



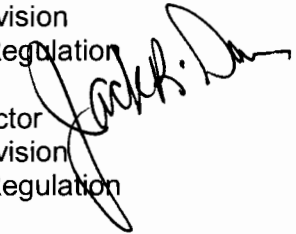
UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 1, 2014

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SUBJECT: SUPPLEMENTAL STAFF GUIDANCE FOR THE SAFETY
EVALUATIONS FOR ORDER EA-12-049 ON MITIGATION
STRATEGIES FOR BEYOND-DESIGN-BASIS EXTERNAL
EVENTS AND ORDER EA-12-051 ON SPENT FUEL POOL
INSTRUMENTATION

Attached is supplemental staff guidance for use by your staff to assist in writing safety evaluations for Orders EA-12-049 and EA-12-051. As NRC staff only rarely reviews documents associated with beyond-design-basis events, this should assist in achieving the proper level of review. The Orders Management Branch is assigned ownership to revise this document as decisions are made by the management team.

Enclosures:

1. Supplemental Staff Guidance
2. Safety Evaluation Template

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**SUPPLEMENTAL STAFF GUIDANCE FOR SAFETY EVALUATIONS FOR ORDER
EA-12-049 ON MITIGATION STRATEGIES FOR BEYOND-DESIGN-BASIS
EXTERNAL EVENTS**

Purpose - The purpose of this Enclosure is to provide additional insights and guidance to the staff regarding the scope of the safety evaluation (SE) for the Mitigation Strategies order for Operating Reactors.

The NRC is issuing the SE to provide to licensees the results of the NRC's review of the licensees' strategies. The intent is to indicate that the staff has agreed that the licensee's final plans are suitable to satisfy the requirements of Order EA-12-049 provided that they have been implemented correctly. The licensee will also be subject to NRC inspections.

General Guidance - This section provides general guidance to NRC technical reviewers on the SE. The licensee is required to comply with the order. The NRC can enforce compliance at any time by issuing a violation for any noncompliance with an order, even after an SE is issued. However, this SE is used to provide assurance to the licensee as to whether or not the NRC staff agrees with the licensee's approach. In general, we expect that due to the preparatory audits and other interactions, we will be able to make a statement that the NRC agrees with the licensee's approach. However, if our evaluation is that the licensee's approach does not meet the requirements of the order, we will state that in the SE.

Another item to note is that the SE is not an inspection report, nor is it intended to determine if the licensee is in compliance with the order. It is an evaluation of the licensee's plans. The evaluation of the implementation of the licensee's plans will be done through inspection. Sometimes the licensee submittals are made under oath or affirmation. However, generally there is no requirement for the use of oath or affirmation except for license applications, license amendments and statements made per Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Section 50.54(f) (see RIS 2001-18, Agencywide Documents Access and Management System (ADAMS) Accession No. ML010990211). For example, many documents submitted by licensees and used by the NRC for the SEs on the station blackout (SBO) rule were not under oath or affirmation. In general, the staff can also use information from NRC audit trips and audit reports. Direct observation by NRC staff or NRC contractors is valid information for a SE, as is information from plant documents approved by the licensee, such as the updated final safety analysis report, plant procedures, and plant engineering evaluations, even if it has not been submitted on the docket. It is only necessary to describe the latest information. It is not necessary to describe the changes the licensee made before deciding on their current strategy.

Shortly after the order compliance date for each reactor, the licensee will submit a letter to the NRC stating that the reactor is in compliance with the order. After the order compliance date for the final reactor at the site, the licensee will submit the compliance letter along with a Final Integrated Program (FIP) document. The NRC's SE will be issued after receipt of the FIP, and we should use the FIP to provide information needed to complete the SE.

The staff has considerable latitude to determine how comprehensive a review should be conducted of the licensee's statements. Based on their experience, the staff should identify areas that are considered to be potential high risk areas, and sample the licensee's evaluations and analyses. The staff is expected to use an appropriate amount of engineering judgment and

reliance upon existing knowledge and expertise in determining the acceptability of the licensee's proposed mitigation strategies. The review is expected to be substantially different from the review of design basis accidents, wherein acceptability is often based on endorsement of deterministic engineering codes and standards or compliance with existing staff positions for design basis accidents. If the staff performs an independent analysis to confirm the results stated by the licensee, that should be mentioned, and the independent analysis should be preserved as an official agency record. We will need to document a rational basis for why we agreed with the licensee that their plan is adequate.

For additional information, the staff should also refer to the J. Davis memo dated August 28, 2013, (ADAMS Accession No. ML13238A263) which provided supplemental staff guidance for the Interim Staff Evaluations (ISEs) on the Mitigation Strategies order, which have previously been issued. For examples of similar types of SEs, see the Indian Point 3 SE on the Station Blackout Rule (ADAMS Accession No. ML093420632) and the Indian Point 2 SE on the Anticipated Transients Without Scram Rule (ADAMS Accession No. ML100320809).

Requirements – The Mitigating Strategies Order EA-12-049 (ADAMS Accession No. ML12054A735) sets forth requirements to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities. The industry guidance for the order, Nuclear Energy Institute (NEI) NEI 12-06, Revision 0 (ADAMS Accession No. ML12242A378), as endorsed by NRC staff in Japan Lessons-Learned Directorate (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-01 (ADAMS Accession No. ML12229A174), sets forth a method of complying with the order. There can be other methods of complying with the order, which are called alternative methods to NEI 12-06. If a licensee cannot comply with the order, they can request relaxation of the order.

Review Areas – The previous staff guidance memo noted above covered a wide range of topics. This guidance memo will focus on certain topics that have been the subject of discussions between the staff, industry, and other interested groups. As such, these issues may benefit from additional guidance.

Topic 1. Demonstration of an analytical basis for the sequence of events based on engineering analyses of the beyond-design-basis external event in accordance with NEI 12-06, Section 3.

Guidance 1.

The engineering analyses are important because they establish the time when licensees must take certain actions, such as having Phase 2 FLEX equipment in service. If licensees do not meet those times, it could potentially result in core damage. Generally the transition to Phase 2 is affected by the need to refill the isolation condenser, or by the length of time that reactor core isolation cooling (RCIC) or the turbine-driven auxiliary feedwater pump (TDAFW) pump can supply cooling water, or by leakage from the reactor coolant system (RCS) which leads to core uncover. If there is substantial margin from when the Phase 2 equipment can be functional compared to when core damage may result, then a less detailed review may suffice. Licensees have either selected a generic thermal-hydraulic analysis as being representative of their plant, or have performed a plant-specific thermal-hydraulic analysis. If the licensee has selected a generic thermal-hydraulic analysis, the reviewer should evaluate if the critical parameters and initial conditions are a close enough match or are bounding for the licensee. If the licensee has

performed a plant-specific analysis, the reviewer should evaluate if that analysis correctly models the licensee's plant and planned actions.

The generic models may include WCAP-17601-P, Rev 1, (ADAMS Accession Nos. ML13042A011 and ML13042A013, both non-public for proprietary reasons) for the pressurized-water reactors (PWRs) and NEDC-33771-P, Rev 1, (ADAMS Accession Nos. ML13037A564 and ML13037A557, both non-public for proprietary reasons) for the containment analysis of boiling-water reactors (BWRs). An additional document that addresses certain aspects of the PWR response is WCAP-17792-P, Rev 0, (includes PA-PSC-0965) (ADAMS Accession No. ML14037A421, non-public for proprietary reasons).

If no open or confirmatory items were identified in this area in the ISE of the licensee's Overall Integrated Plan (OIP), and no additional issues have been identified, reference and summarize the ISE evaluation in the SE.

Topic 2. Leakage from the seals of the pumps in the RCS.

Guidance 2.

For BWRs and PWRs, leakage from the seals of the pumps in the RCS is modeled in the analyses discussed in Topic 1 above.

For BWRs with available steam-driven primary makeup pumps, the leakage from the seals of the recirculation pumps is not expected to be particularly critical. This is because RCIC or HPCI is capable of pumping water into the reactor pressure vessel (RPV) at a rate that would compensate for anticipated amounts of seal leakage. The seal leakage can result in elevated temperature and pressure in the drywell, but the drywell pressure will relieve to the wetwell. The extent of the elevated drywell temperature is perhaps the largest concern, due to potential effects on the seals on drywell penetrations to the secondary containment. The evaluation should verify that there are no significant effects. For BWRs without available steam-driven primary makeup pumps (Nine Mile 1 and Oyster Creek), recirculation pump seal leakage is a critical parameter that, in addition to defining containment conditions as above, further determines when actions to initiate primary makeup must be initiated. The seal leakage assumptions for these plants should be reviewed in detail to determine whether they have been adequately justified.

For PWRs, the leakage from the seals on the reactor coolant pumps (RCPs) is a critical parameter. The only pump typically in service early in the Extended Loss of Alternating Current Power (ELAP) is the TDAFW pump, which pumps water to the steam generators' (SGs) secondary side. Therefore, excessive leakage from the RCS could lead to a loss of natural circulation in the RCS and, if not effectively mitigated, core uncover would eventually follow. Thus, RCS leakage is a key factor in establishing a timeline by which the FLEX pumps must be operational and pumping water into the RCS. Most PWRs are implementing an early cooldown strategy, which reduces the pressure and temperature in the RCS, thereby reducing the leakage from the RCP seals. PWRs have various types of RCP seals. Some examples are:

- Westinghouse standard high-temperature seals.

- Westinghouse low-leakage Shield® passive thermal shutdown seal (SDS) that is a thermally actuated, passive device that is positioned between the No. 1 seal and the No. 1 seal leakoff line to provide a near leak-tight seal when activated.
- Flowserve N-9000™ Seal, which may or may not be installed with a redundant Flowserve Abeyance seal. These seals are typically used in Byron-Jackson RCPs, but have recently also been used in some Westinghouse RCPs.
- Standard Combustion Engineering (CE) seal made by Flowserve.
- CE System 80 seal made by Sulzer (Palo Verde only).

As discussed in NRC Information Notice 2005-14, a typical leakage rate for Westinghouse standard high-temperature seals during an ELAP is 21 gpm. Refer to the Westinghouse request for additional information response dated August 16, 2013 (ADAMS Accession No. ML13235A151, non-public for proprietary reasons), for conditions on the applicability of the typical leakage rate. However, as described in Westinghouse Nuclear Safety Advisory Letter NSAL-14-1, Westinghouse recently identified that the typical seal leakage value was based on generic assumptions regarding seal leakoff line hydraulic losses that are not necessarily applicable to all plants with Westinghouse RCPs and seals. Furthermore, Westinghouse is also reevaluating the behavior of the seal leakage rate under depressurized conditions. Therefore, the SE for plants with Westinghouse seals must explicitly address the issues raised in NSAL-14-1 and ensure that the leakage rate at the depressurized condition is adequately justified.

The seal leakage rate values for CE plants, with the exception of Palo Verde, have typically been based on the assumption that the leakage will be limited by the excess flow check valve in the controlled bleedoff line (e.g., 15 gpm) at the time that adequate subcooling margin is lost. The staff has agreed with this approach. The leakage rate for Palo Verde during an ELAP has already been reviewed in detail by the NRC staff in parallel with the development of this guidance and is not specifically addressed here.

Flowserve has provided a position paper on the performance of their RCP seals during an ELAP. The Abeyance seal used with some Flowserve seals does not rely on elastomers because the Abeyance seal is designed to maintain a leak-tight seal for an extended time at high temperatures. The performance of the Flowserve seal with the Abeyance feature is currently under review by the NRC staff.

The NRC staff is awaiting further information to justify the seal leakage assumptions for certain B&W plants, such as those which have N-9000 seals.

If no open or confirmatory items were identified in this area in the ISE, and no additional issues were subsequently identified, reference and summarize the ISE evaluation in the SE.

Topic 3. Shutdown margin and boric acid mixing in PWRs.

Guidance 3.

Licensees are permitted to assume that all control rods insert at the time of the event. For PWRs, a plant cooldown will eventually result in a loss of shutdown margin and a recriticality

due to the moderator temperature coefficient and the fuel temperature coefficient. The increase in negative reactivity from xenon, which occurs for about the first 10 hours, can be credited, but the decay of xenon will eventually result in the addition of positive reactivity. Borated water injected from the passive emergency core cooling system accumulator tanks can also be credited as long as it mixes adequately with the RCS water. Eventually, injection of borated water into the RCS will be necessary. Under natural circulation conditions, test data shows that borated water injected into the RCS can take a considerable time to mix fully with the bulk RCS water. Licensees should account for this delay in mixing time to provide assurance that their actions to borate the RCS would prevent a recriticality event due to positive reactivity addition from cooldown and xenon decay.

Furthermore, after the termination of natural circulation, boron-deficient water can collect in the RCS loop seals. This boron-depleted coolant originates as steam boiled off from the reactor core. The boiling process concentrates boric acid in the reactor core, emitting steam that is essentially free of boric acid. Because the RCS would be at saturation conditions in this scenario, the steam would condense in the SG tubes. Depending on the SG design, some or all of the resulting condensate would collect in the RCP suction leg. This boron-depleted coolant could later be transported to the core when the RCS is refilled using FLEX pumps and loop circulation flow is restored, potentially resulting in a return to criticality. The industry has issued a generic recommendation that licensees avoid the above scenario by taking actions to restore RCS makeup such that natural circulation in the RCS is maintained. The industry provided a position paper to address boric acid mixing, dated August 16, 2013 (ADAMS Accession No. ML13235A139, non-public for proprietary reasons), which was endorsed (with clarifications) by NRC letter dated January 8, 2014 (ADAMS Accession No. ML13276A183). The reviewer should verify that the licensee conforms to the position paper and the NRC clarifications, or provides sufficient information to justify an alternative position.

Shutdown margin concerns do not apply to BWRs, as they remain subcritical at all temperatures when all control rods are inserted.

If no open or confirmatory items were identified in this area in the ISE, and no additional issues were subsequently identified, reference and summarize the ISE evaluation in the SE.

Topic 4. Extension of battery life using deep load shed.

Guidance 4.

Licensees will set up FLEX generators to charge the plant batteries, but they need to calculate how much time they have to set up the generators before the batteries drop below the required voltage. Licensees are extending the battery time limit by shedding loads from the batteries. Institute of Electrical and Electronics Engineers standards support a reasonable extension to 8 hours of battery life, but the NRC has some concerns over longer extensions. By letter dated August 27, 2013 (ADAMS Accession No. ML13241A186), the industry provided a position paper addressing this concern. By letter dated September 16, 2013 (ADAMS Accession No. ML13241A188), the NRC endorsed the industry position paper (with clarifications). The reviewer should verify that the licensee conforms to the position paper and the NRC clarifications, or provides sufficient information to justify an alternative position.

If no open or confirmatory items were identified in this area in the ISE, and no additional issues were subsequently identified, reference and summarize the ISE evaluation in the SE.

Topic 5. Using separation criteria as an alternative to the guidance of NEI 12-06 for tornado missile protection.

Guidance 5.

Several licensees cannot meet the guidance of NEI 12-06 related to tornado missile protection. They have proposed an alternative to NEI 12-06 which credits separation to provide the tornado missile protection. NEI 12-06, Section 7.3.1.b and c, does allow credit for separation for the protection of stored FLEX equipment. In an NEI 12-06 frequently asked question, a statement was made by NEI that a separation of 1200 feet (with consideration for the predominant path of tornados) would be acceptable. Some licensees cannot meet the 1200 feet, and others are applying separation criteria to items other than equipment storage, such as the robust source of water needed for TDAFW pumps. To gain approval for this alternative, licensees should submit a tornado separation analysis. The analysis should consider the factors listed in NEI 12-06, Section 7.3.1, including shielding by robust structures, and conclude that it is unlikely for a tornado to destroy the redundant and diversely located structures, systems, or components (SSCs). They should compare the axis of separation of the redundant SSCs with the predominant path of tornados in the geographical location to figure out the off-axis distance, then compare that to the tornado damage width data that is available in their area and make a case that it is unlikely for a single tornado to damage the redundant SSCs. The reviewer should verify that the licensee's analysis provides sufficient information to justify an alternative to NEI 12-06. No analyses for tornado missile separation were reviewed in the ISEs.

Topic 6. Use of pre-staged equipment versus the portable equipment described in NEI 12-06.

Guidance 6.

Several licensees have decided that their strategy works better if they permanently pre-stage some of their FLEX equipment. This is an alternative to NEI 12-06, which describes the use of portable equipment. NEI 12-06 does allow moving equipment as needed in anticipation of hurricanes or predicted flooding, so that is not an issue here. The reviewer should evaluate if the permanently pre-staged equipment is located in a robust facility that is designed to survive the event, and if there is ready access for operators using routes that would not be blocked by a seismic event or a flooding event.

If no open or confirmatory items were identified in this area in the ISE, and no additional issues were subsequently identified, reference and summarize the ISE evaluation in the SE.

Topic 7. Maintenance and testing of FLEX equipment.

Guidance 7.

By letter dated October 3, 2013 (ADAMS Accession No. ML13276A573), NEI submitted Electric Power Research Institute (EPRI) Technical Report 3002000623 which contains guidance for the maintenance and testing of FLEX equipment. By letter dated October 7, 2013 (ADAMS Accession No. ML13276A224), NRC found that the EPRI report provides a useful input. The reviewer should evaluate if the licensee has committed to following the EPRI report, or is

following the EPRI report, or has provided an acceptable protocol for maintenance and testing of FLEX equipment.

If no open or confirmatory items were identified in this area in the ISE, and no additional issues were subsequently identified, reference and summarize the ISE evaluation in the SE.

Topic 8. Venting of BWR containments.

Guidance 8.

To date, no PWRs have proposed to vent the containment during an ELAP initiated at power. However, most BWRs have made the venting of containment (primarily the wetwell) part of their strategy, as stated in Section 1.4 of NEI 12-06, for BWR Mark I and II containments. Several BWRs have been granted relaxations to the order to allow them to finish the installation of the hardened vents required by Order EA-13-109 prior to their compliance date for the Mitigation Strategies order. The need for venting arises because most BWRs' primary strategy for decay heat removal (except for the 4 reactors with isolation condensers) involves dumping steam through the SRVs to the wetwell, so the decay heat remains in containment and causes a steady increase in containment temperature and pressure. RCIC is running to maintain the RPV level, but the temperature of the water pumped by RCIC has upper limits due to the fact that the RCIC oil cooler is cooled by the pumped water, and the temperature of the water affects the net positive suction head (NPSH) to RCIC. Most BWRs would vent when the wetwell reaches 212 °F, in order to hold the temperature of the wetwell under about 240 °F.

By letter dated November 21, 2013 (ADAMS Accession Nos. ML13352A061, ML13352A066, and ML13352A079), NEI submitted a Boiling Water Reactor Owners Group (BWROG) report on BWR Mark I and II venting. By letter dated January 9, 2014 (ADAMS Accession No. ML13358A206), the NRC agreed that the changes to the containment venting strategies as described in the BWROG report are acceptable for use as part of strategies proposed in response to Order EA-12-049, provided that licensee implementation is in compliance with normal change processes for plant emergency procedures and provided that plant-specific evaluations support the use of the revised strategies. The NRC stated that the BWROG paper addresses the venting strategy on a generic basis, but plant-specific implementation relies on such items as the capabilities of the installed vent path, net positive suction head for the reactor coolant system injection pumps, and guidance to prevent negative pressure in containment. The reviewer should evaluate the licensee's application of containment venting strategies considering these factors. Refer to the ISE for previous reviews.

Some BWRs with Mark III containments are also venting containment. The reviewer should evaluate these similar to the other BWRs.

Topic 9. Discussion of increased seismic hazard as a result of licensee responses to the NRC 50.54(f) letter dated March 12, 2012 (ADAMS Accession No. ML12053A340).

Guidance 9.

All Central and Eastern United States (CEUS) licenses submitted a Seismic Hazard Evaluation and Screening Report prior to April 1, 2014. By letter dated May 9, 2014 (ADAMS Accession No. ML14111A147), the NRC issued a list and an evaluation of the licensee reports. For some plants, the re-evaluated seismic hazard is larger than the current licensing basis. If the plant's

newly calculated Ground Motion Response Spectrum (GMRS) is above the licensing basis Safe Shutdown Earthquake (SSE) spectrum and above the plant's Individual Plant Examination for External Events (IPEEE) spectrum, the plant "screened in," and will complete an evaluation by December 31, 2014, called the Expedited Seismic Evaluation Process (ESEP) or Expedited Approach. Plants where the re-evaluated seismic hazard is substantially larger than the licensing basis hazard will later submit a seismic risk evaluation (also called a seismic PRA), but that is not due until 2017 or later. The ESEP will evaluate the selected installed equipment and connection points needed to support the strategies for the Mitigation Strategies Order (also referred to as FLEX strategies), which ensures safe shutdown for an ELAP and loss of normal access to the ultimate heat sink (LUHS). The ESEP will also lead the licensees to perform modifications to this equipment as necessary.

The industry guidance (NEI 12-06) for the Mitigation Strategies order discussed using equipment designed to survive the SSE, as at the time there was no plant-specific guidance for seismic hazards greater than the SSE. Most licensees stated in their FLEX OIPs that the seismic re-evaluation pursuant to the 50.54(f) letter was not completed and therefore not assumed in the OIP. They stated that when the re-evaluation was completed, appropriate issues would be entered into the plant corrective action system and addressed on a schedule commensurate with other licensing bases changes. The plant ISEs did not address any seismic hazards greater than the SSE. However, all EA-12-049 SEs (with the possible exception of Watts Bar) will be issued after the plant's ESEP evaluation is submitted. For completeness, SE section 3.5.1 on the seismic hazard should reference the plant's ESEP evaluation and describe actions the licensee has taken, or state that no ESEP evaluation was necessary.

Topic 10. Discussion of increased flooding hazard as a result of licensee responses to the NRC 50.54(f) letter dated March 12, 2012 (ADAMS Accession No. ML12053A340).

Guidance 10.

The Flood Hazard Reevaluation Report (FHRR) was due from Category 1 plants by March 12, 2013; from Category 2 plants by March 12, 2014; and from Category 3 plants by March 12, 2015. The NRC letter dated May 11, 2012 (ADAMS Accession No. ML12097A509) states which plants are in which category. If the FHRR is not bounded by the plant design basis, the licensee was requested to submit a Flood Integrated Assessment Report (FIAR) within two years of the FHRR.

The industry guidance for the Mitigation Strategies order discussed protecting FLEX equipment from the flooding predicted by the most recent site flood analysis (NEI 12-06, Section 6.2.3.1). Most licensees stated in their FLEX OIPs that the flooding re-evaluation pursuant to the 50.54(f) letter was not completed and therefore not assumed in the OIP. They stated that when the re-evaluation was completed, appropriate issues would be entered into the plant corrective action system and addressed on a schedule commensurate with other licensing bases changes. For completeness, SE section 3.5.2 on the flooding hazard should reference the plant's FHRR, FIAR, and associated NRC Staff Assessments and describe actions the licensee has taken.

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

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

[NAME OF LICENSEE (as stated on license)]

[NAME OF PLANT (as stated on license), UNITS X, Y, AND Z]

DOCKET NOS. 50-XXX, 50-YYY, AND 50-ZZZ]

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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. 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 Nuclear Regulatory Commission (NRC) determined that additional requirements needed to be imposed to mitigate such beyond-design-basis external events (BDBEEs).

Accordingly, by letter dated 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.

By letter dated 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, with independent power supplies that are also 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, including the proposed order to implement the enhanced mitigation strategies. As directed by SRM-SECY-12-0025 [Reference 3], the NRC staff issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" [Reference 4], and Order EA-12-051, "Order Modifying Licenses With Regard to Reliable Spent Fuel Pool Instrumentation" [Reference 5].

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 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 capabilities at all units on a site subject to Order EA-12-049.
- 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 capabilities at all units on a site subject to Order EA-12-049.
- 4) Licensees or CP holders must be capable of implementing the strategies in all modes.
- 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. On August 29, 2012, the NRC staff issued its final version of 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, 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 SFP operating deck, and (3) level where fuel remains covered and actions to implement make-up water addition should no longer be deferred.

1. The spent fuel pool level instrumentation shall include the following design features:
 - 1.1 Instruments: The instrumentation shall consist of a permanent, fixed primary instrument channel and a backup instrument channel. The backup instrument channel may be fixed or portable. Portable instruments shall have capabilities that enhance the ability of trained personnel to monitor spent fuel pool water level under conditions that restrict direct personnel access to the pool, such as partial structural damage, high radiation levels, or heat and humidity from a boiling pool.
 - 1.2 Arrangement: The spent fuel pool level instrument channels shall be arranged in a manner that provides reasonable protection of the level indication function against missiles that may result from damage to the structure over the spent fuel pool. This protection may be provided by locating the primary instrument channel and fixed portions of the backup instrument channel, if applicable, to maintain instrument channel separation within the spent fuel pool area, and to utilize inherent shielding from missiles provided by existing recesses and corners in the spent fuel pool structure.
 - 1.3 Mounting: Installed instrument channel equipment within the spent fuel pool shall be mounted to retain its design configuration during and following the maximum seismic ground motion considered in the design of the spent fuel pool structure.
 - 1.4 Qualification: The primary and backup instrument channels shall be reliable at temperature, humidity, and radiation levels consistent with the spent fuel pool water at saturation conditions for an extended period. This reliability shall be established through use of an augmented quality assurance process (e.g., a process similar to that applied to the site fire protection program).
 - 1.5 Independence: The primary instrument channel shall be independent of the backup instrument channel.
 - 1.6 Power supplies: Permanently installed instrumentation channels shall each be powered by a separate power supply. Permanently installed and portable instrumentation channels shall provide for power connections from sources independent of the plant ac and dc power distribution systems, such as portable

generators or replaceable batteries. Onsite generators used as an alternate power source and replaceable batteries used for instrument channel power shall have sufficient capacity to maintain the level indication function until offsite resource availability is reasonably assured.

- 1.7 Accuracy: The instrument channels shall maintain their designed accuracy following a power interruption or change in power source without recalibration.
 - 1.8 Testing: The instrument channel design shall provide for routine testing and calibration.
 - 1.9 Display: Trained personnel shall be able to monitor the spent fuel pool water level from the control room, alternate shutdown panel, or other appropriate and accessible location. The display shall provide on-demand or continuous indication of spent fuel pool water level.
2. The spent fuel pool instrumentation shall be maintained available and reliable through appropriate development and implementation of the following programs:
- 2.1 Training: Personnel shall be trained in the use and the provision of alternate power to the primary and backup instrument channels.
 - 2.2 Procedures: Procedures shall be established and maintained for the testing, calibration, and use of the primary and backup spent fuel pool instrument channels.
 - 2.3 Testing and Calibration: Processes shall be established and maintained for scheduling and implementing necessary testing and calibration of the primary and backup spent fuel pool level instrument channels to maintain the instrument channels at the design accuracy.

On August 24, 2012, following several NEI submittals and discussions in public meetings with NRC staff, the NEI submitted document NEI 12-02, "Industry Guidance for Compliance With NRC Order EA-12-051, To Modify Licenses With Regard to Reliable Spent Fuel Pool Instrumentation," Revision 1 [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 {Feb 2013} [Reference 10], {Licensee} (Name or the licensee) submitted an Overall Integrated Plan for [Nuclear Power Plant] ([Initials]) in response to Order EA-12-049. By letters dated {Aug 2013} [Reference 11], {Feb 2014} [Reference 12], {add all other submittals here} the licensee submitted status reports for the Integrated Plan. The Integrated Plan describes the strategies and guidance under development for implementation by the

licensee for the maintenance or restoration of core cooling, containment, and SFP cooling capabilities following a BDBEE, including modifications necessary to support this implementation, pursuant to Order EA-12-049. By letters dated {**ISE- Nov-Feb 2013-2014**} [Reference 14] and {**on-site audit -2014-2015**} [Reference 15] the NRC issued an Interim Staff Evaluation and audit reports on the licensee's progress. By letter dated {**2014-2016**} [Reference 16] the licensee reported that full compliance with the requirements of Order EA-12-049 was achieved.

3.1 Overall Mitigation Strategy

[NPP] is a [**pressurized-water reactor (PWR); boiling-water reactor (BWR)**] with a [**dry ambient pressure; dry subatmospheric (North Anna, Surry, Millstone 3); ice condenser; Mark I; Mark II; Mark III**] containment.

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 results in an extended loss of ac power (ELAP) with loss of normal access to the ultimate heat sink (LUHS), which is considered 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 shutdown 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.

3.2 Reactor Core Cooling Strategies

[overall description of the reactor core cooling strategy assuming a BDBEE from full power. Modes 5 and 6 are covered in section 3.10.]

[Describe if the licensee adheres to NEI 12-06 or uses an alternative strategy.]

[Some plants have different strategies for different events, such as hurricanes or flooding. In that case, provide both strategies as follows: "3.2.1.1 Strategy for Hurricanes"; "3.2.1.2 Strategy for Other BDBEEs", and also add sections 3.2.2.1, 3.2.2.2, 3.2.3.1, 3.2.3.2, as needed. Also, if the reviewer sees the need to expand a section, just add subsections, e.g. 3.2.4.6.]

3.2.1 Phase 1

[overall summary of the reactor core cooling phase 1 strategy for each strategy (if there are different strategies for different events; repeat the structure for phases 2 and 3, and include containment and SFP as necessary).]

3.2.2 Phase 2

[overall summary of the transition point from phase 1 and the reactor core cooling phase 2 strategy]

3.2.3 Phase 3

[overall summary of the transition point from phase 2 (RRC equipment is typically available at hour 25 if requested at hour 1) and the reactor core cooling phase 3 strategy. Some licensees say that the RRC equipment will just be a backup to the phase 2 equipment; that may be acceptable if they have demonstrated the ability to maintain core cooling indefinitely with the phase 2 equipment.]

3.2.4 Staff Evaluations

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

3.2.4.1.1 Plant SSCs

[Describe which SSCs (permanent plant equipment only, FLEX equipment is discussed in Section 3.6) are being used in the strategy, and evaluate their robustness and availability immediately following the BDBEE. The discussion of room temperature increases will be in section 3.9. State if there are both primary and alternate connection points for FLEX equipment to provide cooling water to the core per NEI 12-06, p.24. The availability of water sources for Phase 1 should be discussed here; Phase 2 and 3 water sources are in 3.2.4.5.]

3.2.4.1.2 Plant Instrumentation

[Discuss the plant instrumentation to be used (reference the ISE if there are no changes), and the ability to obtain key instrument readings by alternate methods.]

3.2.4.2 Thermal-Hydraulic Analyses

[Describe the licensee's thermal-hydraulic methods and analyses and address the adequacy of these methods and analyses.]

The NRC staff concludes that the licensee's analytical approach is **[or is not]** sufficiently accurate (or acceptable) for determining the sequence of events, including the time-sensitive operator actions, and the required equipment to mitigate the event.

3.2.4.3 Reactor Coolant Pump (RCP) Seals **[Recirculation Pump Seals]**

[Discuss the assumed leak rate from the RCP (or recirculation pump) seals and the acceptability of that assumption.]

The NRC staff concludes that the assumed RCP (**or recirculation pump**) seal leak-off rate is **[or is not]** acceptable for use in the thermal-hydraulic analyses.

3.2.4.4 Shutdown Margin Analyses

[Discuss the method used by the licensee to calculate shutdown margin, including the model for boric acid mixing, and if the licensee is following the NRC endorsement of a mixing model (ADAMS Accession No. ML13276A183). If this is a BWR, discuss that BWR rod worth provides satisfactory shutdown margin under all plant conditions, assuming no core damage].

The NRC staff concludes that the planned operator actions will result in acceptable shutdown margin during this event.

3.2.4.5 FLEX Pumps and Water Supplies

[The capacity of portable pumps to supply the flow identified in the thermal-hydraulic analyses is discussed here, including pump sizing and water supplies, for both Phase 2 and 3.]

3.2.4.6 Electrical Analyses

[Describe the licensee's electrical analyses and address the adequacy of these analyses. In particular, discuss the load shed and the length of time that the plant batteries are expected to function. Also discuss if FLEX generators are properly sized to provide the power needed to power the equipment credited in this section.]

3.2.5 Conclusions

[Conclusions stated here] Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that if implemented appropriately should maintain or restore core cooling following a BDBEE consistent with NEI 12-06 guidance as endorsed by JLD-ISG-2012-01 **[or state an alternative]**, and adequately addresses the requirements of the order.

3.3 Spent Fuel Pool Cooling Strategies

[overall description of the spent fuel pool cooling strategy for a BDBEE occurring at full power. The effects of a BDBEE with full core offload to the SFP will be addressed in section 3.10.]
[Describe if the licensee adheres to NEI 12-06 or uses an alternative strategy.]

3.3.1 Phase 1

[overall summary of the spent fuel pool cooling phase 1 strategy]

3.3.2 Phase 2

[overall summary of the transition point from phase 1 and the spent fuel pool cooling phase 2 strategy]

3.3.3 Phase 3

[overall summary of the transition point from phase 2 and the spent fuel pool cooling phase 3 strategy]

3.3.4 Staff Evaluations

3.3.4.1 Availability of Structures, Systems, and Components

3.3.4.1.1 Plant SSCs

[Describe which SSCs (permanent plant equipment only, FLEX equipment is discussed in other sections) are being used in the strategy, and evaluate their robustness and availability following the BDBEE. State if there are both primary and alternate connection points for FLEX equipment to provide cooling water to the SFP per NEI 12-06, p.24. Discuss venting of the SFP area to cope with the temperature, humidity, and condensation from the boiling in the SFP. The availability of water sources for Phase 1 should be discussed here; Phase 2 and 3 water sources are in 3.3.4.3.]

3.3.4.1.2 Plant Instrumentation

[Discuss the plant instrumentation to be used (reference section 4 of this SE for the SFP level instrumentation), and the ability to obtain key instrument readings by alternate methods. Discuss if the environmental conditions would affect SFP level instrumentation by reference to section 4.2.4.]

3.3.4.2 Thermal-Hydraulic Analyses

[Describe the licensee's thermal-hydraulic analyses and address the adequacy of these analyses. In particular, address the amount of decay heat and the flow rate needed.]

3.3.4.3 FLEX Pumps and Water Supplies

[The capacity of portable pumps to supply the flow identified in the thermal-hydraulic analyses is discussed here, including pump sizing and water supplies, for both Phase 2 and 3.]

3.3.4.4 Electrical Analyses

[Describe the licensee's electrical analyses and address the adequacy of these analyses. In particular, discuss the spent fuel pool level instrumentation by referring to section 4 of this SE, and conclude that SFP level readings will be available for at least X hours, which provides time to align FLEX equipment if needed. Also discuss if FLEX generators can provide the power needed to power the equipment credited in this section.]

3.3.5 Conclusions

[Conclusions stated here] 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 a BDBEE consistent with NEI 12-06 guidance as endorsed by JLD-ISG-2012-01 [**or state an alternative**], and adequately addresses the requirements of the order.

3.4 Containment Function Strategies

[overall description of the containment function strategy]
[Describe if the licensee adheres to NEI 12-06 or uses an alternative strategy.]

3.4.1 Phase 1

[overall summary of the containment function phase 1 strategy]

3.4.2 Phase 2

[overall summary of the containment function phase 2 strategy]

3.4.3 Phase 3

[overall summary of the containment function phase 3 strategy]

3.4.4 Staff Evaluations

3.4.4.1 Availability of Structures, Systems, and Components

3.4.4.1.1 Plant SSCs

[Describe which SSCs (permanent plant equipment only, FLEX equipment is discussed in Section 3.6) are being used in the strategy, and evaluate their robustness and availability following the BDBEE. Discuss the maximum temperature and pressure reached in containment (as stated in section 3.4.4.2) and if there is any effect on necessary equipment such as SRVs. The availability of water sources for Phase 1 should be discussed here; Phase 2 and 3 water sources are in 3.4.4.3.]

3.4.4.1.2 Plant Instrumentation

[Discuss the plant instrumentation to be used (reference the ISE if there are no changes), and the ability to obtain key instrument readings by alternate methods. Discuss if the changing environmental conditions in the containment will affect the required instrumentation.]

3.4.4.2 Thermal-Hydraulic Analyses

[Describe the licensee's thermal-hydraulic analyses and address the adequacy of these analyses. State the maximum temperature and pressure expected in the containment.]

3.4.4.3 FLEX Pumps and Water Supplies

[The capacity of portable pumps to supply the flow identified in the T-H analyses is discussed here, including pump sizing and water supplies, for both Phase 2 and 3.]

3.4.4.4 Electrical Analyses

[Describe the licensee's electrical analyses and address the adequacy of these analyses. Discuss if FLEX generators can provide the power needed to power the equipment credited in this section.]

3.4.5 Conclusions

[Conclusions stated here] 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 a BDBEE consistent with NEI 12-06 guidance as endorsed by JLD-ISG-2012-01 **[or state an alternative]**, and adequately addresses the requirements of the order.

3.5 Characterization of External Hazards

[overall description of the characterization of external hazards]

[Describe if the licensee adheres to NEI 12-06 or uses an alternative strategy.]

3.5.1 Seismic

[Describe the licensing basis seismic hazard (the safe shutdown earthquake-SSE, no need to describe the OBE) and if there is new seismic information from the 50.54(f) seismic review, such as the ESEP (due by December 31, 2014), describe that. If the NRC issued a Staff Assessment of the ESEP, describe that. If the plant was not required to perform an ESEP, due to no increase in the seismic hazard, state that. If the ISE info is still good, just reference the ISE and summarize here.]

3.5.2 Flooding

[Describe the licensing basis flooding hazard, including local intense precipitation, and if there is new flooding information from the 50.54(f) flooding review. The Flood Hazard Reevaluation Report (FHRR) was due from Category 1 plants by March 12, 2013; from Category 2 plants by March 12, 2014; and from Category 3 plants by March 12, 2015. The NRC letter dated May 11, 2012 (ML12097A509) states which plants are in which category. If the NRC issued a Staff Assessment of the FHRR, describe that. If the FHRR is not bounded by the plant licensing basis, the licensee was requested to submit a Flood Integrated Assessment Report (FIAR) within two years of the FHRR. If the FIAR was submitted, describe that. If the ISE info is still good, just reference the ISE. Describe any impact from large internal flooding sources or the failure of non-seismically robust downstream dams. State if the licensee has any ground water in-leakage concerns that will require using FLEX equipment to remove ground water.]

3.5.3 Hurricane

[Describe the licensing basis hurricane hazard and state if there is new storm surge information from the 50.54(f) flooding review. If the ISE info is still good, just reference the ISE and summarize here.]

3.5.4 Tornado

[Describe the licensing basis tornado hazard, including tornado missiles. If the ISE info is still good, just reference the ISE and summarize here. If the licensee has submitted a tornado missile hazard analysis based on separation, discuss it in Section 3.6.]

3.5.5 Snow, Ice, and Extreme Cold

[Describe the licensing basis for snow, ice, and low temperature hazard. If the ISE info is still good, just reference the ISE and summarize here.]

3.5.6 Extreme Heat

[Describe the licensing basis for extreme heat. If the ISE info is still good, just reference the ISE and summarize here.]

3.5.7 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 [**or state an alternative**], and adequately addresses the requirements of the order.

3.6 Planned Protection of FLEX Equipment

[Describe how the storage of FLEX equipment provides protection from the hazards listed in section 3.5. If the licensee is crediting separation criteria to show protection from tornados, discuss it here. If the licensee plans to move any equipment prior to a hurricane or predicted flooding, state it here. State if the licensee meets the guidance in NEI 12-06 (p.23) to have N+1 sets of equipment, or has proposed an alternative.]

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[**or state an alternative**], and adequately addresses the requirements of the order.

3.7 Planned Deployment of FLEX Equipment

[Describe the licensee's plans for deployment of FLEX equipment from the FLEX storage locations following a BDBEE. Discuss potential soil liquefaction, removal of debris or snow from the transport path, vehicles to transport the FLEX equipment, and the impact of flooding on transport paths. Discuss the connection points for FLEX equipment and how access is

available through seismically robust structures and is not affected by flooding. The strategy to access the UHS through ice or frazil ice is addressed here. Discuss how refueling of FLEX equipment will be accomplished.]

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

3.8 Considerations in Using Offsite Resources

[Describe the licensee's plans for deployment of offsite resources following a BDBEE. Discuss if flooding or seismic events have been considered in the receipt of offsite resources. Describe the location of Staging Area C (the primary off-site staging area, about 25 miles from the site) and the alternate Staging Area D (if designated). Describe the location of Staging Area B, the interim delivery area on-site. The locations of Staging Area A, the location of the equipment when in operation, need not be discussed. Discuss the plant-specific RRC playbook, and reference our generic review of SAFER and the RRCs if it has been issued.]

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 [**or state an alternative**], and adequately addresses the requirements of the order.

3.9 Habitability and Operations

3.9.1 Equipment Operating Conditions

[Discuss room temperature increases and the effects on the necessary equipment in those rooms, except the SFP area will be discussed in section 3.3.4.1 and containment will be discussed in section 3.4.4. Rooms to consider include the TDAFW and RCIC rooms.]

3.9.2 Personnel Habitability

[Discuss room temperature increases and the effect on plant personnel, and the licensee's coping methods. Rooms include the MCR and any other rooms where personnel are required to be.]

3.9.3 Conclusions

Based on the evaluation above, 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 [**or state an alternative**], and adequately addresses the requirements of the order.

3.10 Water Sources

[Discuss the available water sources and the robustness. If any are qualified for tornado missiles due to separation, refer to Section 3.6. If the water sources are different depending on the event, discuss that here. If there are priorities for water sources (usually based on water quality) discuss it here.

3.11 Shutdown and Refueling Analyses

This order requires that licensees must be capable of implementing the mitigation strategies in all modes. In general, the discussion above focuses on a BDBEE occurring during power operations. This is appropriate, as plants typically operate at power for 90 percent or more of the year. When the BDBEE occurs with the plant at power, the mitigation strategy initially focuses on the use of a pump coupled to a steam-powered turbine to provide the water initially needed for decay heat removal **[revise this for isolation condensers, which are Dresden, Nine Mile 1, and Oyster Creek, according to their strategy]**. If all or most of the fuel has been placed in the SFP, there may be a shorter timeline to implement the makeup of water to the SFP. However, this is balanced by the fact that if immediate cooling is not required for the fuel in the reactor vessel, the operators can concentrate on providing makeup to the SFP. The licensee's analysis shows that following a full core offload to the SFP, about **[X]** hours are available to implement makeup before boil-off results in the water level in the SFP dropping far enough to uncover fuel assemblies, and the licensee has stated that they have the ability to implement makeup to the SFP within that time.

When a plant is in a shutdown mode in which steam is not available to operate the steam-powered pump (which typically occurs when the RCS has been cooled below about 300 °F), another strategy must be used for decay heat removal. On September 18, 2013, NEI submitted to the NRC a position paper entitled "Shutdown/Refueling Modes" (ADAMS Accession No. ML13273A514), which described methods to ensure plant safety in those shutdown modes. By letter dated September 30, 2013 (ADAMS Accession No. ML13267A382), the NRC staff endorsed this position paper as a means of meeting the requirements of the order.

The position paper describes how licensees will maintain FLEX equipment either available for deployment in shutdown and refueling modes, or pre-stage certain equipment. Those plant procedures that are used to respond to loss of cooling in these modes will incorporate FLEX equipment where appropriate. 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. By letter dated **[DATE]** **[Reference X]**, 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. The NRC staff may further evaluate the licensee's resulting program through the inspection process. Based on the evaluation above, the NRC staff concludes that the licensee has developed guidance that if implemented appropriately should maintain or restore core cooling, SFP cooling, and containment following a BDBEE in shutdown and refueling modes consistent with NEI 12-06 guidance as endorsed by JLD-ISG-2012-01 **[or state an alternative]**, and adequately addresses the requirements of the order **[or does not address the requirements of the order]**.

3.12 Procedures and Training

[Discuss the FLEX Support Guidelines (FSGs) in place at the site to respond to BDBEEs. Discuss how the operators will initiate use of the FSGs (typically the operators will start in the plant procedure for loss of all ac power, and if the EDGs and SBO alternate ac source cannot be started they will be directed to implement FSGs while continuing in the loss of all ac power procedure). Discuss the plant procedures that have been revised to respond to BDBEEs, including procedures that direct actions for expected flooding or hurricanes. Discuss training for operations staff and other plant staff here.]

3.13 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, will adequately address the requirements of Order EA-12-049 [or does not address the requirements of the order].

4.0 TECHNICAL EVALUATION OF ORDER EA-12-051

By letter dated {**Feb 2013**} [Reference 17], the licensee submitted an Overall Integrated Plan for [NPP] in response to Order EA-12-051. By letter dated {**JUN-AUG 2013**} [Reference 18] the NRC staff sent a Request for Additional Information (RAI) to the licensee. The licensee provided a response by letter dated {**JUL-OCT 2013**} [Reference 19]. By letter dated {**OCT-DEC 2013**} [Reference 20], the NRC staff issued an Interim Staff Evaluation and RAI to the licensee. The licensee provided a response by letter dated {**2014-2015**} [Reference 21]. By letter dated {**on-site audit -2014-2015**} [Reference 15] the NRC issued an audit report on the licensee's progress.

By letters dated {**Aug 2013**} [Reference 22], {**Feb 2014**} [Reference 23], {**add all other submittals here**} 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 {**2014-2016**} [Reference 2x] 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 {**Westinghouse, Areva, or Mohr**}. 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 {**2014**} [Reference 2x].

4.1 Levels of Required Monitoring

Refer to section 2.2 above for the water levels which must be monitored in the SFP. Level 1 is the level that is adequate to support operation of the normal fuel pool cooling system. Level 2 is the level that is adequate to provide substantial radiation shielding for a person standing on the SFP operating deck. Level 3 is the level where fuel remains covered and actions to implement make-up water addition should no longer be deferred.

[Describe the licensee's values for Level 1, 2, and 3, how they were determined, and provide a reference to the licensee's submittal.]

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

4.2 Evaluation of Design Features

Refer to section 2.2 above for the requirements of the order in regards to the design features that are evaluated below.

4.2.1 Design Features: Instruments

[Describe the final installed configuration, with primary and backup channels and instrument range, and provide references to the licensee's submittals.]

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

4.2.2 Design Features: Arrangement

[Describe the locations of the primary and backup sensor probes, sensor electronics, and displays. Describe channel separation, including power and data cables. Describe if at least one channel could be expected to survive missiles from damage to the structure over the SFP.] The NRC staff concludes that there is sufficient channel separation within the SFP area between the primary and back-up level instruments, sensor electronics, and routing cables to provide reasonable protection against loss of indication of SFP level due to missiles that may result from damage to the structure over the SFP.

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

4.2.3 Design Features: Mounting

[Describe if the mounting is satisfactory to allow the instrument to function per design following the maximum seismic ground motion considered in the design of the SFP structure.]

Based on the discussion above, the NRC staff finds the licensee's proposed mounting design is consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and adequately addresses the requirements of the order.

4.2.4 Design Features: Qualification

[Describe if the channels will operate reliably at the temperature, humidity, and radiation levels consistent with the SFP water at saturation conditions for an extended period. Include other qualification conditions specified in NEI 12-02. NEI 12-02 states that an extended period should be considered to be seven days post-event or until off-site resources can be deployed by the mitigating strategies resulting from Order EA-12-049. Considering that licensees are developing plans under Order EA-12-049 to have offsite resources arrive after 24 hours, if the licensee can justify a time less than 7 days it should be accepted. The licensee shall apply at least an augmented QA process. Note that during an ELAP the sensor electronics and display electronics may be located in an area that experiences elevated temperatures, and should be tested to those temperatures.]

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

4.2.5 Design Features: Independence

[Describe how the primary channel is physically and electrically independent of the backup channel.]

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

4.2.6 Design Features: Power Supplies

[Describe how each channel is powered by a separate power supply. Permanently installed and portable instrumentation channels shall provide for power connections from sources independent of the plant ac and dc power distribution systems, such as portable generators or replaceable batteries.]

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

4.2.7 Design Features: Accuracy

[Describe how the instrument channels maintain their designed accuracy following a power interruption or change in power source without recalibration.]

Based on the discussion above, the NRC staff finds the licensee's proposed instrument accuracy is consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and adequately addresses the requirements of the order.

4.2.8 Design Features: Testing

[Describe how the instrument channel design provides for routine testing and calibration.]

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

4.2.9 Design Features: Display

[Describe how trained personnel are able to monitor the SFP 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 SFP water level. The accessibility of the location shall consider expected conditions following an ELAP, and in a seismically qualified building].

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

4.3 Evaluation of Programmatic Controls

4.3.1 Programmatic Controls: Training

[Describe how personnel will be trained in the use, maintenance, and calibration of the instrumentation and the provision of alternate power to the primary and backup instrument channels. Committing to use the Systematic Approach to Training (SAT) process is acceptable.]

Based on the discussion above, the NRC staff finds that the licensee's proposed plan to train personnel in the use 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 adequately addresses the requirements of the order.

4.3.2 Programmatic Controls: Procedures

[Describe the procedures being established for the testing, calibration, and use of the primary and backup SFP level instrument channels, and how they will be maintained.]

Based on the discussion above, the NRC staff finds that the licensee's proposed procedures are consistent with NEI 12 02, as endorsed by JLD-ISG-2012-03, and adequately address the requirements of the order.

4.3.3 Programmatic Controls: Testing and Calibration

[Describe how processes are being established and maintained for scheduling and implementing necessary testing and calibration of the primary and backup SFP level instrument channels to maintain the instrument channels at the design accuracy. Additionally, the licensee should commit that compensatory actions must be taken if an instrument channel is not expected to be restored or is not restored within 90 days. If both channels become non-functioning then initiate actions within 24 hours to restore one of the channels of instrumentation and implement compensatory actions (e.g., use of alternate suitable equipment or supplemental personnel) within 72 hours.]

Based on the discussion above, the NRC staff finds that the licensee's proposed testing and calibration plan is consistent with NEI 12 02, as endorsed by JLD-ISG-2012-03, and adequately addresses the requirements of the order.

4.4 Conclusions for Order EA-12-051

In its letter dated {date} [Reference 2x], the licensee stated that they would meet the requirements of Order EA-12-051 by following the guidelines of NEI 12-02, as endorsed by JLD-ISG-2012-03. In the evaluation above, the NRC staff finds that the licensee has conformed to the guidelines of NEI 12-02, as endorsed by JLD-ISG-2012-03 **{or has taken an alternative approach compared to NEI 12-02 but has met the requirements of the order}**. Based on the evaluations above, the NRC staff concludes that if the SFP level instrumentation is installed

at {NPP} according to the licensee's proposed design, it will adequately address the requirements of Order EA-12-051 [or does not address the requirements of the order].

5.0 CONCLUSION

Based on the evaluations above, the NRC staff concludes that the licensee has developed guidance and proposed designs which if implemented appropriately will adequately address the requirements of Orders EA-12-049 and EA-12-051.

6.0 REFERENCES

1. SECY-11-0093, "Recommendations for Enhancing Reactor Safety in the 21st Century, the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," July 12, 2011 (ADAMS Accession No. ML11186A950)
2. 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," February 17, 2012 (ADAMS Accession No. ML12039A103)
3. SRM-SECY-12-0025, "Staff Requirements – 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," March 9, 2012 (ADAMS Accession No. ML120690347)
4. Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," March 12, 2012 (ADAMS Accession No. ML12054A736)
5. Order EA-12-051, "Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," March 12, 2012 (ADAMS Accession No. ML12054A679)
6. Nuclear Energy Institute document NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0, August 21, 2012 (ADAMS Accession No. ML12242A378)
7. 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," August 29, 2012 (ADAMS Accession No. ML12229A174)
8. Nuclear Energy Institute 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, dated August 24, 2012 (ADAMS Accession No. ML12240A307)
9. JLD-ISG-2012-03, "Compliance with Order EA-12-051, Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," August 29, 2012 (ADAMS Accession No. ML12221A339)
10. **Licensee OIP for Mitigation Strategies (MS)**
11. **Licensee MS status report Aug 2013**
12. **Licensee MS status report Feb 2014**
13. **Other Licensee MS submittals here**

14. **NRC MS ISE**
15. **NRC MS/SFP Site Audit Report**
16. **Licensee MS full compliance letter**
17. **Licensee OIP for SFP**
18. **NRC RAI letter on SFP**
19. **Licensee Response to NRC RAI letter on SFP**
20. **NRC ISE and RAIs on SFP**
21. **Licensee Response to RAIs on SFP**
22. **Licensee SFP status report Aug 2013**
23. **Licensee SFP status report Feb 2014**
24. **Other Licensee SFP submittals here**
25. **Licensee SFP full compliance letter**

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FROM: Jack R. Davis, Deputy Director */RA/*
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SUBJECT: SUPPLEMENTAL STAFF GUIDANCE FOR THE SAFETY
EVALUATIONS FOR ORDER EA-12-049 ON MITIGATION
STRATEGIES FOR BEYOND-DESIGN-BASIS EXTERNAL
EVENTS AND ORDER EA-12-051 ON SPENT FUEL POOL
INSTRUMENTATION

Attached is supplemental staff guidance for use by your staff to assist in writing safety evaluations for Orders EA-12-049 and EA-12-051. As NRC staff only rarely reviews documents associated with beyond-design-basis events, this should assist in achieving the proper level of review. The Orders Management Branch is assigned ownership to revise this document as decisions are made by the management team.

Enclosures:

1. Supplemental Staff Guidance
2. Safety Evaluation Template

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