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

December 19, 2013

Mr. Adam C. Heflin
Senior Vice President
and Chief Nuclear Officer
Union Electric Company
Ameren Missouri
P.O. Box 620
Fulton, MO 65251

SUBJECT: CALLAWAY PLANT, UNIT 1 - INTERIM STAFF EVALUATION RELATING TO OVERALL INTEGRATED PLAN IN RESPONSE TO ORDER EA-12-049 (MITIGATION STRATEGIES) (TAC NO. MF0772)

Dear Mr. Heflin:

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" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12054A736). By letter dated February 28, 2013 (ADAMS Accession No. ML13063A459), Union Electric Company (UEC, the licensee) submitted its Overall Integrated Plan for Callaway Plant, Unit 1 in response to Order EA-12-049. By letter dated August 29, 2013 (ADAMS Accession No. ML13242A239), UEC submitted a six-month update to the Overall Integrated Plan.

Based on a review of UEC's plan, including the six-month update dated August 29, 2013, and information obtained through the mitigation strategies audit process,[1] the NRC concludes that the licensee has provided sufficient information to determine that there is reasonable assurance that the plan, when properly implemented, will meet the requirements of Order EA-12-049 at Callaway Plant, Unit 1. This conclusion is based on the assumption that the licensee will implement the plan as described, including the satisfactory resolution of the open and confirmatory items detailed in the enclosed Interim Staff Evaluation and Audit Report.

[1] A description of the mitigation strategies audit process may be found at ADAMS Accession No. ML13234A503.

If you have any questions, please contact John Boska at 301-415-2901.

Sincerely,

Jeremy S. Bowen, Chief
Mitigating Strategies Projects Branch
Mitigating Strategies Directorate
Office of Nuclear Reactor Regulation

Docket No. 50-483

Enclosures:
1. Interim Staff Evaluation
2. Technical Evaluation Report

cc w/encl: Distribution via Listserv

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INTERIM STAFF EVALUATION AND AUDIT REPORT BY THE OFFICE OF

NUCLEAR REACTOR REGULATION

RELATED TO ORDER EA-12-049 MODIFYING LICENSES

WITH REGARD TO REQUIREMENTS FOR

MITIGATION STRATEGIES FOR BEYOND-DESIGN-BASIS EXTERNAL EVENTS

UNION ELECTRIC COMPANY

CALLAWAY PLANT, UNIT 1

DOCKET NO. 50-483

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. 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. The Nuclear Regulatory Commission (NRC) determined that additional requirements needed to be imposed to mitigate 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 1]. The 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.

By letter dated February 28, 2013 [Reference 2], Union Electric Company (UEC, the licensee) submitted its Overall Integrated Plan (hereafter referred to as the Integrated Plan) for Callaway Plant, Unit 1 (Callaway) in response to Order EA-12-049. By letter dated August 29, 2013 [Reference 3], UEC submitted a six-month update to the Integrated Plan.

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's regulations and processes, and with determining whether the agency should make 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 4]. These recommendations were enhanced by the NRC staff following interactions with stakeholders. Documentation of the NRC staff's efforts is contained in SECY-11-0124, "Recommended Actions to be Taken without Delay from the Near-Term Task Force Report," dated September 9, 2011 [Reference 5] and SECY-11-0137, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," dated October 3, 2011 [Reference 6].

As directed by the Commission's Staff Requirement Memorandum (SRM) for SECY-11-0093 [Reference 7], the NRC staff reviewed the NTTF recommendations within the context of the NRC's existing regulatory framework and considered the various regulatory vehicles available to the NRC to implement the recommendations. SECY-11-0124 and SECY-11-0137 established the NRC staff's prioritization of the recommendations based upon the potential safety enhancements.

After receiving the Commission's direction in SRM-SECY-11-0124 [Reference 8] and SRM-SECY-11-0137 [Reference 9], the NRC staff conducted public meetings to discuss enhanced mitigation strategies intended to maintain or restore core cooling, containment, and SFP cooling capabilities following beyond-design-basis external events. At these meetings, the industry described its proposal for a Diverse and Flexible Mitigation Capability (FLEX), as documented in the Nuclear Energy Institute's (NEI's) letter dated December 16, 2011 [Reference 10]. FLEX was proposed as a strategy to fulfill the key safety functions of core cooling, containment integrity, and spent fuel cooling. Stakeholder input influenced the NRC staff to pursue a more performance-based approach to improve the safety of operating power reactors than envisioned in NTTF Recommendation 4.2, SECY-11-0124, and SECY-11-0137.

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 11] to the Commission, including the proposed order to implement the enhanced mitigation strategies. As directed by SRM-SECY-12-0025 [Reference 12], 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 1].

Order EA-12-049, Attachment 2,[1] requires that operating power reactor licensees and construction permit holders use a three-phase approach for mitigating beyond-design-basis external events. The initial phase requires the use of installed equipment and resources to

[1] Attachment 3 provides requirements for Combined License holders.

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 operational 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 and have adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to the 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 the order.

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 May 4, 2012, NEI submitted document 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision B [Reference 13] to provide specifications for an industry developed methodology for the development, implementation, and maintenance of guidance and strategies in response to the Mitigating Strategies order. On May 13, 2012, NEI submitted NEI 12-06, Revision B1 [Reference 14]. The guidance and strategies described in NEI 12-06 expand on those that industry developed and implemented to address the limited set of BDBEE that involve the loss of a large area of the plant due to explosions and fire required pursuant to paragraph (hh)(2) in Section 50.54, "Conditions of licenses" of Title 10 of the *Code of Federal Regulations*.

On May 31, 2012, the NRC staff issued a draft version of the interim staff guidance (ISG) document 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 15] and published a notice of its availability for public comment in the *Federal Register* (77 FR 33779), with the comment period running through July 7, 2012. JLD-ISG-2012-01 proposed endorsing NEI 12-06, Revision B1, as providing an acceptable method of meeting the requirements of Order EA-12-049. The NRC staff received seven comments during this time. The NRC staff documented its analysis of these comments in "NRC Response to Public Comments, JLD-ISG-2012-01 (Docket ID NRC-2012-0068)" [Reference 16].

On July 3, 2012, NEI submitted comments on JLD-ISG-2012-01, including Revision C to NEI 12-06 [Reference 17], incorporating many of the exceptions and clarifications included in the draft version of the ISG. Following a public meeting held July 26, 2012, to discuss the remaining exceptions and clarifications, on August 21, 2012, NEI submitted Revision 0 to NEI 12-06 [Reference 18].

On August 29, 2012, the NRC staff issued the 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 19], 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).

The NRC staff determined that the overall integrated plans submitted by licensees in response to Order EA-12-049, Section IV.C.1.a should follow the guidance in NEI 12-06, Section 13, which states that:

> The Overall Integrated Plan should include a complete description of the FLEX strategies, including important operational characteristics. The level of detail generally considered adequate is consistent to the level of detail contained in the Licensee's Final Safety Analysis Report (FSAR). The plan should provide the following information:
>
> 1. Extent to which this guidance, NEI 12-06, is being followed including a description of any alternatives to the guidance, and provide a milestone schedule of planned actions.
> 2. Description of the strategies and guidance to be developed to meet the requirements contained in Attachment 2 or Attachment 3 of the order.
> 3. Description of major installed and portable FLEX components used in the strategies, the applicable reasonable protection for the FLEX portable equipment, and the applicable maintenance requirements for the portable equipment.
> 4. Description of the steps for the development of the necessary procedures, guidance, and training for the strategies; FLEX equipment acquisition, staging or installation, including necessary modifications.
> 5. Conceptual sketches, as necessary to indicate equipment which is installed or equipment hookups necessary for the strategies. (As-built piping and instrumentation diagrams (P&ID) will be available upon completion of plant modifications.)
> 6. Description of how the portable FLEX equipment will be available to be deployed in all modes.

By letter dated August 28, 2013 [Reference 20], the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049. That letter described the process to be used by the staff in its reviews, leading to the issuance of this interim staff evaluation and audit report for each site. The purpose of the staff's audits is to determine the extent to which licensees are proceeding on a path towards successful implementation of the actions needed to achieve full compliance with the order. Additional NRC staff review and inspection may be necessary following full implementation of those actions to verify licensees' compliance with the order.

3.0 TECHNICAL EVALUATION

The NRC staff contracted with MegaTech Services, LLC (MTS) for technical support in the evaluation of the Integrated Plan for Callaway, submitted by UEC's letter dated February 28, 2013, as supplemented. NRC and MTS staff have reviewed the submitted information and held clarifying discussions with UEC in evaluating the licensee's plans for addressing beyond-design-basis external events and its progress towards implementing those plans.

A simplified description of the Callaway Integrated Plan to mitigate the postulated extended loss of ac power (ELAP) event is that the licensee will initially remove the core decay heat by adding water to the steam generators (SGs) and releasing steam from the SGs to the atmosphere. The water will initially be added by the turbine-driven auxiliary feedwater (TDAFW) pump, taking suction from the condensate storage tank (CST). The reactor coolant system (RCS) will be cooled down to about 415 degrees Fahrenheit (°F), which will reduce the RCS and SG pressures. When the TDAFW pump can no longer be operated reliably due to the lowering SG pressure, a FLEX pump will be used to add water to the SGs. When the CST water is depleted, water will be added to the CST from the ultimate heat sink (UHS) pond, using a FLEX pump. Borated water will be added to the RCS using a motor-driven high-pressure FLEX pump stored in the auxiliary building, powered by a FLEX generator, with suction from the boric acid tanks, which are also located in the auxiliary building.

Although the existing CST is not seismically qualified and is not protected from tornado missiles, UEC has committed to construct a new CST that would meet the requirements of the order. By letter dated October 9, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13283A033), UEC requested an extension to the order compliance date to provide additional time to construct the new CST. By letter dated December 11, 2013 (ADAMS Accession No. ML13319A668), the NRC granted an extension of the compliance date to the completion date of the spring 2016 refueling outage.

FLEX generators will be used to reenergize the installed battery chargers to keep the necessary direct current (dc) buses energized, which will then keep the 120 volt ac instrument buses energized. The licensee stated that they will utilize the industry Regional Response Centers (RRCs) for supplies of phase 3 equipment, with the intent of reenergizing certain plant safety buses.

In the postulated extended loss of ac power event, the SFP will initially heat up due to the unavailability of the normal cooling system. A FLEX pump will be aligned and used to add water to the SFP to maintain level as the pool boils. This will maintain a sufficient amount of water above the top of the fuel assemblies for cooling and shielding purposes. In the long term, the licensee plans to reestablish SFP cooling using a heat exchanger.

Callaway has a large dry containment building, which contains the RCS. Callaway plans to use low leakage seals on the reactor coolant pumps. The licensee stated that with these seals limiting the leakage inside the containment, that containment pressure and temperature will remain within acceptable values without active containment cooling. The licensee plans to perform analyses to verify this.

By letter dated December 9, 2013 [Reference 21], MTS documented the interim results of the Integrated Plan review in the attached technical evaluation report (TER). The NRC staff has reviewed this TER for consistency with NRC policy and technical accuracy and finds that it accurately reflects the state of completeness of the Integrated Plan. The NRC staff therefore adopts the findings of the TER with respect to individual aspects of the requirements of Order EA-12-049.

4.0 OPEN AND CONFIRMATORY ITEMS

This section contains a summary of the open and confirmatory items identified as part of the technical evaluation. The NRC and MTS have assigned each review item to one of the following categories:

> Confirmatory Item – an item that is considered conceptually acceptable, but for which resolution may be incomplete. These items are expected to be acceptable, but are expected to require some minimal follow up review or audit prior to the licensee's compliance with Order EA-12-049.
>
> Open Item – an item for which the licensee has not presented a sufficient basis to determine that the issue is on a path to resolution. The intent behind designating an issue as an Open Item is to document items that need resolution during the review process, rather than being verified after the compliance date through the inspection process.

As discussed in Section 3.0, above, the NRC staff has reviewed MTS' TER for consistency with NRC policy and technical accuracy and finds that it accurately reflects the state of completeness of the licensee's Integrated Plan. The NRC staff therefore adopts the open and confirmatory items identified in the TER and listed in the tables below. Minor editorial changes were made by the NRC staff to some items. These summary tables provide a brief description of the issue of concern. Further details for each open and confirmatory item are provided in the corresponding sections of the TER, identified by the item number.

4.1 OPEN ITEMS

Item Number	Description	Notes
3.2.1.2.B	Additional review of the licensee's applicable analysis and relevant Reactor Coolant Pump (RCP) seal leakage testing data is needed to justify that (1) the integrity of the associated O-rings will be maintained at the temperature conditions	

	experienced during the ELAP event, and (2) the seal leakage rate used in the ELAP is adequate and acceptable.	
3.2.1.2.D	The acceptability of the use of the selected seals and the RCP seal leakages rates in the ELAP analysis must be justified.	
3.2.1.3.A	During the NRC audit process the licensee was requested to provide the following information: If the ANS 5.1-1979 + 2 sigma model is used in the ELAP analysis, specify the values of the following key parameters used to determine the decay heat: (1) initial power level, (2) fuel enrichment, (3) fuel burnup, (4) effective full power operating days per fuel cycle, (5) number of fuel cycles, if hybrid fuels are used in the core, and (6) fuel characteristics based on the beginning of the cycle, middle of the cycle, or end of the cycle. Address the adequacy of the values used. If the different decay heat model is used, describe the specific model and address the acceptability of the model and the analytical results.	
3.2.1.8.B	The Pressurized-Water Reactor Owners Group submitted to the NRC a position paper, dated August 15, 2013, which provides 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 would occur under conditions similar to those for which boric acid mixing data is available. During the audit process, the licensee informed the NRC staff of its intent to abide by the generic approach discussed above; however, the NRC staff concluded that the August 15, 2013, position paper was not adequately justified and that further information is required.	
3.2.4.9.A	Information is needed regarding plans for assuring and maintaining fuel oil quality.	
3.4.A	Details are needed to demonstrate the minimum capabilities for offsite resources will be met per NEI 12-06 Section 12.2.	

4.2 CONFIRMATORY ITEMS

Item Number	Description	Notes
3.1.1.2.A	Because the current CST is unprotected from seismic hazard, the licensee is planning to install a new CST. Verification of installation is necessary.	
3.1.1.2.B	Information is needed regarding whether or not electrical power will be required to move or deploy FLEX equipment from storage.	
3.1.2.A	Licensee stated that UHS and refueling water storage tank (RWST) are below flood levels but the licensee needs to	

	address potential consequences such as debris in the UHS or access to RWST. In addition, the staff noted that the deployment of FLEX equipment and associated procedural interfaces may be impacted by the UHS and RWST being below the design-basis flood level.	
3.1.3.3.A	The licensee did not provide information with regard to procedural interface considerations as they relate to tornados.	
3.2.1.A	The licensee needs to confirm that adverse quantities of nitrogen from accumulators will not be injected into the RCS during an ELAP event using an acceptable methodology that accounts for the potential for heat transfer from the containment building to the contents of the accumulator.	
3.2.1.B	The licensee needs to confirm that the potential failure of non-safety-related portions of the turbine-driven auxiliary feedwater pump recirculation header piping would not (1) adversely affect the quantity of condensate required for secondary makeup or (2) result in adverse accumulation of water in the CST pipe chase or other areas of the plant.	
3.2.1.1.A	Reliance on the NOTRUMP code for the ELAP analysis of Westinghouse plants is limited to the flow conditions prior to reflux condensation initiation. This includes specifying an acceptable definition for reflux condensation cooling.	
3.2.1.2.C	Further information is required to assess address the impacts of the Westinghouse 10 CFR Part 21 report, "Notification of the Potential Existence of Defects Pursuant to 10 CFR Part 21," dated July 26, 2013 (ADAMS Accession No. ML13211A168) on the use of the low seal leakage rate in the ELAP analysis.	
3.2.1.5.A	The Integrated Plan did not address whether instrumentation credited in the ELAP analysis for automatic actuations and for indications required for the operators to take action are reliable and accurate in the containment harsh conditions. The licensee responded to this question in the audit process by pointing out that the licensee's self-identified open item related to the containment environment (OI 2) addresses this issue. The licensee also stated that Westinghouse will be asked to perform a GOTHIC analysis of the containment to demonstrate that acceptable temperature and pressure levels will not be exceeded.	
3.2.1.6.A	On page 11 of the Integrated Plan, following the sequence of events listed, the licensee stated that to confirm the times given, the licensee will prepare procedures for each task, perform time study walkthroughs for each of the tasks under simulated ELAP conditions, and account for equipment and tagging and other administrative procedures required to perform the task. Further review of the Sequence of Events will be required following this review.	
3.2.1.8.A	Adequate basis is needed for the timing and quantity of the	

	injection of borated coolant as well as justification that administrative procedures will ensure that subcriticality requirements for future cores are bounded.	
3.2.2.A	The licensee stated the water supply for SFP cooling involves three connections points, all located on the exterior of the fuel building. The connection points on the exterior of the fuel building will need to be protected from high wind missile strikes. If protection is not possible, the connection points will need to be relocated to the inside of the building. The configuration needs to be resolved.	
3.2.2.B	The licensee stated that Westinghouse is being asked to clarify the basis for the 48 hour boil off time for the SFP level and the resulting information will be provided in a future 6-month update to the Integrated Plan.	
3.2.3.A	The licensee will use GOTHIC to analyze containment conditions and based on the results of this evaluation, will develop required actions to ensure maintenance of containment integrity and required instrument function. The licensee stated that a detailed discussion of the GOTHIC analysis will be provided in a future 6-month update to address containment cooling during an ELAP event.	
3.2.4.2.A	The licensee needs to provide details regarding a plan to prevent hydrogen accumulation in the battery room during phases 2 and 3.	
3.2.4.2.B	A discussion is needed specifically on the extreme low temperatures effects of the batteries capability to perform its function for the duration of the ELAP event.	
3.2.4.2.C	The licensee stated that an assessment of room environmental conditions and effects on key equipment was performed and the assessment determined that the near term actions were considered acceptable for 24 hours following a BDBEE scenario as outlined in NEI 12-06. However, the licensee further stated that a future action is required to evaluate coping times beyond 24 hours. This action should also address the capability to vent the SFP area.	
3.2.4.3.A	The potential for (1) freezing of water in FLEX equipment and (2) crystallization of boric acid solution, and therefore the potential need for heat tracing on Chemical and volume control system lines, is still not addressed for long periods of time during the ELAP event scenarios. The licensee stated that additional work is required on these subjects to ensure that the potential for freezing and boron solidification is addressed.	
3.2.4.4.A	The licensee needs to provide information concerning the source of power, storage location and the procedures the operators will use to stage temporary lights.	
3.2.4.4.B	The NRC staff has reviewed the licensee communications assessment (ADAMS Accession Nos. ML12306A199 and	

	ML13056A135) and has determined that the assessment for communications is reasonable. Confirmation is required to demonstrate that upgrades to the site's communications systems have been completed.	
3.2.4.6.A	There were several references in the Integrated Plan regarding the need for analyses and procedures to address ventilation of areas such as equipment rooms and the spent fuel pool area. The licensee responded to questions regarding habitability and stated that the subject of area ventilation will be addressed in a future 6-month update.	
3.2.4.7.A	The licensee stated the primary strategy for providing adequate cooling during Modes 5 and 6 will take suction from the new RWST connection on the RWST drain line. The licensee further stated that the RWST is seismically qualified but not missile protected. The licensee has noted a self-identified open item stating that the RWST will be missile protected to credit its use in core cooling with SGs not available strategies.	
3.2.4.10.A	With regard to the battery load shed evolution, the licensee did not address the general question as to whether the potential loss of plant functions and resulting consequences has been addressed. Also, the licensee explained that the main generator seal oil pump is powered from the balance of plant batteries but did not address generator hydrogen hazards when the balance of plant batteries are exhausted. Licensee is requested to address these concerns.	

Based on a review of UEC's plan, including the six-month update dated August 28, 2013, and information obtained through the mitigation strategies audit process, the NRC concludes that the licensee has provided sufficient information to determine that there is reasonable assurance that the plan, when properly implemented, will meet the requirements of Order EA-12-049 at Callaway. This conclusion is based on the assumption that the licensee will implement the plan as described, including the satisfactory resolution of the open and confirmatory items.

5.0 SUMMARY

As required by Order EA-12-049, the licensee is developing, and will implement and maintain, guidance and strategies to restore or maintain core cooling, containment, and SFP cooling capabilities in the event of a beyond-design-basis external event. These new requirements provide a greater mitigation capability consistent with the overall defense-in-depth philosophy, and, therefore, greater assurance that the challenges posed by beyond-design-basis external events to power reactors do not pose an undue risk to public health and safety.

The NRC's objective in preparing this interim staff evaluation and audit report is to provide a finding to the licensee on whether or not their integrated plan, if implemented as described, provides a reasonable path for compliance with the order. For areas where the NRC staff has insufficient information to make this finding (identified above in Section 4.0), the staff will review these areas as they become available or address them as part of the inspection process. The staff notes that the licensee has the ability to modify their plans as stated in NEI 12-06, Section 11.8. However, additional NRC review and/or inspection may be necessary to verify compliance.

The NRC staff has reviewed the licensee's plans for additional defense-in-depth measures. With the exception of the items noted in Section 4.0 above, the staff finds that the proposed measures, properly implemented, will meet the intent of Order EA-12-049, thereby enhancing the licensee's capability to mitigate the consequences of a beyond-design-basis external event that impacts the availability of ac power and the ultimate heat sink. Full compliance with the order will enable the NRC to continue to have reasonable assurance of adequate protection of public health and safety. The staff will issue a safety evaluation confirming compliance with the order and may conduct inspections to verify proper implementation of the licensee's proposed measures.

6.0 REFERENCES

1. 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)

2. Letter from UEC to NRC, "Overall Integrated Plan in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," dated February 28, 2013 (ADAMS Accession No. ML13063A459)

3. Letter from UEC to NRC, "First Six Month Status Report In Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," dated August 29, 2013 (ADAMS Accession No. ML13242A239)

4. SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," July 12, 2011 (ADAMS Accession No. ML11186A950)

5. SECY-11-0124, "Recommended Actions to be Taken without Delay from the Near-Term Task Force Report," September 9, 2011 (ADAMS Accession No. ML11245A158)

6. SECY-11-0137, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," October 3, 2011 (ADAMS Accession No. ML11272A111)

7. SRM-SECY-11-0093, "Staff Requirements – SECY-11-0093 – Near-Term Report and Recommendations for Agency Actions following the Events in Japan," August 19, 2011 (ADAMS Accession No. ML112310021)

8. SRM-SECY-11-0124, "Staff Requirements – SECY-11-0124 – Recommended Actions to be Take without Delay from the Near-Term Task Force Report," October 18, 2011 (ADAMS Accession No. ML112911571)

9. SRM-SECY-11-0137, "Staff Requirements – SECY-11-0137- Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," December 15, 2011 (ADAMS Accession No. ML113490055)

10. Letter from Adrian Heymer (NEI) to David L. Skeen (NRC), "An Integrated, Safety-Focused Approach to Expediting Implementation of Fukushima Dai-ichi Lessons Learned," December 16, 2011 (ADAMS Accession No. ML11353A008)

11. 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)

12. 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)

13. Nuclear Energy Institute (NEI) document 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision B, May 4, 2012 (ADAMS Accession No. ML12144A419)

14. NEI document NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision B1, May 13, 2012 (ADAMS Accession No. ML12143A232)

15. Draft 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," May 31, 2012 (ADAMS Accession No. ML12146A014)

16. NRC Response to Public Comments, JLD-ISG-2012-01 (Docket ID NRC-2012-0068), August 29, 2012 (ADAMS Accession No. ML12229A253)

17. NEI comments to draft JLD-ISG-2012-01 and document 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision C, July 3, 2012 (ADAMS Accession No. ML121910390)

18. NEI document 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0, August 21, 2012 (ADAMS Accession No. ML12242A378)

19. Final Interim Staff Guidance 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)

20. Letter from Jack R. Davis (NRC) to All Operating Reactor Licensees and Holders of Construction Permits, "Nuclear Regulatory Commission Audits of Licensee Responses to Mitigation Strategies Order EA-12-049," August 28, 2013 (ADAMS Accession No. ML13234A503)

21. Letter from John Bowen, MegaTech Services, LLC, to Eric Bowman, NRC, submitting "Technical Evaluation Reports Related to Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, EA 12-049," dated December 9, 2013 (ADAMS Accession No. ML13346A616)

22. Order EA-13-109, "Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions," June 6, 2013 (ADAMS Accession No. ML13143A321)

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Enclosure 2

Technical Evaluation Report

MEGA-TECH SERVICES LLC

Mega-Tech Services, LLC

Technical Evaluation Report Related to Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, EA-12-049

Revision 1

December 9, 2013

Ameren Missouri, Union Electric Company
Callaway Plant Unit 1
Docket No. 50-483

Prepared for:

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

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1.0 BACKGROUND

Following the events at the Fukushima Dai-ichi nuclear power plant on March 11, 2011, the U.S. Nuclear Regulatory Commission (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, methodical review of NRC regulations and processes to determine 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. These recommendations were enhanced by the NRC staff following interactions with stakeholders. Documentation of the staff's efforts is contained in SECY-11-0124, "Recommended Actions to be Taken without Delay from the Near-Term Task Force Report," dated September 9, 2011, and SECY-11-0137, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," dated October 3, 2011.

As directed by the Commission's staff requirement memorandum (SRM) for SECY-11-0093, the NRC staff reviewed the NTTF recommendations within the context of the NRC's existing regulatory framework and considered the various regulatory vehicles available to the NRC to implement the recommendations. SECY-11-0124 and SECY-11-0137 established the staff's prioritization of the recommendations.

After receiving the Commission's direction in SRM-SECY-11-0124 and SRM-SECY-11-0137, the NRC staff conducted public meetings to discuss enhanced mitigation strategies intended to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities following beyond-design-basis external events (BDBEEs). At these meetings, the industry described its proposal for a Diverse and Flexible Mitigation Capability (FLEX), as documented in Nuclear Energy Institute's (NEI) letter, dated December 16, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML11353A008). FLEX was proposed as a strategy to fulfill the key safety functions of core cooling, containment integrity, and spent fuel cooling. Stakeholder input influenced the NRC staff to pursue a more performance-based approach to improve the safety of operating power reactors relative to the approach that was envisioned in NTTF Recommendation 4.2, SECY-11-0124, and SECY-11-0137.

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," to the Commission, including the proposed order to implement the enhanced mitigation strategies. As directed by SRM-SECY-12-0025, the NRC staff issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events."

Guidance and strategies required by the Order would be available if a loss of power, motive force and normal access to the ultimate heat sink needed to prevent fuel damage in the reactor and SFP affected all units at a site simultaneously. The Order requires a three-phase approach for mitigating BDBEEs. The initial phase requires the use of installed equipment and resources to maintain or restore key safety functions including core cooling, containment, and SFP cooling. 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 offsite. The final phase requires obtaining sufficient offsite resources to sustain those functions indefinitely.

NEI submitted its document NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide" in August 2012 (ADAMS Accession No. ML12242A378) to provide specifications for an industry-developed methodology for the development, implementation, and maintenance of guidance and strategies in response to Order EA-12-049. The guidance and strategies described in NEI 12-06 expand on those that industry developed and implemented to address the limited set of BDBEEs that involve the loss of a large area of the plant due to explosions and fire required pursuant to paragraph (hh)(2) of 10 CFR 50.54, "Conditions of licenses."

As described in 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," the NRC staff considers that the development, implementation, and maintenance of guidance and strategies in conformance with the guidelines provided in NEI 12-06, Revision 0, subject to the clarifications in Attachment 1 of the ISG are an acceptable means of meeting the requirements of Order EA-12-049.

In response to Order EA-12-049, licensees submitted Overall Integrated Plans (hereafter, the Integrated Plan) describing their course of action for mitigation strategies that are to conform with the guidance of NEI 12-06, or provide an acceptable alternative to demonstrate compliance with the requirements of Order EA-12-049.

2.0 EVALUATION PROCESS

In accordance with the provisions of Contract NRC-HQ-13-C-03-0039, Task Order No. NRC-HQ-13-T-03-0001, Mega-Tech Services, LLC (MTS) performed an evaluation of each licensee's Integrated Plan. As part of the evaluation, MTS, in parallel with the NRC staff, reviewed the original Integrated Plan and the first 6-month status update, and conducted an audit of the licensee documents. The staff and MTS also reviewed the licensee's answers to the NRC staff's and MTS's questions as part of the audit process. The objective of the evaluation was to assess whether the proposed mitigation strategies conformed to the guidance in NEI 12-06, as endorsed by the positions stated in JLD-ISG-2012-01, or an acceptable alternative had been proposed that would satisfy the requirements of Order EA-12-049. The audit plan that describes the audit process was provided to all licensees in a letter dated August 29, 2013 from Jack R. Davis, Director, Mitigating Strategies Directorate (ADAMS Accession No. ML13234A503).

The review and evaluation of the licensee's Integrated Plan was performed in the following areas consistent with NEI 12-06 and the regulatory guidance of JLD-ISG-2012-01:

- Evaluation of External Hazards
- Phased Approach
    - Initial Response Phase
    - Transition Phase
    - Final Phase
- Core Cooling Strategies

- SFP Cooling Strategies
- Containment Function Strategies
- Programmatic Controls
  - ➢ Equipment Protection, Storage, and Deployment
  - ➢ Equipment Quality

The technical evaluation (TE) in Section 3.0 documents the results of the MTS evaluation and audit results. Section 4.0 summarizes Confirmatory Items and Open Items that require further evaluation before a conclusion can be reached that the Integrated Plan is consistent with the guidance in NEI 12-06 or an acceptable alternative has been proposed that would satisfy the requirements of Order EA-12-049. For the purpose of this evaluation, the following definitions are used for Confirmatory Item and Open Item.

> Confirmatory Item – an item that is considered conceptually acceptable, but for which resolution may be incomplete. These items are expected to be acceptable, but are expected to require some minimal follow up review or audit prior to the licensee's compliance with Order EA-12-049.
>
> Open Item – an item for which the licensee has not presented a sufficient basis to determine that the issue is on a path to resolution. The intent behind designating an issue as an Open Item is to document items that need resolution during the review process, rather than being verified after the compliance date through the inspection process.

Additionally, for the purpose of this evaluation and the NRC staff's interim staff evaluation (ISE), licensee statements, commitments, and references to existing programs that are subject to routine NRC oversight (Updated Final Safety Analysis Report (UFSAR) program, procedure program, quality assurance program, modification configuration control program, etc.) will generally be accepted. For example, references to existing UFSAR information that supports the licensee's overall mitigating strategies plan, will be assumed to be correct, unless there is a specific reason to question its accuracy. Likewise, if a licensee states that they will generate a procedure to implement a specific mitigating strategy, assuming that the procedure would otherwise support the licensee's plan, this evaluation accepts that a proper procedure will be prepared. This philosophy for this evaluation and the ISE does not imply that there are any limits in this area to future NRC inspection activities.

3.0 TECHNICAL EVALUATION

By letter dated February 28, 2013, (ADAMS Accession No. ML13063A459), and as supplemented by the first six-month status report in letter dated August 29, 2013 (ADAMS Accession No. 13241A239), Union Electric Company (hereinafter referred to as the licensee) provided Callaway Plant's Integrated Plan for Compliance with Order EA-12-049. 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 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. That letter described the process used by the NRC staff in its review, leading to the issuance of an interim staff evaluation and audit report. The purpose of the staff's audit is to determine the extent to which the licensees are proceeding on a path towards successful implementation of the actions needed to achieve full compliance with the Order.

3.1 EVALUATION OF EXTERNAL HAZARDS

Sections 4 through 9 of NEI 12-06 provide the NRC-endorsed methodology for the determination of applicable extreme external hazards in order to identify potential complicating factors for the protection and deployment of equipment needed for mitigation of BDBEEs leading to an extended loss of all alternating current (ac) power (ELAP) and loss of normal access to the ultimate heat sink (UHS). These hazards are broadly grouped into the categories discussed below in Sections 3.1.1 through 3.1.5 of this evaluation. 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.

3.1.1 Seismic Events

NEI 12-06, Section 5.2 states:

> All sites will address BDB [beyond-design-basis] seismic considerations in the implementation of FLEX strategies, as described below. The basis for this is that, while some sites are in areas with lower seismic activity, their design basis generally reflects that lower activity. There are large, and unavoidable, uncertainties in the seismic hazard for all U.S. plants. In order to provide an increased level of safety, the FLEX deployment strategy will address seismic hazards at all sites.
>
> These considerations will be treated in four primary areas: protection of FLEX equipment, deployment of FLEX equipment, procedural interfaces, and considerations in utilizing off-site resources.

[Author's note – The Integrated Plan document for Callaway has pages numbered by two separate methods. At the top of each page, the numbering convention is "Page x of 131". That page count includes the cover letters and other front material. At the bottom of each page, the numbering convention is simply the page number, "3" for example. That page count includes two blank pages at the front of the Integrated Plan but not the cover letters. The effect is that the two page numbers are different for the same page. When referencing the Integrated Plan in this Technical Evaluation, the author will use the page number at the bottom of the page.]

On page 3 of the Integrated Plan, in the section regarding determination of applicable extreme external hazards, the licensee stated that per the Final Safety Analysis Report (FSAR) seismic input, the licensee's seismic criteria for Callaway includes two design basis earthquake spectra: Operating Basis Earthquake (OBE) and Safe Shutdown Earthquake (SSE). The site seismic design response spectra define the vibratory ground motion of the OBE and SSE. The maximum horizontal acceleration for the SSE is 0.20g, and the OBE has a maximum horizontal acceleration of 0.12g. In addition, the licensee stated that all safety-related structures are founded on granular structural fill composed mainly of crushed limestone and dolomite or on conglomerate. Neither material is susceptible to liquefaction. In summary, the seismic hazard applies to Callaway Plant.

The licensee also stated on page 3 that the seismic re-evaluations pursuant to the 10 CFR 50.54(f) letter of March 12, 2012 had not been completed and therefore were not assumed in their Integrated Plan.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to seismic screening if these requirements are implemented as described.

3.1.1.1 Protection of FLEX Equipment – Seismic Hazard

NEI 12-06, Section 5.3.1 states:

1. FLEX equipment should be stored in one or more of following three configurations:

    a. In a structure that meets the plant's design basis for the Safe Shutdown Earthquake (SSE)(e.g., existing safety-related structure).

    b. In a structure designed to or evaluated equivalent to [American Society of Civil Engineers] ASCE 7-10, *Minimum Design Loads for Buildings and Other Structures.*

    c. Outside a structure and evaluated for seismic interactions to ensure equipment is not damaged by non-seismically robust components or structures.

2. 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).

3. Stored equipment and structures should be evaluated and protected from seismic interactions to ensure that unsecured and/or non-seismic components do not damage the equipment.

On page 21 of the Integrated Plan, in the section regarding maintaining core cooling and heat removal, the licensee stated that two locations have been determined for storage of the licensee's FLEX equipment. The primary storage location will be a new FLEX storage bunker. The secondary storage location will be the Unit 2 emergency service water (ESW) Pumphouse. Each of the buildings will have a common set of equipment capable of supporting each FLEX function/strategy. On page 22 of the Integrated Plan, in the section regarding the strategies for maintaining core cooling and heat removal in the transition phase (phase 2), the licensee stated that the storage locations will be designed or evaluated equivalent to ASCE 7-10. Large portable FLEX equipment will be secured as appropriate during SSE and will be protected from seismic interactions with other components. No components will be stacked or at a raised elevation as to cause interference with the deployment of any of the FLEX equipment. Based on the information provided, the considerations of NEI 12-06, Section 5.3.1 have been addressed.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect storage of FLEX equipment if these requirements are implemented as described.

3.1.1.2 Deployment of FLEX Equipment - Seismic Hazard

NEI 12-06, Section 5.3.2 states:

> The baseline capability requirements already address loss of non-seismically robust equipment and tanks as well as loss of all AC. So, these seismic considerations are implicitly addressed.
>
> There are five considerations for the deployment of FLEX equipment following a seismic event:
>
> 1. If the equipment needs to be moved from a storage location to a different point for deployment, the route to be traveled should be reviewed for potential soil liquefaction that could impede movement following a severe seismic event.
>
> 2. At least one connection point for the FLEX equipment will only require access through seismically robust structures. This includes both the connection point and any areas that plant operators will have to access to deploy or control the capability.
>
> 3. If the plant FLEX strategy relies on a water source that is not seismically robust, e.g., a downstream dam, the deployment of FLEX coping capabilities should address how water will be accessed. Most sites with this configuration have an underwater berm that retains a needed volume of water. However, accessing this water may require new or different equipment.
>
> 4. If power is required to move or deploy the equipment (e.g., to open the door from a storage location), then power supplies should be provided as part of the FLEX deployment.
>
> 5. A means to move FLEX equipment should be provided that is also reasonably protected from the event.

With regard to considerations 1 and 2 noted above, the licensee described the protection of connection points for core cooling strategies. The licensee stated that the primary connection point is located in the auxiliary building, which is seismically qualified and missile protected. Access is available through the tendon gallery, which is seismically qualified and protected from a high wind/missile hazard. Similar wording is used in other sections of the Integrated Plan when referring to access paths to connection points. This information is consistent with the guidance provided by NEI 12-06.

Also on page 23 of the Integrated Plan, in the description of core cooling the licensee stated that the FLEX core cooling pump will draw suction from the condensate storage tank (CST). The licensee further states that for this strategy to be successful, the CST must be modified. Because the tank is a non-seismic and non-missile protected tank, the tank would need to be seismically qualified and missile protected to credit it for any plant strategies. By letter dated October 9, 2013 (ADAMS Accession No. ML13283A033), the licensee requested an extension to the order compliance date in order to install a new, seismically qualified and hardened CST that will hold approximately 670,000 gallons of creditable volume. Because the water source for these strategies, the CST, is presently unprotected from both seismic and missile hazards and the resolution is pending, the plan does not yet provide reasonable assurance that the strategies for core cooling and heat removal conform to consideration 3 above. This is identified as Confirmatory Item 3.1.1.2.A in Section 4.2 below.

With regard to consideration 4 above, insufficient information was provided in the Integrated Plan to determine whether or not there is a need to provide power to facilitate moving or deploying strategies (e.g., to open the door from a storage location). This is identified as Confirmatory Item 3.1.1.2.B in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Items, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to equipment deployment if these requirements are implemented as described.

3.1.1.3 Procedural Interfaces – Seismic Hazard

NEI 12-06, Section 5.3.3 states:

> There are four procedural interface considerations that should be addressed.
>
> 1. Seismic studies have shown that even seismically qualified electrical equipment can be affected by BDB seismic events. In order to address these considerations, each plant should compile a reference source for the plant operators that provides approaches to obtaining necessary instrument readings to support the implementation of the coping strategy (see Section 3.2.1.10). This reference source should include control room and non-control room readouts and should also provide guidance on how and where to measure key instrument readings at containment penetrations, where applicable, using a portable instrument (e.g., a Fluke meter). Such a resource could be provided as an attachment to the plant procedures/guidance. Guidance should include critical actions to perform until alternate indications can be connected and on how to control critical equipment without associated control power.
>
> 2. Consideration should be given to the impacts from large internal flooding sources that are not seismically robust and do not require ac power (e.g., gravity drainage from lake or cooling basins for non-safety-related cooling water systems).
>
> 3. For sites that use ac power to mitigate ground water in critical locations, a strategy to remove this water will be required.
>
> 4. Additional guidance may be required to address the deployment of FLEX for those plants that could be impacted by failure of a not seismically robust downstream dam.

On page 18, and other sections of the Integrated Plan where instruments were listed for key parameters for mitigating strategies, the licensee stated that Callaway Plant will develop procedures to read this instrumentation locally, where applicable, using a portable instrument, as per the guidelines of Section 5.3.3 of NEI 12-06. The licensee provided additional information in responding to the audit process. The licensee stated that the procedures for addressing the use of portable instruments used to support the mitigation strategies are not yet developed but will address all the considerations of Section 5.3.3.

The Integrated Plan did not address considerations 2, 3, and 4 above with regard to large impacts from large internal flooding sources, ac power for mitigating ground water, and failure of a downstream dam. The licensee addressed these questions during the audit process by providing the following: Consideration 2 - Callaway does not have large internal flooding sources that are not seismically robust; consideration 3 - Callaway does not use ac power to mitigate ground water in critical locations; and consideration 4 - There are no non-seismic downstream dams at Callaway.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect procedural interfaces if these requirements are implemented as described.

3.1.1.4 Considerations in Using Offsite Resources – Seismic Hazard

NEI 12-06, Section 5.3.4 states:

> Severe seismic events can have far-reaching effects on the infrastructure in and around a plant. While nuclear power plants are designed for large seismic events, many parts of the Owner Controlled Area and surrounding infrastructure (e.g., roads, bridges, dams, etc.) may be designed to lesser standards. Obtaining off-site resources may require use of alternative transportation (such as air-lift capability) that can overcome or circumvent damage to the existing local infrastructure.
>
> 1. The FLEX strategies will need to assess the best means to obtain resources from off-site following a seismic event.

On page 3 of the Integrated Plan, in the section regarding seismic screening, the licensee stated that the FLEX strategies developed for the Callaway Plant will include documentation ensuring that any storage locations and staging routes, and routes from off-site resource support meet the FLEX seismic criteria. On page 13 of the Integrated Plan, the licensee described the industry plans to establish two (2) Regional Response Centers (RRCs) to support utilities during a BDBEE scenario as outlined in NEI 12-06. Each RRC will hold five (5) sets of equipment, four (4) of which will be able to be fully deployed when requested; the fifth set will have equipment in a maintenance cycle. Equipment will be moved from an RRC to a local Assembly Area, established by the Strategic Alliance for FLEX Emergency Response (SAFER) team and the utility. Communications will be established between the affected nuclear site and the SAFER team and required equipment moved to the site as needed. First arriving equipment, as established during development of the nuclear site's playbook, will be delivered to the site within 24 hours from the initial request.

The licensee also stated that the Callaway Plant will negotiate and execute an automatically renewing contract with the vendor of the RRC to establish and maintain a facility that will meet the guidance of NEI 12-06, Section 12.

The licensee addressed the offsite staging areas during the response to the audit process. The licensee stated that offsite staging locations have been selected at a distance greater than 25 miles from the site. Both primary and alternate transportation routes have been identified and, in case neither is available, the RRC will have airlift capability.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to offsite resources if these requirements are implemented as described.

3.1.2 Flooding

NEI 12-06, Section 6.2 states:

> The evaluation of external flood-induced challenges has three parts. The first part is determining whether the site is susceptible to external flooding. The second part is the characterization of the applicable external flooding threat. The third part is the application of the flooding characterization to the protection and deployment of FLEX strategies.

NEI 12-06, Section 6.2.1 states:

> Susceptibility to external flooding is based on whether the site is a "dry" site, i.e., the plant is built above the design basis flood level (DBFL). For sites that are not "dry", water intrusion is prevented by barriers and there could be a potential for those barriers to be exceeded or compromised. Such sites would include those that are kept "dry" by permanently installed barriers, e.g., seawall, levees, etc., and those that install temporary barriers or rely on watertight doors to keep the design basis flood from impacting safe shutdown equipment.

On page 4 of the Integrated Plan, the licensee described the screening for floods. The licensee stated that the maximum plant site flood level from any cause is Elevation 840.16 ft. mean sea level (MSL). The grade level for all structures, systems and components (SSCs) (except for the UHS and refueling water storage tank (RWST)) is an elevation of about 840.5 ft. MSL. Because the plant is built above the design basis flood level, the plant is considered "dry." The licensee concludes that the external flood hazard is screened out for Callaway Plant.

The implication of the foregoing paragraph is that the UHS and the RWST locations below the maximum flood level are inconsequential to the use for mitigating strategies. There is no clarification of this issue in the Integrated Report and it will need to be addressed. For example, it was not clear to the reviewer whether consequences from flooding such as debris in the UHS or access to the RWST should be considered. In addition, the deployment of FLEX equipment and associated procedural interfaces may be impacted by the UHS and RWST being below the design basis level. This is Confirmatory Item 3.1.2.A in Section 4.2 below.

On page 8 of the Integrated Plan, the licensee noted that the flood re-evaluations pursuant to the 10 CFR 50.54(f) letter of March 12, 2012 were not completed. However, in the response to the audit process, the licensee stated that the re-evaluations had since been completed and the results confirmed that the site is a "dry site." The re-evaluation has been submitted to the NRC (ADAMS Accession Number ML13071A316).

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to screening for flooding if these requirements are implemented as described.

3.1.2.1 Protection of FLEX Equipment – Flooding Hazard

NEI 12-06, Section 6.2.3.1 states:

> These considerations apply to the protection of FLEX equipment from external flood hazards:
>
> 1. The equipment should be stored in one or more of the following configurations:
>
>   a. Stored above the flood elevation from the most recent site flood analysis. The evaluation to determine the elevation for storage should be informed by flood analysis applicable to the site from early site permits, combined license applications, and/or contiguous licensed sites.
>
>   b. Stored in a structure designed to protect the equipment from the flood.
>
>   c. FLEX equipment can be stored below flood level if time is available and plant procedures/guidance address the needed actions to relocate the equipment. Based on the timing of the limiting flood scenario(s), the FLEX equipment can be relocated [footnote 2 omitted] to a position that is protected from the flood, either by barriers or by elevation, prior to the arrival of the potentially damaging flood levels. This should also consider the conditions on-site during the increasing flood levels and whether movement of the FLEX equipment will be possible before potential inundation occurs, not just the ultimate flood height.
>
> 2. Storage areas that are potentially impacted by a rapid rise of water should be avoided.

As discussed in the previous section, the Callaway site is designated a "dry site" and as a result, the considerations above are not applicable.

3.1.2.2 Deployment of FLEX Equipment – Flooding Hazard

NEI 12-06, Section 6.2.3.2 states:

> There are a number of considerations that apply to the deployment of FLEX equipment for external flood hazards:

1. For external floods with warning time, the plant may not be at power. In fact, the plant may have been shut down for a considerable time and the plant configuration could be established to optimize FLEX deployment. For example, the portable pump could be connected, tested, and readied for use prior to the arrival of the critical flood level. Further, protective actions can be taken to reduce the potential for flooding impacts, including cooldown, borating the reactor coolant system (RCS), isolating accumulators, isolating reactor coolant pump (RCP) seal leak off, obtaining dewatering pumps, creating temporary flood barriers, etc. These factors can be credited in considering how the baseline capability is deployed.

2. The ability to move equipment and restock supplies may be hampered during a flood, especially a flood with long persistence. Accommodations along these lines may be necessary to support successful long-term FLEX deployment.

3. Depending on plant layout, the UHS may be one of the first functions affected by a flooding condition. Consequently, the deployment of the equipment should address the effects of LUHS [loss of normal access to the ultimate heat sink], as well as extended loss of alternating current power (ELAP).

4. Portable pumps and power supplies will require fuel that will normally be obtained from fuel oil storage tanks that could be inundated by the flood or above ground tanks that could be damaged by the flood. Steps should be considered to protect or provide alternate sources of fuel oil for flood conditions. Potential flooding impacts on access and egress should also be considered.

5. Connection points for portable equipment should be reviewed to ensure that they remain viable for the flooded condition.

6. For plants that are limited by storm-driven flooding, such as Probable Maximum Surge or Probable Maximum Hurricane (PMH), expected storm conditions should be considered in evaluating the adequacy of the baseline deployment strategies.

7. Since installed sump pumps will not be available for dewatering due to the ELAP, plants should consider the need to provide water extraction pumps capable of operating in an ELAP and hoses for rejecting accumulated water for structures required for deployment of FLEX strategies.

8. Plants relying on temporary flood barriers should assure that the storage location for barriers and related material provides reasonable assurance that the barriers could be deployed to provide the required protection.

9. A means to move FLEX equipment should be provided that is also reasonably protected from the event.

As discussed in a previous section, the Callaway site is designated a "dry site" and as a result, the considerations above are not applicable. However, the topic of moving phase 3 FLEX equipment to the site from offsite locations will be discussed in Section 3.1.2.4 below.

3.1.2.3 Procedural Interfaces – Flooding Hazard

NEI 12-06, Section 6.2.3.3 states:

> The following procedural interface considerations should be addressed.
>
> 1. Many sites have external flooding procedures. The actions necessary to support the deployment considerations identified above should be incorporated into those procedures.
>
> 2. Additional guidance may be required to address the deployment of FLEX for flooded conditions (i.e., connection points may be different for flooded vs. non-flooded conditions).
>
> 3. FLEX guidance should describe the deployment of temporary flood barriers and extraction pumps necessary to support FLEX deployment.

As discussed in a previous section, the Callaway site is designated a "dry site" and as a result, the considerations above are not applicable.

3.1.2.4 Considerations in Using Offsite Resources – Flooding Hazard

NEI 12-06, Section 6.2.3.4 states:

> Extreme external floods can have regional impacts that could have a significant impact on the transportation of offsite resources.
>
> 1. Sites should review site access routes to determine the best means to obtain resources from off-site following a flood.
>
> 2. Sites impacted by persistent floods should consider where equipment delivered from offsite could be staged for use on-site.

The considerations above were addressed on page 4 of the Integrated Plan. The licensee stated that although the site is designated a "dry site," the licensee is developing procedures and strategies for delivery of offsite FLEX equipment during phase 3 and will consider regional impacts from flooding.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to offsite resources if these requirements are implemented as described.

3.1.3 High Winds

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 first part of the evaluation of high wind challenges is determining whether the site is potentially susceptible to different high wind conditions to allow characterization of the applicable high wind hazard.

The screening for high wind hazards associated with hurricanes should be accomplished by comparing the site location to NEI 12-06, Figure 7-1 (Figure 3-1 of U.S. NRC, "Technical Basis for Regulatory Guidance on Design Basis Hurricane Wind Speeds for Nuclear Power Plants," NUREG/CR-7005, December, 2009); if the resulting frequency of recurrence of hurricanes with wind speeds in excess of 130 mph exceeds 10^{-6} per year, the site should address hazards due to extreme high winds associated with 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 10^{-6}/year probability exceeds 130 mph, the site should address hazards due to extreme high winds associated with tornadoes.

On page 4 of the Integrated Plan in the section regarding the determination of applicable extreme external hazards, the licensee stated that Figures 7-1 and 7-2 in NEI 12-06 were used for the high wind assessment. The licensee concluded that the Callaway Plant is not susceptible to hurricanes based on its location in central Missouri. The licensee explained that Figure 7-2 indicates a maximum wind speed of 200 mph for Region 1 plants, including the Callaway Plant. In summary, the licensee concluded that the Callaway Plant would not be susceptible to hurricanes so that hazard is screened out, and Callaway Plant does have the potential to experience damaging winds so that hazard is screened in.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to screening if these requirements are implemented as described.

3.1.3.1 Protection of FLEX Equipment - High Wind Hazard

NEI 12-06, Section 7.3.1 states:

> These considerations apply to the protection of FLEX equipment from high wind hazards:
>
> 1. For plants exposed to high wind hazards, FLEX equipment should be stored in one of the following configurations:
>
>   a. In a structure that meets the plant's design basis for high wind hazards (e.g., existing safety-related structure).
>
>   b. In storage locations designed to or evaluated equivalent to ASCE 7-10, *Minimum Design Loads for Buildings and Other Structures* given the limiting tornado wind speeds from Regulatory Guide 1.76 or design basis hurricane wind speeds for the site.
>
>   - Given the FLEX basis limiting tornado or hurricane wind speeds, building loads will be computed in accordance with requirements of ASCE 7-10. Acceptance criteria will be based on building

serviceability requirements not strict compliance with stress or capacity limits. This will allow for some minor plastic deformation, yet assure that the building will remain functional.

- Tornado missiles and hurricane missiles will be accounted for in that the FLEX equipment will be stored in diverse locations to provide reasonable assurance that N sets of FLEX equipment will remain deployable following the high wind event. This will consider locations adjacent to existing robust structures or in lower sections of buildings that minimizes the probability that missiles will damage all mitigation equipment required from a single event by protection from adjacent buildings and limiting pathways for missiles to damage equipment.

- The axis of separation should consider the predominant path of tornados in the geographical location. In general, tornadoes travel from the West or West Southwesterly direction, diverse locations should be aligned in the North-South arrangement, where possible. Additionally, in selecting diverse FLEX storage locations, consideration should be given to the location of the diesel generators and switchyard such that the path of a single tornado will not impact all locations.

- Stored mitigation equipment exposed to the wind should be adequately tied down. Loose equipment should be in protective boxes that are adequately tied down to foundations or slabs to prevent protected equipment from being damaged or becoming airborne. (During a tornado, high winds may blow away metal siding and metal deck roof, subjecting the equipment to high wind forces.)

c. In evaluated storage locations separated by a sufficient distance that minimizes the probability that a single event will damage all FLEX mitigation equipment such that at least N sets of FLEX equipment will remain deployable following the high wind event. (This option is not applicable for hurricane conditions).

  - Consistent with configuration b., the axis of separation should consider the predominant path of tornados in the geographical location.

  - Consistent with configuration b., stored mitigation equipment should be adequately tied down.

On page 22 of the Integrated Plan in the section describing core cooling and heat removal strategies, the licensee stated portable equipment to implement FLEX strategies will be maintained in storage locations that are protected from high winds, i.e., hardened structures designed and built to ASCE 7-10. A similar statement is provided for the transition phase for safety function support and for the FLEX generator.

On page 38 of the Integrated Plan regarding the strategies for maintaining RCS inventory in the transition phase (phase 2), the licensee stated that storage/protection of equipment from high winds would be provided for portable equipment to implement FLEX strategies. The equipment will be maintained in the Auxiliary Building, a Category 1 building designed for protection from high winds.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect protection of equipment if these requirements are implemented as described.

3.1.3.2 Deployment of FLEX Equipment – High Wind Hazard

NEI 12-06, Section 7.3.2 states:

> There are a number of considerations which apply to the deployment of FLEX equipment for high wind hazards:
>
> 1. For hurricane plants, the plant may not be at power prior to the simultaneous ELAP and LUHS condition. In fact, the plant may have been shut down and the plant configuration could be established to optimize FLEX deployment. For example, the portable pumps could be connected, tested, and readied for use prior to the arrival of the hurricane. Further, protective actions can be taken to reduce the potential for wind impacts. These factors can be credited in considering how the baseline capability is deployed.
>
> 2. The ultimate heat sink may be one of the first functions affected by a hurricane due to debris and storm surge considerations. Consequently, the evaluation should address the effects of ELAP/LUHS, along with any other equipment that will be damaged by the postulated storm.
>
> 3. Deployment of FLEX following a hurricane or tornado may involve the need to remove debris. Consequently, the capability to remove debris caused by these extreme wind storms should be included.
>
> 4. A means to move FLEX equipment should be provided that is also reasonably protected from the event.
>
> 5. The ability to move equipment and restock supplies may be hampered during a hurricane and should be considered in plans for deployment of FLEX equipment.

As discussed previously in this report, the Callaway Plant screened out hazards from hurricanes, and therefore, considerations 1, 2, and 5 do not apply.

Considerations 3 and 4 relate to the ability of the licensee to remove debris and transport equipment and supplies. On page 78 of the Integrated Plan, in the list of pressurized water reactor (PWR) Portable Equipment Phase 2, the licensee lists a "Pettibone All-Terrain Forklift (or similar)" and a "Pickup Truck" for use to provide accessibility. The reviewer concluded that the vehicles noted in the Integrated Report will facilitate the debris removal and equipment transport needs. As described on page 21 of the Integrated Plan, two locations have been determined for storage of Callaway Plant FLEX equipment. The primary storage location will be a new FLEX storage bunker. The secondary storage location will be the Unit 2 ESW Pumphouse. Each of the buildings will have a common set of equipment capable of supporting each FLEX function/strategy.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01 and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to deployment of FLEX equipment for a high wind hazard if these requirements are implemented as described.

3.1.3.3 Procedural Interfaces – High Wind Hazard

NEI 12-06, Section 7.3.3, states:

> The overall plant response strategy should be enveloped by the baseline capabilities, but procedural interfaces may need to be considered. For example, many sites have hurricane procedures. The actions necessary to support the deployment considerations identified above should be incorporated into those procedures.

The licensee provided no information with regard to procedural interface considerations as they relate to tornados. Therefore, the plan fails to provide sufficient information to demonstrate conformance with the consideration noted above. This is identified as Confirmatory Item 3.1.3.3.A in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to procedural interfaces if these requirements are implemented as described.

3.1.3.4 Considerations in Using Offsite Resources – High wind hazard

NEI 12-06, Section 7.3.4 states:

> Extreme storms with high winds can have regional impacts that could have a significant impact on the transportation of off-site resources.
>
> 1. Sites should review site access routes to determine the best means to obtain resources from off-site following a hurricane.
>
> 2. Sites impacted by storms with high winds should consider where equipment delivered from off-site could be staged for use on-site.

On page 13 of the Integrated Plan, in the section regarding the RRC plan, the licensee stated that the industry will establish two RRCs to support utilities during a BDBEE scenario as outlined in NEI 12-06. Equipment will be moved from an RRC to a local Assembly Area, established by the SAFER team and the utility.

The licensee addressed the considerations above during the audit process. The licensee stated that offsite staging locations have been selected at a distance greater than 25 miles from the site. Both primary and alternate transportation routes have been identified and, in case neither is available, the RRC will have airlift capability.

The licensee's approach described above, as currently understood, is consistent with the

guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to offsite resources if these requirements are implemented as described.

3.1.4 Snow, Ice and Extreme Cold

As discussed in NEI 12-06, Section 8.2.1:

All sites should consider the temperature ranges and weather conditions for their site in storing and deploying their 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.

On page 4 of the Integrated Plan regarding the determination of applicable extreme external hazards, the licensee stated that screening was performed per NEI 12-06. The licensee concluded that because Callaway Plant site is above the 35th parallel, the FLEX strategies must consider the impedances caused by extreme snowfall with snow removal equipment, as well as the challenges that extreme cold temperature may present. With regard to ice storms, the licensee stated that the Callaway Plant site is not a Level 1 or 2 region as defined by Figure 8-2 of the NEI 12-06, and therefore, the FLEX strategies must consider the impedances caused by ice storms. In summary, the Callaway site screens in for snow, ice and extreme cold.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to screening if these requirements are implemented as described.

3.1.4.1 Protection of FLEX Equipment – Snow, Ice and Extreme Cold Hazard

NEI 12-06, Section 8.3.1 states:

> These considerations apply to the protection of FLEX equipment from snow, ice, and extreme cold hazards:
>
> 1. For sites subject to significant snowfall and ice storms, portable FLEX equipment should be stored in one of the two configurations.
>
>   a. In a structure that meets the plant's design basis for the snow, ice and cold conditions (e.g., existing safety-related structure).
>
>   b. In a structure designed to or evaluated equivalent to ASCE 7-10, *Minimum Design Loads for Buildings and Other Structures* for the snow, ice, and cold conditions from the site's design basis.
>
>   c. Provided the N sets of equipment are located as described in a. or b. above, the N+1 equipment may be stored in an evaluated storage location capable of withstanding historical extreme weather conditions such that the equipment is deployable.

2. 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.).

On page 22 of the Integrated Plan, in the section describing PWR portable equipment phase 2 for core cooling and heat removal, the licensee stated that portable equipment required to implement FLEX strategies will be maintained in heated storage locations. This statement is also referenced in the Integrated Plan in the section describing the spent fuel pool cooling strategies and for the FLEX generator.

On page 38 of the Integrated Plan, in the section regarding the strategies for maintaining RCS inventory control, the licensee stated that storage/protection of equipment from snow, ice, and extreme cold would be provided in the Auxiliary Building which is climate controlled.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to protection of equipment if these requirements are implemented as described.

3.1.4.2 Deployment of FLEX Equipment – Snow, Ice, and Extreme Cold Hazard

NEI 12-06, Section 8.3.2 states:

> There are a number of considerations that apply to the deployment of FLEX equipment for snow, ice, and extreme cold hazards:
>
> 1. The FLEX equipment should be procured to function in the extreme conditions applicable to the site. Normal safety-related design limits for outside conditions may be used, but consideration should also be made for any manual operations required by plant personnel in such conditions.
>
> 2. For sites exposed to extreme snowfall and ice storms, provisions should be made for snow/ice removal, as needed to obtain and transport equipment from storage to its location for deployment.
>
> 3. For some sites, the ultimate heat sink and flow path may be affected by extreme low temperatures due to ice blockage or formation of frazil ice. Consequently, the evaluation should address the effects of such a loss of the UHS on the deployment of FLEX equipment. For example, if UHS water is to be used as a makeup source, some additional measures may need to be taken to assure that the FLEX equipment can utilize the water.

With regard to consideration 1 above, the licensee stated on page 13 of the Integrated Plan that equipment associated with the FLEX strategies will be procured as commercial grade equipment with design, storage, maintenance, testing and configuration control in accordance with NEI 12-06, Section 11.0. (Section 11.2 addresses design of equipment to meet adverse conditions.)

On page 23 of the Integrated Plan in the section regarding core cooling and heat removal, the licensee stated normal plant maintenance will mitigate deployment concerns in icy and/or snow conditions. This plan of action addresses consideration 2 above. In the response to the audit process, the licensee further stated that the Callaway site will have snow and debris removal equipment available and that equipment will be stored in areas protected from the hazards. With regard to consideration 3 above, the licensee's audit response also stated that adequate equipment will be available on site to break up any ice impediments at the UHS to provide access to water.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to deployment if these requirements are implemented as described.

3.1.4.3 Procedural Interfaces – Snow, Ice, and Extreme Cold Hazard

NEI 12-06, Section 8.3.3, states:

> The only procedural enhancements that would be expected to apply involve addressing the effects of snow and ice on transporting the FLEX equipment. This includes both access to the transport path, e.g., snow removal, and appropriately equipped vehicles for moving the equipment.

The Integrated Plan did not specifically address procedures relative to snow, ice and extreme cold but the issue was addressed in the licensee's response to the audit process. The licensee stated that FLEX guideline procedures will be developed to address "Freeze Protection of Portable Equipment, Hose, Connections, etc." That information and the previous discussion of deployment equipment plans provide reasonable assurance that the consideration noted above will be addressed for site procedures.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to procedural interfaces if these requirements are implemented as described.

3.1.4.4 Considerations in Using Offsite Resources – Snow, Ice, and Extreme Cold Hazard

NEI 12-06, Section 8.3.4, states:

> Severe snow and ice storms can affect site access and can impact staging areas for receipt of off-site material and equipment.

On page 13 of the Integrated Plan, in the section regarding the RRC plan, the licensee stated that the industry will establish two RRCs to support utilities during a BDBEE scenario as outlined in NEI 12-06. Equipment will be moved from an RRC to a local Assembly Area, established by the SAFER team and the utility.

Information provided by the licensee and discussed in Section 3.1.3.4 of this report described the licensee's plan to have an offsite staging area 25 miles from the site and that if necessary, equipment could be airlifted to the site. In addition, the licensee has described the onsite equipment available to remove snow and debris and to position the arriving phase 3 equipment once it arrives at the site.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to offsite resources if these requirements are implemented as described.

3.1.5 High Temperatures

NEI 12-06, Section 9 states:

> All sites will address high temperatures. Virtually every state in the lower 48 contiguous United States has experienced temperatures in excess of 110˚F. Many states have experienced temperatures in excess of 120˚F.
>
> In this case, sites should consider the impacts of these conditions on deployment of the FLEX equipment.

On page 5 of the Integrated Plan in the section regarding the determination of applicable extreme external hazards, the licensee stated that based on the available local data and industry estimates, the Callaway Plant site does not experience extreme high temperatures. However, per NEI 12-06, all sites will address high temperatures. Therefore, for FLEX equipment, the Callaway Plant will consider the site maximum expected temperatures in their specification, storage, and deployment requirements, including ensuring adequate ventilation or supplementary cooling, if required.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to screening if these requirements are implemented as described.

3.1.5.1 Protection of FLEX Equipment – High Temperature Hazard

NEI 12-06, Section 9.3.1, states:

> The equipment should be maintained at a temperature within a range to ensure its likely function when called upon.

On page 22 of the Integrated Plan regarding the strategies for maintaining core cooling in the transition phase (phase 2), the licensee addressed the storage/protection of equipment from high temperature hazard by stating that all of the storage locations will be evaluated for high temperature effects. The licensee also stated that ventilation will be provided as required to assure there are no adverse effects on the FLEX equipment. Similar statements are provided for the transition phase for RCS inventory control, SFP cooling, and safety function support.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect equipment protection if these requirements are implemented as described.

3.1.5.2 Deployment of FLEX Equipment – High Temperature Hazard

NEI 12-06, Section 9.3.2 states:

> The FLEX equipment should be procured to function, including the need to move the equipment, in the extreme conditions applicable to the site. The potential impact of high temperatures on the storage of equipment should also be considered, e.g., expansion of sheet metal, swollen door seals, etc. Normal safety-related design limits for outside conditions may be used, but consideration should also be made for any manual operations required by plant personnel in such conditions.

There was insufficient information provided in the Integrated Plan to demonstrate that high temperature was addressed for the deployment of equipment per the guidance of the NEI 12-06 Section 9.3.2 consideration noted above. However, the licensee addressed this issue during the audit process by stating that the potential impact of high temperatures, such as thermal expansion, will be addressed in the design and construction of the storage facilities.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect deployment if these requirements are implemented as described.

3.1.5.3 Procedural Interfaces - High Temperature Hazard

NEI 12-06, Section 9.3.3 states:

> The only procedural enhancements that would be expected to apply involve addressing the effects of high temperatures on the portable equipment.

On page 13 of the Integrated Plan in the section describing how the programmatic controls will be met, the licensee stated that equipment associated with these strategies will be procured as commercial equipment with design, storage, maintenance, testing, and configuration control as outlined in NEI 12-06 section 11.0.

The NEI section referenced above includes the guidance "When specifying portable equipment, the capacities should ensure that the strategy can be effective over a range of plant and environmental conditions." The licensee's plan for procedural interfaces in the context of high temperatures provides reasonable assurance that guidance and strategies developed following the licensee's plan will conform to the guidance in the consideration above.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to procedural interfaces if these requirements are implemented as described.

3.2 PHASED APPROACH

Attachment (2) to Order EA-12-049 describes the three-phase approach required for mitigating beyond-design-basis external events in order to maintain or restore core cooling, containment and spent fuel pool cooling capabilities. The phases consist of an initial phase using installed equipment and resources, followed by a transition phase using portable onsite equipment and consumables and a final phase using offsite resources.

To meet these EA-12-049 requirements, Licensees will establish a baseline coping capability to prevent fuel damage in the reactor core or spent fuel pool and to maintain containment capabilities in the context of a beyond-design-basis external event that results in the loss of all ac power, with the exception of buses supplied by safety-related batteries through inverters, and loss of normal access to the UHS.

As discussed in NEI 12-06, Section 1.3, plant specific analysis will determine the duration of each phase.

3.2.1 RCS Cooling and Heat Removal, and RCS Inventory Control Strategies

NEI 12-06, Table 3-2 and Appendix D summarize one acceptable approach for the reactor core cooling strategies. This approach uses the installed auxiliary feedwater (AFW)/emergency feedwater (EFW) system to provide steam generator (SG) makeup sufficient to maintain or restore SG level in order to continue to provide core cooling for the initial phase. This approach relies on depressurization of the SGs for makeup with a portable injection source in order to provide core cooling for the transition and final phases. This approach accomplishes reactor coolant system (RCS) inventory control and maintenance of long term subcriticality through the use of low leakage reactor coolant pump (RCP) seals and/or borated high pressure RCS makeup with a letdown path.

As described in NEI 12-06, Section 3.2.1.7 and JLD-ISG-2012-01, Section 2.1, strategies that have a time constraint to be successful should be identified and a basis provided that the time can be reasonably met. NEI 12-06, Section 3 provides the performance attributes, general criteria, and baseline assumptions to be used in developing the technical basis for the time constraints. Since the event is a beyond-design-basis event, 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 3.2.1.4 describes boundary conditions for the reactor transient.

Acceptance criteria for the analyses serving as the technical basis for establishing the time constraints for the baseline coping capabilities described in NEI 12-06, which provide an acceptable approach, as endorsed by JLD-ISG-2012-01, to meeting the requirements of EA-12-049 for maintaining core cooling are 1) the preclusion of core damage as discussed in NEI 12-06, Section 1.3 as the purpose of FLEX; and 2) prevention of recriticality as discussed in Appendix D, Table D-1.

During the NRC audit process, the licensee was asked to discuss their position regarding recommendations listed in WCAP-17601, Section 3.1. These recommendations address the following subjects for consideration in developing FLEX strategies:

(1) Initiation of cooldown,
(2) Development of inventory coping time,
(3) Instrumentation required for attaining core cooling,
(4) Sub-criticality study,

(5) Maintaining adequate shutdown margin by various sources,
(6) The use of safe shutdown (SSD)/low leakage seal,
(7) Feedwater interruption times,
(8) Feeding a single SG,
(9) Prevention of nitrogen injection from accumulators, and
(10) Cooldown limits on SGs.

The licensee addressed each of the subjects above during the audit process. The licensee stated that all recommendations with the exception of number 8 were applicable to the FLEX strategies at the Callaway Plant. With regard to number 8, the licensee stated that because the Callaway plant will perform a symmetric cooldown using all four loops, the strategy of feeding a single steam generator was not applicable. The licensee's response to the audit process referenced numerous documents where detailed information could be found clarifying the rational for applicability of the subjects above, how the recommendations were considered in the ELAP analysis and how the recommendations are to be implemented.

Specifically regarding item (9) in the above list, the licensee stated during the audit that the methodology for analyzing the accumulators to ensure that nitrogen injection would be prevented during an ELAP event had not been completed. Successful completion of this analysis is identified as Confirmatory Item 3.2.1.A in Section 4.2 below.

Based upon a review of the integrated plan submittal, the NRC staff questioned whether the potential failure of the non-safety-related portion of the turbine-driven AFW pump recirculation header piping could (1) affect the quantity of condensate required for secondary makeup or (2) result in accumulation of water in the CST pipe chase. During the audit, the licensee stated that this recirculation line is being evaluated for manual isolation as part of the FLEX strategy. Successful completion of this evaluation is identified as Confirmatory Item 3.2.1.B in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Items, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect the Westinghouse recommendations discussed above if these requirements are implemented as described.

3.2.1.1. Computer Code Used for ELAP Analysis.

NEI 12-06, Section 1.3 states:

> To the extent practical, generic thermal hydraulic analyses will be developed to support plant specific decision-making. Justification for the duration of each phase will address the on-site availability of equipment, the resources necessary to deploy the equipment consistent with the required timeline, anticipated site conditions following the beyond-design-basis external event, and the ability of the local infrastructure to enable delivery of equipment and resources from offsite.

It was not clear from the information provided in the Integrated Plan what computer codes and thermal-hydraulic analyses were utilized as the basis for the plant specific decision making. The licensee responded to questions from the NRC staff during the audit process related to the issue of computer codes used for ELAP analyses and core cooling by explaining that TR-FSE-13-4, Appendix C, provides timing and deployment timelines and the corresponding actions and the safety functions. From the review of that document, it appears likely that the generic Westinghouse calculations with the NOTRUMP code informed the development of the integrated plan for Callaway. Although NOTRUMP has been reviewed and approved for performing small break LOCA analysis for PWRs, the NRC staff had not previously examined its technical adequacy for simulating an ELAP event. In particular, the ELAP scenario is differentiated from typical design-basis small-break LOCA scenarios in several key respects, including the absence of normal emergency core cooling system (ECCS) injection and the substantially reduced leakage rate, which places significantly greater emphasis on the accurate prediction of primary-to-secondary heat transfer, natural circulation, and two-phase flow within the RCS. As a result of these differences, concern arose associated with the use of the NOTRUMP code for ELAP analysis for modeling of two-phase flow within the RCS and heat transfer across the steam generator tubes as single-phase natural circulation transitions to two-phase flow and the reflux condensation cooling mode. This concern resulted in the following Confirmatory Item:

> Reliance on the NOTRUMP code for the ELAP analysis of Westinghouse plants is limited to the flow conditions prior to reflux condensation initiation. This includes specifying an acceptable definition for reflux condensation cooling. This is identified as Confirmatory Item 3.2.1.1.A in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to the computer codes used to perform ELAP analysis if these requirements are implemented as planned.

3.2.1.2 Reactor Coolant Pump Seal Leakage Rates

NEI 12-06, Section 1.3 states:

> To the extent practical, generic thermal hydraulic analyses will be developed to support plant specific decision-making. Justification for the duration of each phase will address the on-site availability of equipment, the resources necessary to deploy the equipment consistent with the required timeline, anticipated site conditions following the beyond-design-basis external event, and the ability of the local infrastructure to enable delivery of equipment and resources from offsite.

During an ELAP, cooling to the reactor coolant pump (RCP) seal packages will be lost and water at high temperatures may degrade seal materials leading to excess seal leakage from the RCS. Without ac power available to the ECCS, inadequate core cooling may eventually result from the leakage out of the seals. The ELAP analysis credits operator actions to align the high pressure RCS makeup sources and replenish the RCS inventory in order to ensure the core is covered with water, thus precluding inadequate core cooling. The amount of high pressure RCS makeup needed is mainly determined by the seal leakage rate, therefore the seal leakage rate is of primary importance in an ELAP analysis as greater values of the leakage rates will result in a shorter time period for the operator action to align the high pressure RCS makeup water sources.

The licensee provided a sequence of events (SOE) in their Integrated Plan, which included the time constraints and their technical basis. The SOE is based on an analysis using specific RCP seal leakage rates. The issue of RCP seal leakage rates was identified as a Generic Concern and addressed by NEI in the following submittals:

- WCAP-17601-P, Revision 1, “Reactor Coolant System Response to the Extended Loss of AC Power Event for Westinghouse, Combustion Engineering and Babcock & Wilcox NSSS Designs” dated January 2013 (ADAMS Accession No. ML13042A011 and ML13042A013 (Non-Publically Available)).
- A position paper dated August 16, 2013, entitled “Westinghouse Response to NRC Generic Request for Additional Information (RAI) on Reactor coolant (RCP) Seal Leakage in Support of the Pressurized Water reactor Owners Group (PWROG)” (ADAMS Accession No. ML13190A201 (Non-Publically Available)).

After review of these submittals, the U.S. NRC staff has placed certain limitations for Westinghouse Designed Plants. Those limitations and their corresponding Confirmatory Item numbers for this TER are provided as follows:

(1) For the plants using Westinghouse RCPs and seals that are not the SHIELD shutdown seals, the RCP seal initial maximum leakage rate should be greater than or equal to the upper bound expectation for the seal leakage rate for the ELAP event (21 gpm/seal) discussed in the PWROG white paper addressing the RCP seal leakage for Westinghouse plants. If the RCP seal leakage rates used in the plant-specific ELAP analyses are less than the upper bound expectation for the seal leakage rate discussed in the whitepaper, justification should be provided. If the seals are changed to non-Westinghouse seals, the acceptability of the use of non-Westinghouse seals should be addressed, and the RCP seal leakage rates for use in the ELAP analysis should be provided with acceptable justification. As indicated in the licensee's Integrated Plan and response to the audit process, Callaway will use SHIELD seals. Therefore, this issue is not applicable to Callaway.

(2) In some plant designs, such as those with 1200 to 1300 psia SG design pressures and no accumulator backing of the main steam system power-operated relief valve (PORV) actuators, the cold legs could experience temperatures as high as 580 ^{0}F before cooldown commences. This is beyond the qualification temperature (550 ^{0}F) of the O-rings used in the RCP seals. Regarding Callaway, during the audit process, the licensee indicated that a symmetrical cooldown maintaining the cold leg temperature below 550 °F would ensure that the qualification temperature of the O-rings was not exceeded. However, the licensee also stated that the lift setpoint of the steam generator atmospheric steam dumps is 1140 psia, which corresponds to a saturation temperature of approximately 561 °F. Based on this information, it is not clear that delaying an RCS cooldown for 12 hours is appropriate. Therefore, for Callaway and other Westinghouse designs, a discussion of the information (including the applicable analysis and relevant seal leakage testing data) will need to be reviewed to justify that (1) the integrity of the associated O-rings will be maintained at the temperature conditions experienced during the ELAP event, and (2) the seal leakage rate used in the ELAP is adequate and acceptable. The PWROG is working on these issues and will submit the NRC position papers to the NRC that will contain test data regarding the maximum seal leakage rates of Westinghouse traditional and SHIELD seals, and Flowserve seals at higher cold-leg temperatures. The NRC will review the position papers upon their receipt. As such, resolution of this concern is identified as Open Item 3.2.1.2.B in Section 4.1 below.

(3) Some Westinghouse plants have installed or will install the SHIELD shutdown seals, or

other types of low leakage seals, and have credited or will credit a low seal leakage rate (e.g., 1 gpm/seal) in the ELAP analyses for the RCS response. For those plants, information should be provided to address the impacts of the Westinghouse 10 CFR Part 21 report, "Notification of the Potential Existence of Defects Pursuant to 10 CFR Part 21," dated July 26, 2013 (ADAMS No. ML13211A168) on the use of the low seal leakage rate in the ELAP analysis. This is identified as Confirmatory Item 3.2.1.2.C in Section 4.2 below.

(4) If the seals are changed to the newly designed SHIELD seals, or non-Westinghouse seals, the acceptability of the use of the newly designed Generation 3 SHIELD seals, or non-Westinghouse (Flowserve) seals should be addressed, and the RCP seal leakages rates for use in the ELAP analysis should be provided with acceptable justification. The PWROG is working on these issues and will submit to the NRC position papers that will contain test data regarding the maximum seal leakage rates of SHIELD seals and Flowserve seals. The NRC will review the position papers when receives them. As such, resolution of this concern is identified as Open Item 3.2.1.2.D in Section 4.1 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory/Open Items, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to reactor coolant pump seals if these requirements are implemented as described.

3.2.1.3 Decay Heat

NEI Section 3.2.1.2 states in part:

> The initial plant conditions are assumed to be the following:
>
> (1) Prior to the event the reactor has been operating at 100 percent rated thermal power for at least 100 days or has just been shut down from such a power history as required by plant procedures in advance of the impending event.

On page 5 of the Integrated Plan, item A1 stated the plant is assumed to be operating at full power at the start of the event. On pages 15, 16, and 17 of the Integrated Plan describing phase 1 core cooling and heat removal, and on page 19 of the plan describing phase 2 core cooling and heat removal, the licensee describes the sequence of actions to be taken to provide cooling water to the core following an ELAP event. However, no discussion regarding decay heat modeling was provided. During the NRC audit process the licensee was requested to provide the following information: Address the applicability of assumption 4 on page 4-13 of WCAP-17601, which states that "Decay heat is per ANS 5.1-1979 + 2 sigma, or equivalent." If the ANS 5.1-1979 + 2 sigma model is used in the ELAP analysis, specify the values of the following key parameters used to determine the decay heat: (1) initial power level, (2) fuel enrichment, (3) fuel burnup, (4) effective full power operating days per fuel cycle, (5) number of fuel cycles, if hybrid fuels are used in the core, and (6) fuel characteristics based on the beginning of the cycle, middle of the cycle, or end of the cycle. Address the adequacy of the values used. If the different decay heat model is used, describe the specific model and address the acceptability of the model and the analytical results.

In response to the NRC request, the licensee stated that the information requested was available in their reference document TR-FSE-13, Callaway Plant Specific Evaluation of Significant PWROG Generic NSSS Parameters Supporting FLEX Integrated Plan, Revision 0, Table C-4. Although the referenced Table C-4 did identify that the ANS 5.1-1979 +2 sigma model would be used, the other information requested in the audit process (items 1 through 6 above) were not presented in that Table. Providing the additional information is identified as Open Item 3.2.1.3.A in Section 4.1 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Open Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to decay heat removal if these requirements are implemented as described.

3.2.1.4 Initial Values for Key Plant Parameters and Assumptions

NEI 12-06, Section 3.2 provides a series of assumptions to which initial key plant parameters (core power, RCS temperature and pressure, etc.) should conform. When considering the code used by the licensee and its use in supporting the required event times for the SOE, it is important to ensure that the initial key plant parameters not only conform to the assumptions provided in NEI 12-06, Section 3.2, but that they also represent the starting conditions of the code used in the analyses and that they are included within the code's range of applicability.

On pages 5 and 6 of the licensee's Integrated Plan, the licensee listed their initial plant conditions and initial conditions for Callaway. The list conformed to the guidance of NEI 12-06 Section 3.2.1.2. In addition, the list is consistent with the initial conditions listed in WCAP-17601-P. The licensee stated on page 91, in Attachment 1B, NSSS Significant Reference Analysis Reconciliation Table, that there are no deviations from the WCAP-17601-P, Revision 1.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to initial conditions if these requirements are implemented as described.

3.2.1.5 Monitoring Instrumentation and Controls

NEI 12-06, Section 3.2.1.10 states in part:

> The parameters selected must be able to demonstrate the success of the strategies at maintaining the key safety functions as well as indicate imminent or actual core damage to facilitate a decision to manage the response to the event within the Emergency Operating Procedures and FLEX Support Guidelines or within the severe accident management guidelines (SAMGs). Typically these parameters would include the following:
>
> - SG Level
> - SG Pressure
> - RCS Pressure
> - RCS Temperature
> - Containment Pressure
> - SFP Level

> The plant-specific evaluation may identify additional parameters that are needed in order to support key actions identified in the plant procedures/guidance or to indicate imminent or actual core damage

On pages 18, and again on pages 20 and 21 of the Integrated Plan, the licensee provides the following list of instrumentation to support phase 1 and phase 2 coping strategies for maintaining core cooling and heat removal:

1. SG Level – Normal Power Source: Class 1E; Long-Term Power Source: Temporary DG
2. AFW Flow indication (downstream of connection points) – Normal Power Source: Class 1E; Long-Term Power Source: Temporary DG
3. SG Pressure – Normal Power Source: Class 1E; Long-Term Power Source: Temporary DG
4. CST Level – Normal Power Source: Non-Class 1-E; a temporary battery will be used to repower the non-Class 1E racks ([Licensee identified] Open Item OI4)
5. RCS Hot Leg Temperature (if CETs not available)– Normal Power Source: Class 1E; Long-Term Power Source: Temporary DG
6. RCS Cold Leg Temperature – Normal Power Source: Class 1E; Long-Term Power Source: Temporary DG
7. Core Exit Thermocouple – Normal Power Source: Class 1E; Long- Term Power Source: Temporary DG
8. RCS Pressure – Normal Power Source: Class 1E; Long-Term Power Source: Temporary DG
9. Pressurizer Level – Normal Power Source: Class 1E; Long-Term Power Source: Temporary DG

Similar lists are provided on pages 33, 36, 37, 42 and 43 for instrumentation to support safety functions. In addition, the licensee stated that Callaway Plant will develop procedures to read this instrumentation locally, where applicable, using a portable instrument, as required by Section 5.3.3 of NEI 12-06.

Also, there is a licensee identified open item on page 84 of the Integrated Plan related to those instrument lists. The licensee states that for non-Class 1E instrumentation that will be repowered using a temporary battery, an analysis will need to be performed to determine battery life and frequency of replacing battery.

The Integrated Plan did not address whether instrumentation credited in the ELAP analysis for automatic actuations and for indications required for the operators to take action are reliable and accurate in the containment harsh conditions. The licensee responded to this question in the audit process by pointing out that the licensee's self identified open item related to the containment environment (OI 2) addresses this issue. The licensee also stated that Westinghouse will be asked to perform a GOTHIC analysis of the containment to demonstrate that acceptable temperature and pressure levels will not be exceeded. Demonstration of these acceptable temperature and pressure levels is identified as Confirmatory Item 3.2.1.5.A in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to monitoring if these requirements are implemented as described.

3.2.1.6 Sequence of Events

NEI 12-06, Section 3.2.1.7, Item 6) states:

> Strategies that have a time constraint to be successful should be identified and a basis provided that the time can reasonably be met.

NEI 12-06, Section 3.2.2 addresses the minimum baseline capabilities:

> Each site should establish the minimum coping capabilities consistent with unit-specific evaluation of the potential impacts and responses to an ELAP and LUHS. In general, this coping can be thought of as occurring in three phases:
>
> - Phase 1: Cope relying on installed plant equipment.
> - Phase 2: Transition from installed plant equipment to on-site FLEX equipment.
> - Phase 3: Obtain additional capability and redundancy from off-site equipment until power, water, and coolant injection systems are restored or commissioned.

The Sequence of Events is discussed on pages 9, 10 and 11 of the Integrated Plan and on Attachment 1A on pages 87 through 90. As discussed in detail in Section 3.2.1.1 of this report, there are unresolved issues regarding the thermal-hydraulic analyses utilized in the development of this timeline and the reviewer understands that changes in the analyses results could have an impact on the timeline. The thermal-hydraulic analyses issue is previously identified as Confirmatory Item 3.2.1.1.A.

On page 11 of the Integrated Plan, following the sequence of events listed, the licensee stated that to confirm the times given, the licensee will prepare procedures for each task, perform time study walkthroughs for each of the tasks under simulated ELAP conditions, and account for equipment and tagging and other administrative procedures required to perform the task. This final confirmation process by the licensee is identified as Confirmatory Item 3.2.1.6.A in Section 4.2 below.

On page 10 of the Integrated Plan, in the sequence of events list, item 9 describes the plant cooldown. The plant cooldown will begin within 8 hours and will have a duration of 4 hours. The atmospheric relief valves (ARVs) and the turbine driven auxiliary feedwater pump (TDAFWP) will be used for symmetric plant cooldown. On page 16 of the Integrated Plan, the licensee stated that a secondary nitrogen source would be installed to facilitate repositioning of the TDAFW flow control valves. On page 17 of the Integrated Plan, the licensee stated that the Callaway Plant is designing a modification that will supplement the existing backup nitrogen capacity for the ARVs. This strategy was refined in the 6-month update. The new strategy is to use an air compressor rather than a backup nitrogen supply. The licensee's response to the audit process provided further clarification. The licensee stated that a single air compressor would be capable of providing air for the TDAFW control valves and ARVs. In addition, the licensee stated that the air compressor would be located in the Auxiliary Building which is a safety-related structure, and would be powered from FLEX generators.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to the sequence of events if these requirements are implemented as described.

3.2.1.7 Cold Shutdown and Refueling

NEI 12-06 Table 1–1, lists the coping strategy requirements as presented in Order EA-12-049. Item (4) of that list states:

> Licensee or CP holders must be capable of implementing the strategies in all modes.

The generic concern related to shutdown and refueling requirements is applicable to Callaway. This generic concern has been resolved generically through the NRC endorsement of Nuclear Energy Institute (NEI) position paper entitled "Shutdown/Refueling Modes" (ADAMS Accession No. ML13273A514); and has been endorsed by the NRC in a letter dated September 30, 2013 (ADAMS Accession No. ML13267A382).

The position paper describes how licensees will, by procedure, maintain equipment available for deployment in shutdown and refueling modes. The NRC staff concluded that the position paper provides an acceptable approach for demonstrating that the licensees are capable of implementing mitigating strategies in all modes of operation. The NRC staff will evaluate the licensee's resulting program through the audit and inspection process.

The licensee has informed the NRC of their plans to abide by this generic resolution in the response to the audit process. They noted that the site corrective action program is tracking this issue to completion.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to cold shutdown and refueling if these requirements are implemented as described.

3.2.1.8 Core Sub-Criticality

NEI 12-06 Table 3-2 states in part that:

> All plants provide means to provide borated RCS makeup.

On page 10 of the integrated report, in the section regarding the timeline events, the licensee stated that a plant cooldown will begin within 8 hours and will have a duration of 4 hours. The ARVs and the TDAFWP will be used to ensure a symmetric plant cooldown. Actual cooldown time is projected to be approximately 1.5 hours but 4 hours is assumed because local AFW and ARV control is required.

Depressurization of the RCS will result in a decrease in loss of the RCS inventory from RCP seal leakage, and in turn, an increase in available time for the operator to take action and maintain the core covered with water. In the presence of a negative moderator temperature coefficient, the cooldown by steaming through the atmospheric dump valves (ADVs) increases positive reactivity in the core. If the control rod worth from the inserted control rods following a reactor trip and the boron concentration from the accumulators and other sources of makeup is not sufficient to overcome the positive reactivity addition from the cooldown, the reactor will return to power. As a result of the power increase and RCS pressure decrease, the calculated departure from nucleate boiling ratio (DNBR) may decrease, possibly causing fuel damage.

On page 35 of the Integrated Plan, the licensee stated that the phase 2 activities for RCS inventory control involve aligning the high pressure electric RCS pump to provide borated coolant for RCS makeup and to maintain the reactor subcritical. To ensure that the core is maintained subcritical, borated injection to the RCS is provided from the boric acid tanks via a motor-driven pump stored and staged in the auxiliary building. This injection also compensates for RCS leakage and contraction, enabling refill of the RCS and eventually reestablishing level in the pressurizer.

The licensee provided information during the audit regarding the quantity of borated coolant and the timing of its injection to maintain the core in a subcritical state. However, the basis for the quantity and timing of the borated coolant injection was not clear. Specifically, it was not clear whether the negative reactivity insertion requirements were derived based on the current fuel cycle, a reference fuel cycle, etc. It was further unclear how the licensee would ensure that the subcriticality requirements for future cores would be bounded. The resolution of these issues is identified as Confirmatory Item 3.2.1.8.A in Section 4.2 below.

The NRC staff reviewed the licensee's Integrated Plan and determined that the Generic Concern associated with the modeling of the timing and uniformity of the mixing of a liquid boric acid solution injected into the reactor coolant system (RCS) under natural circulation conditions potentially involving two-phase flow was applicable to the Callaway site.

The Pressurized Water Reactor Owners Group submitted a position paper, dated August 15, 2013 (withheld from public disclosure due to proprietary content), which provides 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 would occur under conditions similar to those for which boric acid mixing data is available. The NRC staff concluded that the August 15, 2013, position paper was not adequately justified and has not endorsed this position paper. As such, resolution of this concern for the Callaway site is identified as Open Item 3.2.1.8.B in Section 4.1 below.

The licensee's approach described above, as currently understood, has raised concerns which must be addressed before confirmation can be provided that the Integrated Plan is consistent with the guidance found in NEI 12-06, such that there would be reasonable assurance that the requirements of Order EA-12-049 will be met with respect to core sub-criticality. These questions are identified as an Open and a Confirmatory Item above and in Section 4.1 and 4.2 below.

3.2.1.9 Use of Portable Pumps

NEI 12-06, Section 3.2.2, Guideline (13), states in part:

> Regardless of installed coping capability, all plants will include the ability to use portable pumps to provide RPV/RCS/SG [reactor pressure vessel/reactor coolant system/steam generator] makeup as a means to provide diverse capability

> beyond installed equipment. The use of portable pumps to provide RPV/RCS/SG makeup requires a transition and interaction with installed systems. For example, transitioning from reactor core isolation cooling (RCIC) to a portable FLEX pump as the source for RPV makeup requires appropriate controls on the depressurization of the RPV and injection rates to avoid extended core uncovery. Similarly, transition to a portable pump for SG makeup may require cooldown and depressurization of the SGs in advance of using the portable pump connections. Guidance should address both the proactive transition from installed equipment to portable and reactive transitions in the event that installed equipment degrades or fails. Preparations for reactive use of portable equipment should not distract site resources from establishing the primary coping strategy. In some cases, in order to meet the time-sensitive required actions of the site-specific strategies, the FLEX equipment may need to be stored in its deployed position.

NEI 12-06 Section 11.2 states in part:

> Design requirements and supporting analysis should be developed for portable equipment that directly performs a FLEX mitigation strategy for core, containment, and SFP that provides the inputs, assumptions, and documented analysis that the mitigation strategy and support equipment will perform as intended.

On page 19 of the Integrated Plan in the section describing the phase 2 core cooling, the licensee stated that the transition into Phase 2 will be required once the operating conditions of the TDAFWP cannot be maintained. The primary and secondary strategies involve staging the FLEX core cooling pump. The FLEX core cooling pump will draw from the CST. On page 35 of the Integrated Plan in the section discussing the strategy for maintaining RCS inventory control during the transition phase the licensee describes the utilization of a portable electric pump for strategy implementation. On page 54, the licensee identifies the use of a portable SFP pump for phase 2 strategies. These sections of the Integrated Plan demonstrate conformance with the guidance of NEI 12-06 Section 3.2.2, Guideline 13 with regard to using portable pumps to provide makeup as a means to enable diverse capability beyond installed equipment and the transition and interaction with installed systems.

However, the reviewer and the NRC staff identified several questions that were not addressed in the Integrated Plan. These are:

a) There was no discussion of required time (mission time) to deploy the pump strategies and whether or not the mission times were consistent with the ELAP analysis.

b) There was no discussion of the analyses for determining required head and flow capacities required for the pumps.

c) There was no information to demonstrate that the proposed flow and head criteria for the pumps and the mission time identified will be adequate to maintain core cooling, and sub-criticality for phases 2 and 3 of the ELAP.

The licensee responded to these questions during the audit process. The licensee's responses corresponding to the items above are discussed below:

a) The licensee referred to reference document TR-FSE-13-4, Table C-1 to provide mission time information. This table identified the ELAP elapsed time requirement to implement the strategies but did not address the mission time expected to execute the strategy. However, on page 11 of the Integrated Plan, the licensee committed to perform time study walkthroughs for each of the strategy sequence of events tasks to confirm the executions times.

b) The licensee referred to document CN-FSE-12-11 to provide information regarding the analyses used to determine pump flow and head characteristics of the mitigation strategy pumps. The reviewer confirmed that document contained the engineering bases for developing the selection criteria for the pumps based on Callaway's proposed strategy configurations.

c) The licensee referred to reference document TR-FSE-13-4, Table C-4 to provide substantiation that the proposed flow and head criteria for the pumps, and the mission time identified, will be adequate to maintain core cooling and sub-criticality for phases 2 and 3 of the ELAP. The reviewer confirmed that this document identified the phase 2 and 3 mitigation strategy requirements and that it made further reference to additional analysis documents as the basis of conclusions.

The reviewer concluded that for the purposes of this report, the information provided above addressed the questions identified. It is noted that the licensee's completion of the time study walkthroughs for each of the strategy sequence of events tasks to confirm the execution times has been identified previously as Confirmatory Item 3.2.1.6.A in Section 4.2 below

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect the use of portable pumps if these requirements are implemented as described.

3.2.2 Spent Fuel Pool Cooling Strategies

NEI 12-06, Table 3-2 and Appendix D summarize one acceptable approach for the SFP cooling strategies. This approach uses a portable injection source to provide 1) makeup via hoses on the refuel deck/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 alternatively 3) spray via portable monitor nozzles from the refueling deck/floor capable of providing a minimum of 200 gallons per minute (gpm) per unit (250 gpm to account for overspray). This approach will also provide a vent pathway for steam and condensate from the SFP.

As described in NEI 12-06, Section 3.2.1.7 and JLD-ISG-2012-01, Section 2.1, strategies that have a time constraint to be successful should be identified and a basis provided that the time can be reasonably met. NEI 12-06, Section 3 provides the performance attributes, general criteria, and baseline assumptions to be used in developing the technical basis for the time constraints. Since the event is a beyond-design-basis event, the analysis used to provide the technical basis for time constraints for the mitigation strategies may use nominal initial values (without uncertainties) for plant parameters, and best-estimate physics data. All equipment used for consequence mitigation may assume to operate at nominal setpoints and capacities. 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 described in NEI 12-06, which provide an acceptable approach to meeting the requirements of EA-12-049 for maintaining SFP cooling. This criterion is keeping the fuel in the SFP covered.

In the section of the Integrated Plan discussing the spent fuel pool cooling for phase 2, the licensee explained that SFP cooling would be provided using a portable SFP pump and that the pump would draw suction from the RWST. The licensee stated the water supply for SFP cooling involves three connections points, all located on the exterior of the fuel building. The licensee further stated that although the piping inside the fuel building is protected from the hazards, the connection points on the exterior of the fuel building will need to be protected from high wind missile strikes. If protection is not possible, the connection points will need to be relocated to the inside of the building. Because the configuration has not been resolved, this is identified as Confirmatory Item 3.2.2.A in Section 4.2 below.

On page 11 of the integrated report in the section discussing the events timeline, the licensee stated that per the Integrated Plan reference document TR-FSE-13-4, Callaway Plant FLEX Integrated Plan, the SFP water will begin to boil at 5.4 hours after the start of the ELAP event. The reference document also states that the time for the water level to reach 15 ft. above the top of the racks is 48 hours. To preclude uncovering the spent fuel racks, the licensee's plan is to initiate SFP makeup 33 hours following the start of the ELAP event. Although a review of TR-FSE-13-4 identified several instances where the 48 hour boil off time was mentioned as fact, it was not clear from the document what the analytical technical basis was for that time event. The licensee responded to this question in the audit response and stated that Westinghouse is being asked to clarify the basis for the 48 hour boil off time and the resulting information will be provided in a future 6-month update to the Integrated Plan. This is identified as Confirmatory Item 3.2.2.B in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Items, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to equipment deployment if these requirements are implemented as described.

3.2.3 Containment Functions Strategies

NEI 12-06, Table 3-2 and Appendix D provide 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. One of these acceptable approaches is by analysis.

The licensee intends to perform an analysis which demonstrates that the pressure and temperature response of the containment following an ELAP will not challenge the containment limits. Based on the results of this evaluation, required actions to ensure maintenance of containment integrity and required instrument function will be developed.

On page 45, 47 and again on page 49 of the Integrated Plan in the sections regarding phase 1, 2, and 3 strategies for maintaining containment, the licensee stated that containment pressure and temperature are expected to increase during an ELAP due to loss of containment cooling and RCS leakage into containment. The licensee further stated that with the installation of the low leakage RCP shutdown seals, the pressure and temperature are not expected to rise to levels that could challenge the containment structure. The licensee explained that to validate this expectation, a containment evaluation, using GOTHIC, will be performed based on the boundary conditions described in Section 2 of NEI 12-06, and based on the results of this evaluation, required actions to ensure maintenance of containment integrity and required instrument function will be developed. The licensee discussed this issue in the audit response and stated that a detailed discussion of the GOTHIC analysis will be provided in a future 6-month update to address containment cooling during an ELAP event. This is identified as Confirmatory Item 3.2.3.A in Section 4.2 below. (Note: This containment evaluation is likely dependent on the resolution of the Open and Confirmatory Items specified in Section 3.2.1.2, "Reactor Coolant Pump Seal Leakage Rates".)

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to containment function strategies if these requirements are implemented as described.

3.2.4 Support Functions

3.2.4.1 Equipment Cooling – Cooling Water

NEI 12-06, Section 3.2.2, Guideline (3) states:

> *Plant procedures/guidance should specify actions necessary to assure that equipment functionality can be maintained (including support systems or alternate method) in an ELAP/LUHS or can perform without ac power or normal access to the UHS.*
>
> Cooling functions provided by such systems as auxiliary building cooling water, service water, or component cooling water may normally be used in order for equipment to perform their function. It may be necessary to provide an alternate means for support systems that require ac power or normal access to the UHS, or provide a technical justification for continued functionality without the support system.

In its Integrated Plan, the licensee made no reference regarding the need for, or use of, additional cooling systems necessary to assure that coping strategy equipment functionality can be maintained. Nonetheless, the only portable equipment used for coping strategies identified in the Integrated Plan that would require some form of cooling are portable diesel powered pumps and generators. These self-contained commercially available units would not be expected to require an external cooling system nor would they require AC power or normal access to the UHS.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to cooling water for equipment cooling if these requirements are implemented as described.

3.2.4.2 Ventilation – Equipment Cooling

NEI 12-06, Section 3.2.2, Guideline (10) states in part:

> Plant procedures/guidance should consider loss of ventilation effects on specific energized equipment necessary for shutdown (e.g., those containing internal electrical power supplies or other local heat sources that may be energized or present in an ELAP.
>
> ELAP procedures/guidance should identify specific actions to be taken to ensure that equipment failure does not occur as a result of a loss of forced ventilation/cooling. Actions should be tied to either the ELAP/LUHS or upon reaching certain temperatures in the plant. Plant areas requiring additional air flow are likely to be locations containing shutdown instrumentation and power supplies, turbine-driven decay heat removal equipment, and in the vicinity of the inverters. These areas include: steam driven AFW pump room, ... the control room, and logic cabinets. Air flow may be accomplished by opening doors to rooms and electronic and relay cabinets, and/or providing supplemental air flow.
>
> Air temperatures may be monitored during an ELAP/LUHS event through operator observation, portable instrumentation, or the use of locally mounted thermometers inside cabinets and in plant areas where cooling may be needed. Alternatively, procedures/guidance may direct the operator to take action to provide for alternate air flow in the event normal cooling is lost. Upon loss of these systems, or indication of temperatures outside the maximum normal range of values, the procedures/guidance should direct supplemental air flow be provided to the affected cabinet or area, and/or designate alternate means for monitoring system functions.
>
> For the limited cooling requirements of a cabinet containing power supplies for instrumentation, simply opening the back doors is effective. For larger cooling loads, such as ... AFW pump rooms, portable engine-driven blowers may be considered during the transient to augment the natural circulation provided by opening doors. The necessary rate of air supply to these rooms may be estimated on the basis of rapidly turning over the room's air volume.
>
> Actuation setpoints for fire protection systems are typically at 165-180°F. It is expected that temperature rises due to loss of ventilation/cooling during an ELAP/LUHS will not be sufficiently high to initiate actuation of fire protection systems. If lower fire protection system setpoints are used or temperatures are expected to exceed these temperatures during an ELAP/LUHS, procedures/guidance should identify actions to avoid such inadvertent actuations or the plant should ensure that actuation does not impact long term operation of the equipment.

On page 16 and 17 of the Integrated Plan regarding core cooling and heat removal, the licensee stated that an assessment of room environmental conditions and effects on key equipment was performed and the assessment determined that the near term actions were considered acceptable for 24 hours following a BDBEE scenario as outlined in NEI 12-06. However, the licensee further stated that a future action is required to evaluate coping times beyond 24 hours.

In addition, on page 62 and 65 of the Integrated Plan regarding safety function support, the licensee stated that strategies are being developed for temporary ventilation. On page 53, the licensee stated that an analysis will need to be performed to prove the acceptability of SFP vent capabilities with the roll up door opened. In the response to the audit process, the licensee stated that FLEX guideline procedures will be developed to implement temporary ventilation strategies.

The licensee has also stated during the audit response process that specifics about the plan to develop a battery room ventilation plan have yet to be develop to prevent hydrogen accumulation in phases 2 and 3. The licensee anticipates that detail discussion about this activity will be provided in FSG-5 "Initial Assessment and Flex Equipment Staging". This is identified as Confirmatory Item 3.2.4.2.A in Section 4.2 below.

A discussion is needed specifically on the extreme low temperatures effects of the batteries capability to perform its function for the duration of the ELAP event. This is identified as Confirmatory Item 3.2.4.2.B in Section 4.2 below.

Because the final strategies and procedures to address these ventilation issues are not yet complete, there is insufficient information in the Integrated Plan to demonstrate conformance with the NEI 12-06 Section 3.2.2, Guideline 10. This is identified as Confirmatory Item 3.2.4.2.C in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Items, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to ventilation for equipment cooling if these requirements are implemented as described.

3.2.4.3 Heat Tracing

NEI 12-06, Section 3.2.2, Guideline (12) states:

> *Plant procedures/guidance should consider loss of heat tracing effects for equipment required to cope with an ELAP. Alternate steps, if needed, should be identified to supplement planned action.*
>
> Heat tracing is used at some plants to ensure cold weather conditions do not result in freezing important piping and instrumentation systems with small diameter piping. Procedures/guidance should be reviewed to identify if any heat traced systems are relied upon to cope with an ELAP. For example, additional condensate makeup may be supplied from a system exposed to cold weather where heat tracing is needed to ensure control systems are available. If any such systems are identified, additional backup sources of water not dependent on heat tracing should be identified.

The licensee did not address the loss of heat tracing in the Integrated Plan. However, in the response to the audit process, the licensee stated that FLEX guidance procedures will be developed to address portable equipment, hoses, connection, etc., with regard to freeze protection.

In addition, with regard to the need for boric acid line heat tracing, the licensee made reference to information in the FSAR stating that all portions of the chemical and volume control system (CVCS) system that normally contain concentrated boric acid solution are located within a heated building. The potential for crystallization of boric acid solution, and therefore the potential need for heat tracing on CVCS lines is still not addressed for long periods of time during the ELAP event scenarios. The licensee addressed this issue in the response to the audit process by stating that additional work is required on this subject to ensure that the potential boron solidification is addressed.

The issues above associated with freeze protection and boric acid precipitation are identified as Confirmatory Item 3.2.4.3.A, in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to heat tracing if these requirements are implemented as described.

3.2.4.4 Accessibility – Lighting and Communications

NEI 12-06, Section 3.2.2, Guideline (8) states:

> *Plant procedures/guidance should identify the portable lighting (e.g., flashlights or headlamps) and communications systems necessary for ingress and egress to plant areas required for deployment of FLEX strategies.*
>
> Areas requiring access for instrumentation monitoring or equipment operation may require portable lighting as necessary to perform essential functions.
>
> Normal communications may be lost or hampered during an ELAP. Consequently, in some cases, portable communication devices may be required to support interaction between personnel in the plant and those providing overall command and control.

It was not clear from the review of the licensee's Integrated Plan that the use of portable lighting to support FLEX strategy implementation had been addressed. The licensee discussed this issue in the response to the audit process by stating that temporary lighting will be utilized and that procedures are being developed to address the locations and use of temporary lighting. This has been identified as Confirmatory Item 3.2.4.4.A in section 4.2 below.

The NRC staff has reviewed the licensee communications assessment (ML12305A426 and ML13056A599) in response to the March 12, 2012 50.54(f) request for information letter for DNPS and, as documented in the staff analysis (ML13130A089) has determined that the assessment for communications is reasonable, and the analyzed existing systems, proposed enhancements, and interim measures will help to ensure that communications are maintained. Therefore, there is reasonable assurance that the guidance and strategies developed by the licensee will conform to the guidance of NEI 12-06 Section 3.2.2, Guideline (8) regarding communications capabilities during an ELAP. This has been identified as Confirmatory Item 3.2.4.4.B in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the

guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Items, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect accessibility with regard to lighting and communications if these requirements are implemented as described.

3.2.4.5 Protected and Internal Locked Area Access

NEI 12-06, Section 3.2.2, Guideline (9) states:

> *Plant procedures/guidance should consider the effects of ac power loss on area access, as well as the need to gain entry to the Protected Area and internal locked areas where remote equipment operation is necessary.*
>
> At some plants, the security system may be adversely affected by the loss of the preferred or Class 1E power supplies in an ELAP. In such cases, manual actions specified in ELAP response procedures/guidance may require additional actions to obtain access.

The licensee's Integrated Plan did not address protected and internal locked areas. However, the licensee's response to the audit process explained that non-licensed operators are issued appropriate keys to locked areas when they are assigned to the operating crew. In addition, plant security personnel will be utilized during an ELAP event thus providing additional access capability to locked areas.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to access to locked areas if these requirements are implemented as described.

3.2.4.6 Personnel Habitability – Elevated Temperature

NEI 12-06, Section 3.2.2, Guideline (11), states:

> *Plant procedures/guidance should consider accessibility requirements at locations where operators will be required to perform local manual operations.*
>
> Due to elevated temperatures and humidity in some locations where local operator actions are required (e.g., manual valve manipulations, equipment connections, etc.), procedures/guidance should identify the protective clothing or other equipment or actions necessary to protect the operator, as appropriate.
>
> FLEX strategies must be capable of execution under the adverse conditions (unavailability of installed plant lighting, ventilation, etc.) expected following a BDBE resulting in an ELAP/LUHS. Accessibility of equipment, tooling, connection points, and plant components shall be accounted for in the development of the FLEX strategies. The use of appropriate human performance aids (e.g., component marking, connection schematics, installation sketches, photographs, etc.) shall be included in the FLEX guidance implementing the FLEX strategies.

NEI 12-06 Section 9.2 states,

Virtually every state in the lower 48 contiguous United States has experienced temperatures in excess of 110 degrees F. Many states have experienced temperatures in excess of 120 degrees F.

There were several references in the Integrated Plan regarding the need for analyses and procedures to address ventilation of areas such as equipment rooms and the spent fuel pool area. The licensee responded to questions regarding habitability in the response to the audit process and stated that the subject of area ventilation will be addressed in a future 6-month update. This is identified as Confirmatory Item 3.2.4.6.A in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to habitability if these requirements are implemented as described.

3.2.4.7 Water Sources.

NEI 12-06, Section 3.2.2, Guideline (5) states:

Plant procedures/guidance should ensure that a flow path is promptly established for makeup flow to the steam generator/nuclear boiler and identify backup water sources in order of intended use. Additionally, plant procedures/guidance should specify clear criteria for transferring to the next preferred source of water.

Under certain beyond-design-basis conditions, the integrity of some water sources may be challenged. Coping with an ELAP/LUHS may require water supplies for multiple days. Guidance should address alternate water sources and water delivery systems to support the extended coping duration. Cooling and makeup water inventories contained in systems or structures with designs that are robust with respect to seismic events, floods, and high winds, and associated missiles are assumed to be available in an ELAP/LUHS at their nominal capacities. Water in robust UHS piping may also be available for use but would need to be evaluated to ensure adequate NPSH can be demonstrated and, for example, that the water does not gravity drain back to the UHS. Alternate water delivery systems can be considered available on a case-by-case basis. In general, all CSTs should be used first if available. If the normal source of makeup water (e.g., CST) fails or becomes exhausted as a result of the hazard, then robust demineralized, raw, or borated water tanks may be used as appropriate.

Heated torus water [BWR] can be relied upon if sufficient [net positive suction head] NPSH can be established. Finally, when all other preferred water sources have been depleted, lower water quality sources may be pumped as makeup flow using available equipment (e.g., a diesel driven fire pump or a portable pump drawing from a raw water source). Procedures/guidance should clearly specify the conditions when the operator is expected to resort to increasingly impure water sources.

On pages 72 through 76 of the Integrated Plan, the licensee addressed water sources for coping strategies for both borated and nonborated needs. The CST and RWST have been identified as water sources for RCS cooling, RCS inventory control, and SFP cooling. The subject of the CST not presently being seismically qualified has been previously addressed in Section 3.1.1.2 and is identified as Confirmatory Item 3.1.1.2.A in Section 4.2.

On page 26 of the Integrated Plan in the section describing the phase 2 strategy modifications for core cooling, the licensee stated the primary strategy for providing adequate cooling during Modes 5 and 6 will take suction from the new RWST connection on the RWST drain line. The licensee further stated that the RWST is seismically qualified but not missile protected. The licensee has noted a self identified open item stating that the RWST will be missile protected to credit its use in core cooling with SGs not available strategies. Required missile protection of the RWST is identified as Confirmatory Item 3.2.4.7.A in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to water sources if these requirements are implemented as described.

3.2.4.8 Electrical Power Sources/Isolations and Interactions

NEI 12-06, Section 3.2.2, Guideline (13) states in part:

> The use of portable equipment to charge batteries or locally energize equipment may be needed under ELAP/LUHS conditions. Appropriate electrical isolations and interactions should be addressed in procedures/guidance.

On page 64 of the Integrated Plan in the section on safety functions, the licensee stated that the primary electrical need during phase 2 is dc power for critical instrumentation and would be accomplished in one of two ways. The primary strategy is to repower the battery chargers directly through a dedicated circuit from a portable 480V FLEX generator. The alternate strategy is to back feed the Class 1E 480V buses through switchgear and selectively power the battery charger circuits.

On page 79 and 80, in the Integrated Plan, the submittal includes a table that lists additional equipment (Generator and Large Diesel Generator) for phase 3. However, this equipment is not discussed in the body of the Integrated Plan. The licensee addressed this in the audit response and stated that the generator listed in the table on page 79 refers to the 480VAC generator that will supply the battery chargers. The capacity is specified as 49 kw per generator. The large diesel generators listed in the table on page 81 of the Integrated Plan are the 4160VAC diesel generators. Three megawatts is specified per generator for Callaway Plant's phase 3 strategy of using the installed ECCS Residual Heat Removal (RHR) pump and the installed Component Cooling Water (CCW) pump for cooling the RCS.

Although the Integrated Plan addressed the use of backup diesel powered generators to provide backup power, it was not clear how the Plan addressed the guidance in NEI 12-06, Section 3.2.2, Guideline (13) regarding isolation and interactions. The licensee addressed this question in the response to the audit process by stating that a) Class 1E equipment is protected from faults by utilizing safety-related circuit breakers or disconnect switches between safety and non-safety related equipment, and b) by ensuring that the electrical bus is isolated from its normal power source prior to connecting a FLEX generator thus preventing multiple sources from powering electrical busses. The licensee also stated that the subject of isolation is formally addressed in MP 12-0020 STARS-ENG-5000-8.1 regarding "Redundancy, Diversity, and Separation Requirements." And finally, the licensee stated that Callaway will have approved procedures to ensure these alignments are satisfied.

In addition, the licensee provided in report DAR-PEUS-12-3, Revision 1, conceptual designs, sizing calculations, and installation requirements for the flex diesel generators, feeders, boxes, switches and other electrical equipment.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect electrical isolations and interactions if these requirements are implemented as described.

3.2.4.9 Portable Equipment Fuel

NEI 12-06, Section 3.2.2, Guideline (13) states in part:

> The fuel necessary to operate the FLEX equipment needs to be assessed in the plant specific analysis to ensure sufficient quantities are available as well as to address delivery capabilities.

NEI 12-06, Section 3.2.1.3, consideration (5) states:

> Fuel for FLEX equipment stored in structures with designs which are robust with respect to seismic events, floods and high winds and associated missiles, remains available.

The licensee briefly discussed the topic of diesel fuel on page 10, item 14 and on page 11, item 23 of the Integrated Plan. The licensee states that there is a need to "provide a more exact basis" for fuel needs once the portable equipment specifications for fuel consumption are known. However, there was no discussion of fuel oil storage capacity or protection from hazards, and means of refueling for indefinite periods. The licensee addressed those questions in the response to the audit process in TR-FSE-13-4 rev 1. The licensee stated that fuel is available from the following sources: 1) A storage tank with a capacity of 256,000 gallons, 2) three day tanks with a capacity of 250 gallons each, 3) A 3,000 gallon underground diesel fuel storage tank, 4) An emergency offsite diesel fuel storage tank with capacity of 6000 gallons, 5) two 100,000 gallon emergency fuel oil storage tank located near the diesel generator building, 6) two emergency diesel generator fuel oil day tanks with 600 gallon capacity each, and 7) fuel staged at the Regional Response Centers. The licensee identified corrective action document CAR 20110618, Action 4 that was generated to address and track the resolution of the fuel oil supply needs of the first 24 hours of the event. In addition, the licensee stated that contractual arrangements are in place to refill emergency fuel tanks when necessary. And finally, the Integrated Plan identified a fuel oil transport vehicle and supplemental fuel oil supplies as part of the phase 3 equipment requirements.

No information was provided regarding assuring and maintaining fuel oil quality. This is identified as Open Item 3.2.4.9.A in Section 4.1.

The licensee's approach described above, as currently understood, is consistent with the

guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Open Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to fuel oil if these requirements are implemented as described.

3.2.4.10 Load Reduction to Conserve DC Power

NEI 12-06, Section 3.2.2, guideline (6) states:

> *Plant procedures/guidance should identify loads that need to be stripped from the plant dc buses (both Class 1E and non-Class 1E) for the purpose of conserving dc power.*
>
> DC power is needed in an ELAP for such loads as shutdown system instrumentation, control systems, and dc backed air AOVs and MOVs [air operated valves and motor operated valves]. Emergency lighting may also be powered by safety-related batteries. However, for many plants, this lighting may have been supplemented by Appendix R and security lights, thereby allowing the emergency lighting load to be eliminated. ELAP procedures/guidance should direct operators to conserve dc power during the event by stripping nonessential loads as soon as practical. Early load stripping can significantly extend the availability of the unit's Class 1E batteries. In certain circumstances, AFW/HPCI /RCIC [auxiliary feedwater/high pressure coolant injection/reactor core isolation cooling] operation may be extended by throttling flow to a constant rate, rather than by stroking valves in open-shut cycles.
>
> Given the beyond-design-basis nature of these conditions, it is acceptable to strip loads down to the minimum equipment necessary and one set of instrument channels for required indications. Credit for load-shedding actions should consider the other concurrent actions that may be required in such a condition.

On page 62 of the Integrated Plan regarding safety function support, the licensee stated that the Callaway Plant Class 1E DC NK battery system provides dc electrical power to Class 1E DC loads and NK instrumentation. The system consists of four batteries separated into two load groups. Each battery has sufficient stored energy to operate all the necessary emergency loads for 8 hours after loss of AC power or charger failure without load shedding. The licensee further states that load shedding will begin 45 minutes after the event and be completed within 15 minutes. And finally, the licensee states that battery run time can be extended to 14 hours with the implementation of load shedding.

Review of the Integrated Plan for Callaway revealed that the Generic Concern related to battery duty cycles beyond 8 hours is applicable to the plant. The Generic Concern related to extended battery duty cycles, has been resolved generically through the NRC endorsement of NEI position paper entitled "Battery Life Issue" (ADAMS Accession No. ML13241A186 (position paper) and ML13241A188 (NRC endorsement letter)).

The purpose of the Generic Concern and associated endorsement of the position paper was to resolve concerns associated with Integrated Plan submittals in a timely manner and on a generic basis, to the extent possible, and provide a consistent review by the NRC. Position papers provided to the NRC by industry further develop and clarify the guidance provided in NEI 12-06 related to industry's ability to meet the requirements of Order EA-12-049, "Order

Modifying Licenses with Regard to Requirements for Mitigation Strategies for beyond Design Basis External Events."

The Generic Concern related to extended battery duty cycles required clarification of the capability of the existing vented lead-acid station batteries to perform their expected function for durations greater than 8 hours throughout the expected service life of the battery. The position paper provided sufficient basis to resolve this concern by developing an acceptable method for demonstrating that batteries will perform as specified in a plant's Integrated Plan. The methodology relies on the licensee's battery sizing calculations developed in accordance with the Institute of Electrical and Electronics Engineers Standard 485, "Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations," load shedding schemes, and manufacturer data to demonstrate that the existing vented lead-acid station batteries can perform their intended function for extended duty cycles (i.e., beyond 8 hours). The NRC staff will evaluate a licensee's application of the guidance (calculations and supporting data) in its development of the final Safety Evaluation documenting review of the licensee's Integrated Plan.

The NRC staff concluded that the position paper provides an acceptable approach for licensees to use in demonstrating that vented lead-acid batteries can be credited for durations longer than 8 hours. The licensee has informed the NRC of their plans to abide by this generic resolution and has provided supporting information in Callaway FLEX Battery Coping Analysis, CN-PEUS-12-09.

In addition to the Generic Concern related to extended battery life, the following plant specific issues were identified during the review of the licensee's Integrated Plan:

a) Integrated Plan did not specify minimum dc bus voltage required or the basis for that voltage.

b) Integrated Plan did not discuss details of the loads shed and did not discuss operator actions required to execute the load shed.

c) Integrated Plan did not discuss potential for loss of functions such as main generator seal oil pumps due to load shedding.

The licensee addressed these topics in the response to the audit process as follows:

a) Bus voltage - The licensee stated that the minimum bus voltage is 105 vdc and that the basis for this value is addressed in the NEI white paper "Battery Life Issue."

b) Load shed - The licensee responded by stating that most loads will be shed from the class 1E dc bus except for a minimum set (i.e., channel) of instruments per NEI 12-06 to support strategy implementation. The licensee further stated that 125 vdc power will be available to operate the atmospheric dump valves, as well as the turbine driven auxiliary feedwater pump flow control valves and other loads to maintain safety functions. Operator actions for the load shed will be executed in the 125 vdc switchgear rooms located in the control building. All switches, breakers, or disconnects for this load shed process are located in these rooms.

c) Lost functions - The licensee stated that the main generator seal oil pump is powered from balance of plant batteries that are not part of the load shed.

The licensee's response to a), and b) above addressed the concerns but the issue of lost functions during load shed, item c), remains a concern. The licensee response did not address the general question as to whether the potential loss of plant functions and resulting consequences has been addressed. Also, the licensee explained that the main generator seal oil pump is powered from the balance of plant batteries but did not address generator hydrogen hazards when the balance of plant batteries are exhausted. These concerns are identified as Confirmatory Item 3.2.4.10.A in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to load reduction to conserve dc batteries if these requirements are implemented as described.

3.3 PROGRAMMATIC CONTROLS

3.3.1 Equipment Maintenance and Testing

NEI 12-06, Section 3.2.2, Guideline (15) states:

> 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 two-unit site would nominally have at least three portable pumps, three sets of portable ac/dc power supplies, three sets of hoses & cables, etc. It is also acceptable to have a single resource that is sized to support the required functions for multiple units at a site (e.g., a single pump capable of all water supply functions for a dual unit site). In this case, the N+1 could simply involve a second pump of equivalent capability. In addition, it is also acceptable to have multiple strategies to accomplish a function (e.g., two separate means to repower instrumentation). In this case the equipment associated with each strategy does not require N+1. The existing 50.54(hh)(2) pump and supplies can be counted toward the N+1, provided it meets the functional and storage requirements outlined in this guide. The N+1 capability applies to the portable FLEX equipment described in Tables 3-1 and 3-2 (i.e., that equipment that directly supports maintenance of the key safety functions). Other FLEX support equipment only requires an N capability.

NEI 12-06, Section 11.5 states:

1. FLEX mitigation equipment should be initially tested or other reasonable means used to verify performance conforms to the limiting FLEX requirements. Validation of source manufacturer quality is not required.

2. Portable equipment that directly performs a FLEX mitigation strategy for the core, containment, or SFP should be subject to maintenance and testing[1] guidance provided in INPO [Institute of Nuclear Power Operations] AP 913,

Equipment Reliability Process, to verify proper function. The maintenance program should ensure that the FLEX equipment reliability is being achieved. Standard industry templates (e.g., Electrical Power Research Institute (EPRI)) and associated bases will be developed to define specific maintenance and testing including the following:

a. Periodic testing and frequency should be determined based on equipment type and expected use. Testing should be done to verify design requirements and/or basis. The basis should be documented and deviations from vendor recommendations and applicable standards should be justified.

b. Preventive maintenance should be determined based on equipment type and expected use. The basis should be documented and deviations from vendor recommendations and applicable standards should be justified.

c. Existing work control processes may be used to control maintenance and testing. (e.g., PM Program, Surveillance Program, Vendor Contracts, and work orders).

3. 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.

    a. The unavailability of installed plant equipment is controlled by existing plant processes such as the Technical Specifications. When installed 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.

    b. Portable equipment may be unavailable for 90 days provided that the site FLEX capability (N) is available.

    c. Connections to permanent equipment required for FLEX strategies can be unavailable for 90 days provided alternate capabilities remain functional.

    d. Portable equipment that is expected to be unavailable for more than 90 days or expected to be unavailable during forecast site specific external events (e.g., hurricane) should be supplemented with alternate suitable equipment.

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

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

Review of the Integrated Plan for Callaway plant revealed that the Generic Concern related to maintenance and testing of FLEX equipment is applicable to the plant. This Generic Concern has been resolved generically through the NRC endorsement of the EPRI technical report on preventive maintenance of FLEX equipment, submitted by NEI by letter dated October 3, 2013 (ADAMS Accession No. ML13276A573). The endorsement letter from the NRC staff is dated October 7, 2013 (ADAMS Accession No. ML13276A224).

This Generic Concern involves clarification of how licensees would maintain FLEX equipment such that it would be readily available for use. The technical report provided sufficient basis to resolve this concern by describing a database that licensees could use to develop preventative maintenance programs for FLEX equipment. The database describes maintenance tasks and maintenance intervals that have been evaluated as sufficient to provide for the readiness of the FLEX equipment. The NRC staff has determined that the technical report provides an acceptable approach for maintaining FLEX equipment in a ready-to-use status. The licensee informed the NRC of their plans to abide by this generic resolution.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to equipment maintenance and testing if these requirements are implemented as described.

3.3.2 Configuration Control

NEI 12-06, Section 11.8 states:

1. The FLEX strategies and basis will be maintained in an overall program document. This program document will also contain a historical record of previous strategies and the basis for changes. The document will also contain the basis for the ongoing maintenance and testing programs chosen for the FLEX equipment.
2. Existing plant configuration control procedures will be modified to ensure that changes to the plant design, physical plant layout, roads, buildings, and miscellaneous structures will not adversely impact the approved FLEX strategies.
3. Changes to FLEX strategies may be made without prior NRC approval provided:
   a) The revised FLEX strategy meets the requirements of this guideline.
   b) An engineering basis is documented that ensures that the change in FLEX strategy continues to ensure the key safety functions (core and SFP cooling, containment integrity) are met.

On page 7 of the Integrated Plan discussing key site assumptions to implement NEI 12-06 strategies, the licensee stated that these pre-planned strategies developed to protect the public health and safety will be incorporated into the unit emergency operating procedures in accordance with established emergency operating procedure (EOP) change processes, and their impact to the design basis capabilities of the unit evaluated under 10 CFR 50.59. The plant Technical Specifications contain the limiting conditions for normal unit operations to ensure that design safety features are available to respond to a design basis accident and direct the required actions to be taken when the limiting conditions are not met. The result of the beyond-design-basis event may place the plant in a condition where it cannot comply with certain Technical Specifications and/or with its Security Plan, and, as such, may warrant invocation of 10 CFR 50.54(x) and/or 10 CFR 73.55(p).

On page 13 of the Integrated Plan regarding programmatic controls, the licensee stated that the unavailability of equipment and applicable connections that directly performs a FLEX mitigation strategy will be managed using plant equipment control guidelines developed in accordance with NEI 12-06, Section 11.5. In addition, the FLEX strategies and basis will be maintained in an overall program document. Existing plant configuration control procedures will be modified to ensure that changes to the plant design, physical plant layout, roads, buildings, and miscellaneous structures will not adversely impact the approved FLEX strategies in accordance with NEI 12-06, Section 11.8.

The Integrated Plan provides reasonable assurance that guidance and strategies, and the procedures, and programs developed will conform to the guidance of NEI 12-06, Section 11.8 Items 1, 2 and 3 noted above.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to configuration control if these requirements are implemented as described.

3.3.3 Training.

NEI 12-06, Section 11.6, Training, states:

1. Programs and controls should be established to assure personnel proficiency in the mitigation of beyond-design-basis events is developed and maintained. These programs and controls should be implemented in accordance with an accepted training process.
2. Periodic training should be provided to site emergency response leaders on beyond- design-basis emergency response strategies and implementing guidelines. Operator training for beyond-design-basis event accident mitigation should not be given undue weight in comparison with other training requirements. The testing/evaluation of Operator knowledge and skills in this area should be similarly weighted.
3. Personnel assigned to direct the execution of mitigation strategies for beyond-design- basis events will receive necessary training to ensure familiarity with the associated tasks, considering available job aids, instructions, and mitigating strategy time constraints.
4. "ANSI/ANS 3.5, Nuclear Power Plant Simulators for use in Operator Training" certification of simulator fidelity (if used) is considered to be sufficient for the initial stages of the beyond-design-basis external event scenario until the current capability of the simulator model is exceeded. Full scope simulator models will not be upgraded to accommodate FLEX training or drills.
5. Where appropriate, the integrated FLEX drills should be organized on a team or crew basis and conducted periodically; with all time-sensitive actions to be evaluated over a period of not more than eight years. It is not the intent to

connect to or operate permanently installed equipment during these drills and demonstrations.

On page 13 of the Integrated Plan regarding training, the licensee stated that training plans will be developed for plant groups such as the emergency response organization (ERO), security, fire response, emergency planning (EP), operations, engineering, maintenance, and instrumentation and controls. The training plan development will be done in accordance with Callaway Plant procedures using the Systematic Approach to Training, and will be implemented to ensure that the required Callaway Plant staff is trained prior to implementation of FLEX. The training program will comply with the guidelines outlined in Section 11.6 of NEI 12-06.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to training if these requirements are implemented as described.

3.4 OFFSITE RESOURCES

NEI 12-06, Section 12.2 lists the following minimum capabilities for offsite resources for which each licensee should establish the availability of:

1) A capability to obtain equipment and commodities to sustain and backup the site's coping strategies.
2) Off-site equipment procurement, maintenance, testing, calibration, storage, and control.
3) A provision to inspect and audit the contractual agreements to reasonably assure the capabilities to deploy the FLEX strategies including unannounced random inspections by the Nuclear Regulatory Commission.
4) Provisions to ensure that no single external event will preclude the capability to supply the needed resources to the plant site.
5) Provisions to ensure that the off-site capability can be maintained for the life of the plant.
6) Provisions to revise the required supplied equipment due to changes in the FLEX strategies or plant equipment or equipment obsolescence.
7) The appropriate standard mechanical and electrical connections need to be specified.
8) Provisions to ensure that the periodic maintenance, periodic maintenance schedule, testing, and calibration of off-site equipment are comparable/consistent with that of similar on-site FLEX equipment.
9) Provisions to ensure that equipment determined to be unavailable/non-operational during maintenance or testing is either restored to operational status or replaced with appropriate alternative equipment within 90 days.
10) Provision to ensure that reasonable supplies of spare parts for the off-site equipment are readily available if needed. The intent of this provision is to reduce the likelihood of extended equipment maintenance (requiring in excess of 90 days for returning the equipment to operational status).

On pages 13 and 14 of the integrated report in the section discussing the Regional Response Center, the licensee stated the industry will establish two RRCs to support utilities during a BDBEE scenario as outlined in NEI 12-06. Each RRC will hold five sets of equipment, four of which will be able to be fully deployed when requested; the fifth set will have equipment in a maintenance cycle. Equipment will be moved from an RRC to a local Assembly Area, established by the SAFER team and the utility. Communications will be established between the affected nuclear site and the SAFER team and required equipment moved to the site as needed. First arriving equipment, as established during development of the nuclear site's playbook, will be delivered to the site within 24 hours from the initial request.

The licensee's use of off-site resources, as described above, conforms to the guidance found in NEI 12-06, Section 12.2, with regard to the capability to obtain equipment and commodities to sustain and backup the site's coping strategies (guideline 1). However, insufficient information has been included to provide reasonable assurance that guidance will be established to conform to the remaining items of NEI 12-06, Section 12.2 (guidelines 2 through 10). It should be noted that the guidelines above are designed to address the Phase 3 equipment and associated programs and procedures. This has been identified as Open Item 3.4.A, in Section 4.1 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Open Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to offsite resources if these requirements are implemented as described.

4.0 SUMMARY OF CONFIRMATORY AND OPEN ITEMS

4.1 OPEN ITEMS

Item Number	Description	Notes
3.2.1.2.B	Additional review of the licensee's applicable analysis and relevant RCP seal leakage testing data is needed justify that (1) the integrity of the associated O-rings will be maintained at the temperature conditions experienced during the ELAP event, and (2) the seal leakage rate used in the ELAP is adequate and acceptable.	
3.2.1.2.D	The acceptability of the use of the selected seals and the RCP seal leakages rates in the ELAP analysis should be provided with acceptable justification.	
3.2.1.3.A	During the NRC audit process the licensee was requested to provide the following information: If the ANS 5.1-1979 + 2 sigma model is used in the ELAP analysis, specify the values of the following key parameters used to determine the decay heat: (1) initial power level, (2) fuel enrichment, (3) fuel burnup, (4) effective full power operating days per fuel cycle, (5) number of fuel cycles, if hybrid fuels are used in the core, and (6) fuel characteristics based on the beginning of the cycle, middle of the cycle, or end of the cycle. Address the adequacy of the values used. If the different decay heat model is used, describe the specific model and address the acceptability of the model and the analytical results.	
3.2.1.8.B	The PWROG submitted to NRC a position paper, dated August 15, 2013, which provides 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 would occur under conditions similar to those for which boric acid mixing data is available. During the audit process, the licensee informed the NRC staff of its intent to abide by the generic approach discussed above; however, the NRC staff concluded that the August 15, 2013, position paper was not adequately justified and that further information is required.	
3.2.4.9.A	No information was provided regarding assuring and maintaining fuel oil quality.	
3.4.A	Details are needed to demonstrate the minimum capabilities for offsite resources will be met per NEI 12-06 Section 12.2.	

4.2 CONFIRMATORY ITEMS

Item Number	Description	Notes
3.1.1.2.A	CST is presently unprotected from seismic hazard. Licensee is planning to install new CST. Verify installation.	
3.1.1.2.B	Information needed regarding whether or not electrical power will be required to move or deploy FLEX equipment from storage.	
3.1.2.A	Licensee stated that UHS and RWST are below flood levels but the licensee needs to address potential consequences such as debris in the UHS or access to RWST. In addition, the staff noted that the deployment of FLEX equipment and associated procedural interfaces may be impacted by the UHS and RWST being below the design basis flood level.	
3.1.3.3.A	The licensee did not provide information with regard to procedural interface considerations as they relate to tornados.	
3.2.1.A	The licensee should confirm that adverse quantities of nitrogen from accumulators will not be injected into the RCS during an ELAP event using an acceptable methodology that accounts for the potential for heat transfer from the containment building to the contents of the accumulator.	
3.2.1.B	The licensee should confirm that the potential failure of non-safety-related portions of the turbine-driven auxiliary feedwater pump recirculation header piping would not (1) adversely affect the quantity of condensate required for secondary makeup or (2) result in adverse accumulation of water in the CST pipe chase or other areas of the plant.	
3.2.1.1.A	Reliance on the NOTRUMP code for the ELAP analysis of Westinghouse plants is limited to the flow conditions prior to reflux condensation initiation. This includes specifying an acceptable definition for reflux condensation cooling.	
3.2.1.2.C	Further information is required to assess address the impacts of the Westinghouse 10 CFR Part 21 report, "Notification of the Potential Existence of Defects Pursuant to 10 CFR Part 21,"	

	dated July 26, 2013 (ADAMS No. ML13211A168) on the use of the low seal leakage rate in the ELAP analysis.	
3.2.1.5.A	The Integrated Plan did not address whether instrumentation credited in the ELAP analysis for automatic actuations and for indications required for the operators to take action are reliable and accurate in the containment harsh conditions. The licensee responded to this question in the audit process by pointing out that the licensee's self identified open item related to the containment environment (OI 2) addresses this issue. The licensee also stated that Westinghouse will be asked to perform a GOTHIC analysis of the containment to demonstrate that acceptable temperature and pressure levels will not be exceeded.	
3.2.1.6.A	On page 11 of the Integrated Plan, following the sequence of events listed, the licensee stated that to confirm the times given, the licensee will prepare procedures for each task, perform time study walkthroughs for each of the tasks under simulated ELAP conditions, and account for equipment and tagging and other administrative procedures required to perform the task. Further review of the Sequence of Events will be required following this review.	
3.2.1.8.A	Provide adequate basis for the timing and quantity of the injection of borated coolant and provide justification that administrative procedures will ensure that subcriticality requirements for future cores are bounded.	
3.2.2.A	The licensee stated the water supply for SFP cooling involves three connections points, all located on the exterior of the fuel building. The connection points on the exterior of the fuel building will need to be protected from high wind missile strikes. If protection is not possible, the connection points will need to be relocated to the inside of the building. The configuration has not been resolved.	
3.2.2.B	The licensee stated that Westinghouse is being asked to clarify the basis for the 48 hour boil off time for the SFP level and the resulting information will be provided in a future 6-month update to the Integrated Plan.	
3.2.3.A	The licensee will use GOTHIC to analyze containment conditions and based on the results of this evaluation, will develop required actions to ensure maintenance of containment integrity and required instrument function. The licensee stated that a detailed discussion of the GOTHIC analysis will be provided in a future 6-month update to address containment cooling during an ELAP event.	
3.2.4.2.A	The licensee needs to provide details regarding a plan to prevent hydrogen accumulation in the battery room during phases 2 and 3.	
3.2.4.2.B	A discussion is needed specifically on the extreme low temperatures effects of the batteries capability to perform its function for the duration of the ELAP event.	
3.2.4.2.C	The licensee stated that an assessment of room environmental	

	conditions and effects on key equipment was performed and the assessment determined that the near term actions were considered acceptable for 24 hours following a BDBEE scenario as outlined in NEI 12-06. However, the licensee further stated that a future action is required to evaluate coping times beyond 24 hours. This action should also address the capability to vent the SFP area.	
3.2.4.3.A	The potential for (1) freezing of water in FLEX equipment and (2) crystallization of boric acid solution, and therefore the potential need for heat tracing on CVCS lines, is still not addressed for long periods of time during the ELAP event scenarios. The licensee stated that additional work is required on these subjects to ensure that the potential for freezing and boron solidification is addressed.	
3.2.4.4.A	The licensee needs to provide information concerning the source of power, storage location and the procedures the operators will use to stage temporary lights.	
3.2.4.4.B	The NRC staff has reviewed the licensee communications assessment (ML12306A199 and ML13056A135 and has determined that the assessment for communications is reasonable. Confirmation is required to demonstrate that upgrades to the site's communications systems have been completed.	
3.2.4.6.A	There were several references in the Integrated Plan regarding the need for analyses and procedures to address ventilation of areas such as equipment rooms and the spent fuel pool area. The licensee responded to questions regarding habitability and stated that the subject of area ventilation will be addressed in a future 6-month update.	
3.2.4.7.A	The licensee stated the primary strategy for providing adequate cooling during Modes 5 and 6 will take suction from the new RWST connection on the RWST drain line. The licensee further stated that the RWST is seismically qualified but not missile protected. The licensee has noted a self identified open item stating that the RWST will be missile protected to credit its use in core cooling with SGs not available strategies.	
3.2.4.10.A	With regard to the battery load shed evolution, the licensee did not address the general question as to whether the potential loss of plant functions and resulting consequences has been addressed. Also, the licensee explained that the main generator seal oil pump is powered from the balance of plant batteries but did not address generator hydrogen hazards when the balance of plant batteries are exhausted. Licensee is requested to address these concerns.	

If you have any questions, please contact John Boska at 301-415-2901.

Sincerely,

/RA/

Jeremy S. Bowen, Chief
Mitigating Strategies Projects Branch
Mitigating Strategies Directorate
Office of Nuclear Reactor Regulation

Docket No. 50-483

Enclosures:
1. Interim Staff Evaluation
2. Technical Evaluation Report

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NAME	JBoska	SLent	EBowman	JBowen
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OFFICE	NRR/MSD/MESB/BC	NRR/MSD/MRSB/BC	NRR/MSD/D	NRR/MSD/MSPB/BC
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