately address the requirements of Order EA-12-051.

5.0 CONCLUSION

In August 2013 the NRC staff started audits of the licensee's progress on Orders EA-12-049 and EA-12-051. The staff conducted an onsite audit at Ginna in May 2015 [Reference 17]. The licensee reached its final compliance date for Orders EA-12-049 and EA-12-051 on November 6, 2015, and has declared that the plant is in compliance with the orders. The purpose of this safety evaluation is to document the strategies and implementation features that the licensee has committed to. Based on the evaluations above, the NRC staff concludes that the licensee has developed guidance and proposed designs that if implemented appropriately should adequately address the requirements of Orders EA-12-049 and EA-12-051. The NRC staff will conduct an onsite inspection to verify that the licensee has implemented the strategies and equipment to demonstrate compliance with the orders.

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Date: July 14, 2016

These reports were required by the order, and are listed in the attached safety evaluation. By letters dated December 5, 2013 (ADAMS Accession No. ML13337A625), and June 18, 2015 (ADAMS Accession No. ML15154B332), the NRC staff issued an ISE and audit report, respectively, on the licensee's progress. By letter dated March 26, 2014 (ADAMS Accession No. ML14083A620), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-051 in accordance with NRC NRR Office Instruction LIC-111, similar to the process used for Order EA-12-049. By letter dated December 15, 2015 (ADAMS Accession No. ML15350A130), Exelon submitted its compliance letter in response to Order EA-12-051. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-051.

The enclosed safety evaluation provides the results of the NRC staff's review of Exelon's strategies for Ginna. 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 191, "Implementation of Mitigation Strategies and Spent Fuel Pool Instrumentation Orders and Emergency Preparedness Communications/Staffing/ Multi-Unit Dose Assessment Plans" (ADAMS Accession No. ML14273A444). This inspection will be conducted in accordance with the NRC's inspection schedule for the plant.

If you have any questions, please contact John Boska, Orders Management Branch, R. E. Ginna Project Manager, at 301-415-2901 or at John.Boska@nrc.gov.

Sincerely,
/RA/

Mandy Halter, Acting Chief
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