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

February 27, 2014

Mr. Louis Cortopassi
Site Vice President and Chief Nuclear Officer
Omaha Public Power District
Fort Calhoun Station
Mail Stop FC-2-4
9610 Power Lane
Blair, NE 68008

SUBJECT: FORT CALHOUN STATION, UNIT 1 - INTERIM STAFF EVALUATION RELATING TO OVERALL INTEGRATED PLAN IN RESPONSE TO ORDER EA-12-049 (MITIGATION STRATEGIES) (TAC NO. MF0969)

Dear Mr. Cortopassi:

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. ML13064A298), Omaha Public Power District (OPPD, the licensee) submitted its Overall Integrated Plan for Fort Calhoun Station, Unit 1 in response to Order EA-12-049. By letter dated August 28, 2013 (ADAMS Accession No. ML13268A075), OPPD submitted a six-month update to the Overall Integrated Plan.

Based on a review of OPPD's plan, including the six-month update dated August 28, 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 Fort Calhoun Station, 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. By letter dated February 24, 2014 (ADAMS Accession No. ML14055A412), OPPD submitted its second six-month update to the Overall Integrated Plan. Due to this update's recent submission, it was not considered for this Interim Staff Evaluation and Technical Evaluation Report but will be reviewed in the ongoing audit process.

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

If you have any questions, please contact James Polickoski, Mitigating Strategies Project Manager, at 301-415-5430 or at james.polickoski@nrc.gov.

Sincerely,

Victor Cusumano (for Jeremy Bowen)

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

Docket No. 50-285

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

OMAHA PUBLIC POWER DISTRICT

FORT CALHOUN STATION, UNIT 1

DOCKET NO. 50-285

## 1.0 INTRODUCTION

The earthquake and tsunami at the Fukushima Dai-ichi nuclear power plant in March 2011, highlighted the possibility that extreme natural phenomena could challenge the prevention, mitigation, and emergency preparedness defense-in-depth layers. 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 (BDBEE). 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], Omaha Public Power District (the licensee or OPPD) provided the Overall Integrated Plan (hereafter referred to as the Integrated Plan) for compliance with Order EA-12-049 for Fort Calhoun Station Unit 1 (Fort Calhoun or FCS). The Integrated Plan describes the guidance and strategies under development for implementation by OPPD 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. As further required by the order, by letter dated August 28, 2013 [Reference 3], the licensee submitted the first six-month status report since the submittal of the Integrated Plan, describing the progress made in implementing the requirements of the order.

## 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 if 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 a BDBEE. 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 BDBEEs. The initial

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

phase requires the use of installed equipment and resources to maintain or restore core cooling, containment and SFP cooling capabilities. The transition phase requires providing sufficient, portable, onsite equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from off site. The final phase requires obtaining sufficient offsite resources to sustain those functions indefinitely. Specific 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 BDBEEs 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 used by the staff in its review, leading to the issuance of this interim staff evaluation (ISE) 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. 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 Mega-Tech Services, LLC (MTS) for technical support in the evaluation of the Integrated Plan for Fort Calhoun, submitted by OPPD's letter dated February 28, 2013, as supplemented. NRC and MTS staff have reviewed the submitted information and held clarifying discussions with OPPD in evaluating the licensee's plans for addressing BDBEEs and its progress towards implementing those plans.

A simplified description of the Fort Calhoun 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 using the turbine-driven auxiliary feedwater pump (TDAFWP) to supply water to the steam generators (SGs) from the emergency feedwater storage tank (EFWST) and manually release steam from the main steam safety valves or atmospheric dump valves. In order to address reactivity concerns and control reactor coolant system (RCS) inventory loss, the licensee will isolate the reactor coolant pump (RCP) seal leakage controlled bleedoff (CBO) and commence a rapid cooldown of the RCS within two hours of an ELAP allowing the safety injection tanks to inject borated water. Within 5 hours, the portable FLEX 200 kilo-watt (kw) diesel generator (DG) will be aligned to power the FLEX safety injection and refueling water tank (SIRWT) pump (FSP) to provide makeup to the EFWST from the SIRWT for continued core cooling by the TDAFWP. The licensee's longer term core cooling strategy includes providing direct SG injection with water supplied from either an electric-driven well pump, or a fire truck pump or diesel-driven portable pump supplying water from the Missouri River. The licensee's longer term RCS inventory control strategy includes utilizing the FLEX 200 kw DG to power either an installed charging pump or the FSP to supply water from the SIRWT or boric acid storage tank to the RCS. FLEX 200 kw and 10 kw DGs will power the 125 Vdc vital battery chargers and allow energizing critical loads such as required motor-operated valves, direct current components, and desired ac instrumentation. Additional equipment and supplies, such as portable 4160 v DGs, mobile boration equipment, and additional fuel for portable equipment, will be delivered from one of two Regional Response Centers (RRCs) established by the nuclear power industry to provide supplemental accident mitigation equipment.

With regard to containment, the licensee concluded by analysis that containment will not be challenged until approximately 10 days after the ELAP event or considerably longer should CBO isolation be maintained. Should long term containment cooling be required, the licensee will utilize either the containment spray system, or an RRC provided DG and diesel-driven pump to power a containment cooling fan and supply river water to the containment cooler.

In the postulated ELAP event, the SFP will initially heat up due to the unavailability of the normal cooling system. To provide makeup and cooling water flow to the SFP, the licensee will refill the SFP from the SIRWT using either the FSP or an alternate FLEX portable pump, or from the Missouri River using the fire truck pump, well pump, or diesel-drive portable pump. The licensee intends to install manually operated dampers to provide a ventilation pathway in the SFP area. The licensee is considering the use of RRC-provided equipment for long term SFP cooling strategy options.

By letter dated February 25, 2014 [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, in general, 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 the NRC considers 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 for NRC to determine that the issue is on a path to resolution. The intent behind designating an issue as an open item is to document significant 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, in general, it accurately reflects the state of completeness of the licensee's Integrated Plan. The open and confirmatory items identified in the TER are listed in the tables below, with some NRC item characterization changes and minor NRC edits made for clarity from the TER version. Further details for each open and confirmatory item are provided in the corresponding sections of the TER, identified by the item number.

As a clarification of a difference between the ISE open and confirmatory item list below and the enclosed TER, this ISE consolidated TER open items 3.2.1.2.A and 3.2.1.6.A into new open item 3.2.1.6.B.

## 4.1 OPEN ITEMS

| Item Number | Description | Notes |
|---|---|---|
| 3.2.1.6.B | Sequence of Events - Confirm whether the CENTS code ELAP reanalysis reflecting the CBO isolation modification affected the SOE timeline, and if so, that the SOE timeline has been updated and the overall FLEX mitigation strategies reflect these results. | |

4.2 CONFIRMATORY ITEMS

| Item Number | Description | Notes |
|---|---|---|
| 3.1.1.1.A | Protection of FLEX equipment (seismic hazard) - Confirm that all FLEX equipment stored in the auxiliary building and the new FLEX Support Building (FSB) are seismically restrained to ensure equipment is not damaged during a seismic event and that the FLEX equipment is not damaged by non-seismically robust equipment due to seismic interactions. | |
| 3.1.1.2.A | Deployment of FLEX equipment (seismic hazard) - Confirm that deployment pathways for the FLEX portable equipment are not susceptible to soil liquefaction. | |
| 3.1.1.3.A | Procedural Interfaces (seismic) - Confirm the licensee develops (1) methods and locations for alternate monitoring of key parameters; (2) guidance on critical actions to perform until alternate indications can be obtained; and (3) guidance on control of critical equipment without control power. | |
| 3.1.1.4.A | Off-site Resources - Confirm the location of the off-site staging area(s) and acceptability of the access routes considering the seismic, flooding, high wind, snow, ice and extreme cold hazard. | |
| 3.1.2.2.A | Deployment (flood) – Confirm the method of accessing the ultimate heat sink (UHS), the Missouri River, using FLEX equipment during high river levels or after flood waters inundate the site up to the current design basis flood elevation of 1014 foot elevation is addressed. The plan does not identify the deployed location of the fire truck or river drafting pump nor how they are accessed and monitored by plant operators, considering the site's flooded condition. | |
| 3.1.3.1.A | Protection of FLEX Equipment (high wind hazard) - Confirm the design code used for the FSB for the high wind hazard and the method of protection of the N+1 FLEX equipment from tornado borne missiles is acceptable. | |
| 3.2.1.1.A | CENTS – Confirm that the use of CENTS in the ELAP analysis for FCS is limited to the flow conditions before reflux boiling initiates. This includes providing a justification for how the initiation of reflux boiling is defined. Confirm that the reanalysis for the case with the CBO isolated conforms to the above | |

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| | limitations. | |
| 3.2.1.2.B | RCP Seal Leakage Rates - Confirm the selection and justification for the seal leakage rates assumed in the ELAP analysis from the initiation of the ELAP event to the time frame when subcooling in the RCS cold legs decreases to less than 50 degrees °F. Confirm the calculated maximum temperature and pressure, and minimum subcooling in the RCS cold legs during the ELAP before isolation of the CBO. Confirm the seal leakage rates per RCP before and after isolation of the CBO used in the ELAP reanalysis for determination of the SOE and associated time limes. | |
| 3.2.1.3.A | Decay Heat - Confirm the key physics parameters used for each of the decay heat evaluation scenarios to ensure that the FCS ELAP response is conservative relative to the ANS standard. | |
| 3.2.1.4.A | Initial Values for Key Plant Parameters and Assumptions – Confirm which inputs and assumptions are appropriate relative to being plant specific or derived from WCAP-17601-P. | |
| 3.2.1.5.A | Monitoring Instrumentation and Controls - Confirm suitability of EFWST level monitoring instrumentation considering the environmental conditions in the auxiliary building following an ELAP event. | |
| 3.2.1.5.B | Monitoring Instrumentation and Controls - Confirm suitability of existing or replacement SIT level instrumentation considering the environmental conditions in the containment following an ELAP event. | |
| 3.2.1.8.A | Core Sub-Criticality – Confirm that the reanalysis discussed in Confirmatory Item 3.2.1.1.A continues to align with the generic resolution for boron mixing under natural circulation conditions potentially involving two-phase flow, in accordance with the Pressurized-Water Reactor Owners Group position paper, dated August 15, 2013 (ADAMS Accession No. ML13235A135 (non-public for proprietary reasons)), and subject to the conditions provided in the NRC endorsement letter dated January 8, 2014 (ADAMS Accession No. ML13276A183) following SOE and FLEX mitigation strategy impacting changes. | |
| 3.2.4.1.A | Equipment Cooling (Water) – Confirm installed charging pumps can operate during an ELAP considering the loss of support equipment. | |
| 3.2.4.2.A | Equipment Cooling (Ventilation) - Confirm that the licensee addresses environmental conditions in the vicinity of and access to all deployed FLEX equipment in the auxiliary building, to ensure continuous equipment operation and acceptable human performance. | |
| 3.2.4.2.B | Equipment Cooling (Ventilation) - Confirm that the licensee addresses environmental conditions in the main control room (CR) and the need for ventilation prior to re-establishing power | |

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|---|---|---|
| | to the CR ventilation fans using the FLEX DG at approximately 9 hours after the ELAP as indicated on the SOE timeline. | |
| 3.2.4.2.C | Equipment Cooling (Ventilation) - Confirm the acceptability of the battery room temperatures (extreme hot or extreme cold) on battery performance. | |
| 3.2.4.2.D | Equipment Cooling (Ventilation) - Confirm the acceptability of the hydrogen buildup in the battery room during charging. | |
| 3.2.4.4.A | Lighting- Confirm the lighting provisions for all areas within the auxiliary building where FLEX equipment is deployed as well as the outdoor areas where FLEX equipment is deployed. | |
| 3.2.4.4.B | Communications - Confirm that upgrades to the site's communications systems have been completed. | |
| 3.2.4.5.A | Protected and Internal Locked Area Access – Confirm how the provisions for access to protected areas and internally locked areas are incorporated into the FLEX mitigation strategies. | |
| 3.2.4.7.A | Water Sources – Confirm that the licensee addresses the impacts of water chemistry from the various onsite sources for potential use in FLEX strategy installed and portable equipment. | |
| 3.2.4.8.A | Electrical Power Sources- Confirm the technical basis for the selection and size of the FLEX generators to be used in support of the coping strategies and the planned approach for fault protection and electrical separation between existing power sources and the FLEX power sources. | |
| 3.2.4.9.A | Portable Equipment Fuel – Confirm the total fuel consumption needs when FLEX equipment designs are finalized. | |
| 3.2.4.10.A | Load Reduction to Conserve DC Power- Confirm if the non-1E battery modification becomes a plan revision to extend the battery life of the existing Class 1E batteries and that any changes to the FLEX mitigation strategies have been incorporated. | |
| 3.3.1.A | Use of Portable Pumps- Confirm that the number of FLEX pumping equipment for accessing the UHS during the Phase 2 coping strategies meets the spare (N+1) capability. One fire truck and two river drafting pumps are provided to access the UHS. Confirm whether the river drafting pumps alone can achieve the mitigation strategy objectives (without the use of the fire truck) during both the flooded and non-flooded site conditions. Alternately, confirm implementation of a qualified well as a diverse alternate source of a long term water supply. | |
| 3.4.A | Off-Site Resources – Confirm how conformance with NEI 12-06, Section 12.2 guidelines 2 through 10 will be met. | |

Based on this review of OPPD'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 Fort Calhoun. 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 this ISE and Audit Report.

## 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 BDBEE. 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 BDBEEs to power reactors do not pose an undue risk to public health and safety.

The NRC's objective in preparing this ISE 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. 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 BDBEE that impacts the availability of ac power and the UHS. 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 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12054A736)

2. Letter from OPPD to NRC, "Omaha Public Power District's 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. ML13064A298)

3. Letter from OPPD to NRC, "Omaha Public Power District's First Six-Month Status Report for the Implementation of Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated August 28, 2013 (ADAMS Accession No. ML13268A075)

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 Daiichi 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. NEI document NEI 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 industry comments to draft JDL-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 NEI 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, Mega-Tech Services, LLC, to Eric Bowman, NRC, submitting "Fifth Batch SE Final Revision 1 – 1 Site (Fort Calhoun)" providing revision 1 of the final version of the fifth batch of Safety Evaluation (SEs) (one site) for the Technical Evaluation Reports (TERs) Related to Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, EA 12-049," dated February 25, 2014 (ADAMS Accession No. ML14056A438)

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Enclosure 2

Technical Evaluation Report

ML14049A361

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

February 25, 2014

Omaha Public Power District
Fort Calhoun Station
Docket No. 50-285

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 28, 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 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. ML13064A298), and as supplemented by the first six-month status report in a letter dated August 28, 2013 (ADAMS Accession No. ML13241A412), Omaha Public Power District (the licensee or OPPD) provided the Fort Calhoun Station (FCS) Integrated Plan for compliance with Order EA-12-049. The Integrated Plan describes the strategies and guidance under development for implementation by OPPD 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 NRC 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.

On page 2 of its Integrated Plan regarding determination of applicable extreme external hazards, the licensee stated that seismic hazards are applicable to the Fort Calhoun site. Per the Updated Safety Analysis Report (USAR) Section 2.4.3, the design basis earthquake (DBE) maximum ground accelerations are 0.08 g horizontal and two -thirds of 0.08 g vertical. The maximum hypothetical earthquake values are 0.17g horizontal ground acceleration and two-thirds of 0.17g vertical ground accelerations. The licensee has appropriately screened in this external hazard and identified the hazard levels for reasonable protection of the FLEX equipment.

On page 4 of its Integrated Plan, the licensee stated that the seismic re-evaluation pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.54(f) letter of March 12, 2012 had not been completed and therefore was not assumed in its Integrated Plan. As the re-evaluations are completed, appropriate issues will be entered into the corrective action system.

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 for seismic hazards, 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 18 of its Integrated Plan, the licensee stated that Fort Calhoun Station (FCS) will store the FLEX portable equipment either within the safety-related plant structures or in a storage building(s) that will meet the NEI 12-06 protection guidelines. On page C-24 in the Integrated Plan, the licensee stated that a robust storage building is required to be built to contain the FLEX equipment. The licensee further described that the building will have to be stout enough to provide protection to the equipment from design basis events, such as; the safe shutdown earthquake (SSE) which the reviewer understands to have been described as the maximum hypothetical earthquake in the screening section of the Integrated Plan, flood and severe weather. In consideration of flood hazards, this building will be built on an elevated location located approximately 2,600 ft. west of the reactor building.

During the audit process, the licensee stated that FCS has prepared a design requirements document for the construction of a FLEX Storage Building (FSB). This document defines the design criteria for the building, derived from Section 5 thru 10 of NEI 12-06. A conceptual design for the building is currently being developed that will describe the building attributes that will be included to ensure that the design conforms with the provisions NEI 12-06. The design requirements document provides, in part, for the following;

- Power for the FLEX storage building shall be independent of the plant's power system
- The FSB shall have 100% backup diesel generator power available
- Fuel storage shall be provided for the FSB diesel generators
- Fuel storage shall be provided for the FLEX diesel generators
- HVAC system shall be provided

The licensee posted the conceptual design drawing of the FSB on its e-portal. The design illustrates the stored FLEX equipment, the FSB diesel generators, diesel fuel oil storage, HVAC system, and other stored items to be used to support the mitigation strategies. The FLEX storage building will contain tools and other consumable supplies, such as food, sanitary materials, flashlight batteries and other staples necessary to maintain plant operations.

On page C-13 of the Integrated Plan, the licensee stated that the FLEX safety injection and refueling water tank pump (FSP) and the dedicated diesel generator to power the FSP, pre-deployed in the auxiliary building, will be seismically mounted. The FSP is used to transfer water from the safety injection and refueling water tank (SIRWT) to the reactor coolant system (RCS), spent fuel pool or the emergency feedwater storage tank (EFWST). The Integrated Plan does not address how other portable FLEX equipment stored in either the new storage building or stored in the auxiliary building is secured to protect them during a seismic event. This is identified as Confirmatory Item 3.1.1.1.A in Section 4.2.

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 protection 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 respect to consideration 1;

On page 2 of its Integrated Plan, the licensee stated that the FCS USAR was reviewed to perform a limited evaluation of the liquefaction potential for a design basis earthquake (DBE) event. The site is underlain by 65 to 75 feet of unconsolidated alluviar and glacial deposits, largely loose to moderately compact silty sand and deeper sands and gravels resting on sedimentary bedrock. To ensure against liquefaction, a criterion of densities of 85 percent average was established and a vibroflotation system was utilized to provide the necessary densification of soils under principal structures. Therefore, the licensee stated that the likelihood of liquefaction at the site for a DBE event appears to be low. However, the deployment pathways for the FLEX portable equipment were not specifically addressed as being within the area evaluated in the FCS USAR for liquefaction. This is identified as Confirmative Item 3.1.1.2.A in Section 4.2.

With respect to consideration 2;

During the audit process, the licensee stated that all equipment and connections being used for FLEX response are located in or will be deployed to the auxiliary building. The auxiliary building can be accessed directly from the yard through the truck bay.

With respect to consideration 3;

The Integrated Plan did not directly address potential failure of a downstream dam and the impact on accessing water from the ultimate heat sink, the Missouri River, to implement the FLEX coping capabilities. However, abnormal operating procedure AOP-01 "Acts of Nature" addresses accessing the river water under condition of low water level from the plant's intake structure. During the audit process the licensee stated that FLEX does not credit the intake structure or the raw water (RW) pumps for mitigation in any of the scenarios. In case of low river level, the fire truck may not be able to take water directly from the river. The minimum river level is reported to be 981 feet elevation. Therefore, a modification it is planned to install a platform by the river at elevation 996. A diesel-driven pump will be placed there to take the water from the river and supply it to the fire truck for further pumping the water to where it is needed.

With respect to consideration 4;

During the audit process, the licensee stated that a fuel storage tank will be provided in the FSB. This fuel supply will be adequate to ensure the capability of the FSB diesel generator to support the FSB for up to 72 hours.

With respect to consideration 5;

On page C-24 of its Integrated Plan, licensee listed the FLEX equipment to be stored in the new FSB. The list includes a four wheel drive truck, trailers, and boats which are used for deploying the FLEX 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 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 deployment of FLEX equipment, 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 [alternating current] 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.

With respect to consideration 1;

During the audit process, the licensee stated that it will establish methods for obtaining the values of at least one channel of the parameters listed on page B-19 in the Integrated Plan. These methods will be incorporated into the emergency operating procedures (EOPs) and/or FLEX support guidelines (FSGs) at appropriate locations. The exact methods for alternate monitoring have not been established yet. Due to the unique issues associated with BDB flooding, FCS intends to wait until preliminary information on maximum flood levels is obtained from their flooding re-evaluations before determining methods and locations for monitoring key parameters, such that they will be available for all BDBEE. The licensee has not addressed the critical actions to perform until alternate indications can be connected and on how to control critical equipment without associated control power. This is identified as Confirmatory Item 3.1.1.3.A in Section 4.2.

With respect to consideration 2;

During the audit process, the licensee stated that FCS has conducted a review of plant documentation to assess internal flooding relative to the requirements of NEI 12-06 Section 5.3.3 consideration 2. This review included identification of potential flooding sources not requiring ac power, such as tanks and systems that would be pressurized via a self-powered pump from an external source, to supply water to a break. These two types of sources are considered to be the main flooding sources within the plant when no ac power is available. During the audit process the licensee stated that Fort Calhoun confirmed that all sources of internal flooding that could affect FLEX implementation are either seismically rugged or can be secured prior to impacting FLEX implementation.

During the audit process, the licensee stated that the only flooding source of concern is a break in the fire protection (FP) system fed by the diesel-driven fire pump. However, this pump can be secured by the control room operator upon discovery of a flooding risk. Damage assessment actions taken following a BDBEE would assure discovery of the fire protection system break. The auxiliary building basement has a large capacity and would collect any internal flood water until the FP system can be secured.

With respect to consideration 3;

During the audit process, the licensee stated that the only requirement for ac power is for protection of the intake structure and RW pumps for flood levels above 1007 foot elevation. However, FLEX does not credit the intake structure or the RW pumps for mitigation in any of the scenarios. Remaining flood penetrations are passive in nature and do not require any ac power. Further, the licensee stated that additional walkdowns were conducted in response to the NTTF Recommendation 2.3 (ADAMS Accession No. ML12056A050) request for additional information letter of March 12, 2012, using NEI 12-07, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features," (ADAMS Accession No. ML12144A401) which confirmed that the flood penetrations were installed in accordance with design requirements and were in good material condition. Furthermore, the licensee noted that during the 2011 flood at FCS, which reached 1007 foot level, there was only minimal ground water intrusion, which did not require ac power for mitigation.

With respect to consideration 4;

AOP-01 addresses accessing the river water under condition of low water level from the plant's intake structure. During the audit process the licensee stated that FLEX does not credit the intake structure or the raw water (RW) pumps for mitigation in any of the scenarios. In cases of low river level, the fire truck may not be able to take water directly from the river. The minimum river level is reported to be 981 feet elevation. Therefore, a modification it is planned to install a platform by the river at elevation 996. A diesel driven pump will be placed there to take the water from the river and supply it to the fire truck for further pumping to where it is needed.

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 considering the seismic hazard, 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 11 of its Integrated Plan, the licensee stated that FCS will utilize the nuclear industry established Regional Response Centers (RRCs). Each RRC will hold five sets of equipment, four of which will be able to be fully deployed when requested and the fifth set will have equipment in a maintenance cycle. Equipment will be moved from an RRC to a local assembly area. Communications will be established between the affected nuclear site and the Strategic Alliance for FLEX Emergency Response (SAFER) team and required equipment moved to the site as needed. First arriving equipment, as established during development of the nuclear site's SAFER Response Plan (playbook), will be delivered to the site within 24 hours from the initial request. The licensee stated that FCS has signed a contract to participate in the RRC arrangement.

On page B-46 of its Integrated Plan, the licensee stated that the Fort Calhoun Station Phase 2 FLEX implementation strategies are intended to allow for indefinite operation, with the exception of maintaining the containment function and logistical support for consumable supplies, especially fuel and water. However, an eventual transition to a long term cooling strategy is necessary to achieve a stable cold shutdown condition and minimize liquid and gaseous releases to the environment. It is anticipated that the first piece of equipment provided by the RRC will be delivered within 24 hours of notification of the RRC and that full deployment will be achieved in 72 hours. However, it is anticipated that only logistical support for consumables such as fuel and other supplies will be needed in the 72 hour timeframe. The current FCS Phase 2 FLEX equipment and interconnections are designed to maintain all key parameters for at least 7 days, which will provide adequate time to complete the connection of the RRC supplied equipment.

The licensee has not identified the off-site staging areas nor assessed the access routes to the site considering the seismic hazard. This is identified as Confirmatory Item 3.1.1.4.A in Section 4.2.

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 use of off-site resources considering the seismic hazard, 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 in part:

> 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 2 its Integrated Plan, the licensee stated that USAR, Section 2.7 provides the design basis flooding information at FCS. The design basis flood level for FCS is 1014 feet above mean sea level, which is based on the estimation by the United States Army Corp of Engineers of the flood level that might result from the failure of Oahe or Fort Randall Dams, coincident with a probable maximum flood level of 1,009.3 feet. Grade elevation for the FCS site is approximately elevation 1003 – 1004 feet above MSL. During the audit process, the licensee stated that analyses indicate that it could take several weeks for the floodwaters to subside. Therefore, the FCS flood mitigating strategies are intended to cope for an indefinite period of time.

On pages 5 and B-43 of the Integrated Plan, the licensee further characterized the flood threat stating that based on historical evidence it can be assumed there will be at least two days' warning of an impending flood that could significantly impact the operational capabilities of the plant.

On page 4 of its Integrated Plan, the licensee stated that the flooding re-evaluation pursuant to the 10 CFR 50.54(f) letter of March 12, 2012, had not been completed and therefore not assumed in its Integrated Plan. As the re-evaluations are completed, appropriate issues will be entered into the corrective action system.

On page 3 of the Integrated Plan, the licensee stated that the FCS site screens in for an assessment for external 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 screening and characterization of the flooding hazard, 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.

On page 18 of the Integrated Plan, the licensee stated that it will store the FLEX portable equipment either within the safety-related plant structures or in a storage building(s) that will meet the NEI 12-06 protection guidelines.

On page B-43 of the Integrated Plan the licensee stated that the FLEX storage building proposed for FCS will be located near the current owner controlled access point about 2,600 feet west of the reactor building at approximately 1090 foot elevation which is significantly higher than the maximum conceivable flood level currently predicted by the Army Corps of Engineers. Equipment housed in the building will include watercraft that can be used for personnel and equipment transport when the flood level exceeds that which would support wheeled vehicles.

On page 2 of the Integrated Plan the licensee stated that flooding protection of FLEX equipment in the auxiliary building against the 1014-foot elevation flood is provided by removable flood barriers and sandbagging.

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 FLEX equipment from the flooding hazard, if these requirements are implemented as described.

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 which 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 RCS [reactor coolant system], isolating accumulators, isolating RCP [reactor coolant pump] 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 ultimate heat sink may be one of the first functions affected by a flooding condition. Consequently, the deployment of the FLEX equipment should address the effects of LUHS [loss of ultimate heat sink], as well as ELAP.

4. Portable pumps and power supplies will require fuel that would 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.

With respect to consideration 1:

On pages 5 and B-43 of the Integrated Plan, the licensee stated that based on historical evidence it can be assumed there will be at least two days' warning of an impending flood that could significantly impact the operational capabilities of the plant. Given this advance warning, the two day time period can be used to place the plant in a condition that would be most conducive to maintaining the ELAP/LUHS mitigation objectives for the period of inundation until the flood waters recede and system restoration can begin. On page B-44, the licensee further stated that if the river level is predicted to remain below elevation 1014 feet (with enough margin to provide confidence that the design basis level will not be exceeded), procedural direction will be provided to pre-stage FLEX equipment stored in the FLEX storage building to appropriately flood protected areas within the plant. FLEX systems will be deployed in a manner that will allow rapid response in the event of an ELAP, but will remain disconnected until the ELAP is experienced to avoid potential failures due to interaction with installed safety equipment. FLEX equipment will be fueled and operationally tested prior to the arrival of the flood to minimize the potential for unexpected failures in the early stages of the flood.

With respect to consideration 2:

On page B-43 of the Integrated Plan, the licensee stated that equipment housed in the FSB will include watercraft such as shallow draft skiffs and/or pontoon boats that can be used for personnel and equipment transport when the flood level exceeds that which would support wheeled vehicles.

With respect to consideration 3:

Although as noted above in the discussion related to consideration 1, where the licensee states that during the flood warning period FLEX equipment will be pre-staged to appropriately flood protected areas within the plant, the Integrated Plan does not contain any specific information on how the UHS, the Missouri River, is accessed to support the FLEX mitigation strategies during conditions of high river water levels or after flood waters inundate the site up to the current design basis flood level of 1014 foot elevation. The plan does not identify the deployed location of the fire truck or the river drafting pump nor how they are accessed and monitored by plant operators, considering the site's flooded condition. This is identified as Confirmatory Item 3.1.2.2.A in Section 4.2.

With respect to consideration 4:

On page B-44 of the Integrated Plan, the licensee stated that, initially during flood conditions, fuel for portable equipment will be provided from the safety-related diesel generator DG fuel oil storage tank (FO-1) or the DG day tanks, using portable fuel transfer pumps and tanks. On page C- 28 of the Integrated Plan, the licensee described a modification to enable transfer of diesel fuel from the underground seismic Category I tank to the auxiliary building truck bay area. This modification will tap into the diesel supply piping from the underground diesel oil tank and install piping into the truck bay. There, provisions will be made to use a battery powered pump to pump the oil into the FLEX DGs deployed in the truck bay.

During the audit process, the licensee stated that a fuel storage tank will also be provided in the FSB. This fuel supply will be adequate to ensure the diesel generator supporting the FSB for up to 72 hours, and provide an initial fuel fill for equipment stored in the building. The FSB will not be not subject to flooding.

With respect to consideration 5:

On page B-43 of the Integrated Plan the licensee stated that for the design basis flood case, the installed equipment, systems and instrumentation specified in NEI 12-06 would remain available for mitigation of an ELAP/LUHS, and FLEX equipment can be deployed and protected such that the strategies established for other BDBEEs would be available for flooding as well.

With respect to consideration 6: Not applicable to FCS. As discussed in Section 3.1.2 of this report, the FCS screens out the hurricane hazard.

With respect to consideration 7:

During the audit process, the licensee stated that FCS is susceptible to ground water intrusion, as portions of the safety related structures are located below ground level. The licensee noted that the 2011 flood at FCS, which reached 1007 foot level, confirmed that there was only minimal ground water intrusion, and did not require ac power for mitigation. The only requirement for ac power is for protection of the intake structure and RW pumps for flood levels above 1007 foot elevation. However, FLEX strategies do not credit the intake structure or the RW pumps for mitigation in any of the scenarios. Remaining flood penetrations are passive in nature and do not require any ac power.

With respect to consideration 8:

During the audit process, the licensee stated that the flood barriers used for floods greater than 1007 foot elevation are not normally installed. They are stored and installed using gaskets and bolts for any flood predicted to exceed 1004 foot elevation. Since the barriers are not normally installed, they would not be subject to damage from a seismic or wind generated missile event. Further, the updated probable maximum precipitation (PMP) evaluation has shown that severe floods at FCS would not be the result of a large local precipitation event. Rather, they are the result of upstream snow melt/runoff requiring excessive impoundment releases or an upstream dam break. Thus, the licensee concluded that it is not necessary to consider the impact of other BDBEEs on the deployment and installation of the flood barriers.

With respect to consideration 9:

On page C-24 of its Integrated Plan, licensee listed the FLEX equipment to be stored, thus protected, in the new FSB. The list includes a four wheel drive truck, trailers, and boats which are used for deploying the FLEX equipment. As stated in Section 3.1.2.1 of this report, the FSB is located above the design basis flood elevation.

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 deployment of FLEX equipment considering the flood hazard, if these requirements are implemented as described.

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.

On page B-43 of the Integrated Plan, the licensee stated that actions to address ELAP/LUHS on notification of impending flood include invoking current plant procedures. Per existing procedures, the plant will be placed in cold shutdown if river level is expected to exceed 1004 foot elevation. The licensee further stated that this action provides a number of beneficial effects, including establishment adequate shutdown margin to account for xenon decay, increasing margin to thermal limits, reducing potential RCS leakage rate (protect reactor coolant pump (RCP) seals) and reducing system pressures so that low pressure makeup water sources can be used.

During the audit process, the licensee further stated that for floods up to the design basis elevation, current station procedures provide detailed instructions for flood preparation and response. Overall guidance is provided in AOP-01, "Acts of Nature." To address a potential ELAP scenario, this procedure (or supporting procedures) will be revised to direct the movement of FLEX equipment to its flood protected position upon warning of a flood that would exceed an elevation that would hinder FLEX equipment deployment. The licensee further stated that for procedure guidance regarding flood conditions, EOPs and/or FSGs will be developed.

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 considering the flood hazard, if these requirements are implemented as described.

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 off-site 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 off-site could be staged for use on-site.

The considerations in using offsite resources discussed in Section 3.1.1.4 of this report are also applicable considering the flood hazard. The licensee has not identified the off site staging areas nor assessed the access routes to the site considering the flood hazard. This is combined with Confirmatory Item 3.1.1.4.A in Section 4.2.

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 the issue related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to use of off-site resources considering the flood hazard, 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 3 of the Integrated Plan, the licensee stated that the FCS site screens in for high winds and tornadoes, and the FCS site screens out for hurricanes because it is located several hundred miles from the nearest sea coast. Review of figure 7-1 of NEI 12-06 confirms that the wind contour for FCS is less than 130 mph and thus hurricanes need not be considered.

On page 3 of the Integrated Plan, the licensee noted the following information per the USAR;

- The fastest wind speed at the site location for a 100-year period of recurrence is 90 miles per hour (mph) at 30 feet above the ground level
- The design basis maximum wind velocity of a tornado is 500 mph in some cases and 300 mph in other cases.

Review of figure 7-2 of NEI 12-06 confirms that the FCS site is located in Region 1 and therefore should consider tornado wind speeds of greater than 130 mph.

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 for the high wind hazard, if these requirements are implemented as described.

3.1.3.1 Protection of FLEX Equipment - High Winds 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 would be computed in accordance with requirements of ASCE 7-10. Acceptance criteria would be based on building serviceability requirements not strict compliance with stress or capacity limits. This would allow for some minor plastic deformation, yet assure that the building would 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 would 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 would damage all FLEX mitigation equipment such that at least N sets of FLEX equipment would 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 18 of its Integrated Plan, the licensee stated that FCS will store the FLEX portable equipment either within the safety-related plant structures or in a storage building(s) that will meet the NEI 12-06 protection guidelines. The licensee did not provide information as to the design code to be used for the FSB for the high wind hazard or method of protection from tornado borne missiles of the N+1 FLEX equipment. This is identified as Confirmatory Item 3.1.3.1.A in Section 4.2.

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 protection of FLEX equipment in a high wind hazard, if these requirements are implemented as described.

3.1.3.2 Deployment of FLEX Equipment - High Winds 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 would 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.

On page C-24 of its Integrated Plan, licensee listed the FLEX equipment to be stored in the new FSB. The list includes a four wheel drive truck, trailers, and boats which are used for deploying the FLEX equipment. Also listed is a front end loader for debris and snow removal.

Considerations 1, 2 and 5 are not applicable to FCS since the plant is not susceptible to the hurricane winds hazard.

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 FLEX equipment deployment considerations in a high wind hazard, if these requirements are implemented as described.

3.1.3.3 Procedural Interfaces - High Winds 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.

Abnormal operating procedure AOP-01, "Acts of Nature" posted on the licensee's e-portal, addresses the plant's current response to high wind conditions. Appropriate steps for responding to ELAP/LUHS events in the presence of high winds will be incorporated into EOPs and/or FSGs.

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 considering the high wind hazard, if these requirements are implemented as described.

3.1.3.4 Considerations in Using Offsite Resources – High Winds 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.

The considerations in using offsite resources discussed in Section 3.1.1.4 of this report are also applicable considering the high wind hazard. The licensee has not identified the off site staging areas nor assessed the access routes to the site considering the high wind hazard. This is combined with Confirmatory Item 3.1.1.4.A in Section 4.2.

.

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 the issue related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to use of off-site resources considering the high wind hazard, if these requirements are implemented as described.

3.1.4 Snow, Ice and Extreme Cold

As discussed in part 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 $35^{th}$ 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 3 of the Integrated Plan, the licensee stated that per the USAR, the maximum snow and ice accumulation in and around FCS in any 24-hour period was 18.3 inches. The lowest recorded temperature from National Weather Service data in Omaha is -32 degrees F. The site is located above the $35^{th}$ parallel and according to NEI 12-06 Section 8.2.1 the plant should provide the capability to address the impedances caused by extreme snowfall. The FCS site screens in for snow, ice storms, 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 for snow, ice, and extreme cold hazards, if these requirements are implemented as described.

3.1.4.1 Protection 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 18 of the Integrated Plan, the licensee stated that it will store the FLEX portable equipment either within the safety-related plant structures or in a storage building(s) that will meet the NEI 12-06 protection guidelines. The conceptual design of the new FSB is described in Section 3.1.1.1 of this report. The licensee posted the conceptual design drawing of the FSB on its e-portal. The design provides for a HVAC system for maintaining a heated environment during cold weather.

During the audit process, the license stated that specifications for FLEX equipment will include the ability to drain the equipment to preclude freezing of process fluids and coolant systems will be equipped with adequate anti-freeze to ensure that they will remain operational in the lowest postulated temperatures established for BDBEE conditions. In addition to FLEX equipment being stored "dry," all storage locations (auxiliary building and FLEX storage building) will be climate controlled prior to onset of the event. Given the heavy concrete construction of these structures, they would not be expected to lose temperature rapidly, before the equipment is deployed and made operational.

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 FLEX equipment considering the snow, ice and extreme cold hazard, 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 FLEX 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 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 respect to consideration 1:

During the audit process, the licensee stated that he FCS modification design procedure requires the consideration of environmental conditions when specifying equipment that will be used to support plant operations. Section 4.10.3.A in procedure PED-GEI-3, "Preparation of Modifications," addresses environmental condition considerations, including temperatures. The operating environment under which the FLEX equipment must operate will be defined as part of the FLEX design process for the associated support systems and components.

With respect to consideration 2:

The conceptual design drawing of the FSB layout posted on the licensee's e-portal shows the following equipment stored inside that is to be used for snow removal;

- Front End Loader, for debris and/or snow removal
- A four wheel drive truck with a snow blower

With respect to consideration 3:

Although the existing procedure AOP-01, "Acts of Nature," addresses the formation of frazil ice in the intake structure, the Integrated Plan did not address potential adverse impact of frazil ice or other ice blockage on the use of portable pump or fire trucks drawing on the ultimate heat sink. During the audit the licensee stated if the UHS is utilized, FLEX debris clearing equipment will be available to ensure an opening in the ice can be provided to accommodate a suction hose.

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 considering the snow, ice and extreme cold hazard, 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 transport the FLEX equipment. This includes both access to the transport path, e.g., snow removal, and appropriately equipped vehicles for moving the equipment.

During the audit process, the licensee stated that as part of the environmental review for design of FLEX system and component interfaces, FCS will address low temperatures and their potential effects on FLEX equipment deployment and operation.

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 considering the snow, ice and extreme cold hazard, 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 materials and equipment.

The considerations in using offsite resources discussed in Section 3.1.1.4 of this report are also applicable considering the snow, ice and extreme cold hazard. The licensee has not identified the off site staging areas nor assessed the access routes to the site considering the snow, ice and extreme cold hazard. This is combined with Confirmatory Item 3.1.1.4.A in Section 4.2.

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 the issue related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to use of off-site resources considering the snow, ice and extreme cold hazard, if these considerations are implemented as described.

3.1.5 High Temperatures

NEI 12-06, Section 9.2 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 3 of the Integrated Plan, the licensee stated that per the USAR the extreme temperature recorded at the site is 114 degrees F. Thus, the FCS site screens in for extreme heat.

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 for high temperature, 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 18 of the Integrated Plan, the licensee stated that it will store the FLEX portable equipment either within the safety-related plant structures or in a storage building(s) that will meet the NEI 12-06 protection guidelines. The conceptual design of the new FSB is described in Section 3.1.1.1 of this report. The licensee posted the conceptual design drawing of the FSB on its e-portal. The design provides for a HVAC system for controlling the environment in the FSB.

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 FLEX equipment considering the effects of high temperature, 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.

As discussed in Section 3.1.5.1 above, the conceptual design of the FSB provides for a HVAC system. The ability to deploy FLEX equipment from the FSB is not expected to be adversely affected by high ambient temperatures.

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 the FLEX equipment considering the high temperature hazard, 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 FLEX equipment.

During the audit process, the licensee stated that he FCS modification design procedure requires the consideration of environmental conditions when specifying equipment that will be used to support plant operations. Section 4.10.3.A in procedure PED-GEI-3, "Preparation of Modifications," addresses environmental condition considerations, including temperatures. The operating environment under which the FLEX equipment must operate will be defined as part of the FLEX design process for the associated support systems and components.

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 addressing the effects of high temperatures on the FLEX equipment, 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 BDBEEs in order to maintain or restore core cooling, containment and SFP 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 SFP and to maintain containment capabilities in the context of a BDBEE 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 described in NEI 12-06, Section 1.3, "[p]lant-specific analyses will determine the duration of each phase." This baseline coping capability is supplemented by the ability to use portable pumps to provide reactor pressure vessel (RPV)/reactor makeup in order to restore core or SFP capabilities as described in NEI 12-06, Section 3.2.2, Guideline (13). The NRC endorsed this approach with JLD-ISG-2012-01.

### 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 leak reactor coolant pump 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 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 3.2.1.4 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.

3.2.1.1 Computer Code Used for the ELAP Analysis

NEI 12-06, Section 1.3 states in part:

> 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.

On page 6 of the Integrated Plan, the licensee stated that a site specific NSSS evaluation has been performed using Combustion Engineering Nuclear Transient Simulation (CENTS) computer code. The analysis is consistent with WCAP-17601-P. Attachment 1B of the Integrated Plan provides a summary of key parameters of interest.

During the audit process, the licensee addressed the seven objectives and recommendations of WCAP-17601 Section 3.2 in response to an ELAP event. The recommendations and licensees responses are as follows:

> Objective 1 recommends isolating CBO [RCP controlled bleed off] return line as early as possible.
>
> Current plant design does not ensure early and continuous CBO isolation. FCS intends to modify the CBO relief isolation valve to ensure that it can be closed and will remain closed in an ELAP event. To support FLEX strategies, FCS will revise the EOPs in a manner to credit CBO isolation in 10 minutes.
>
> Objective 2 recommends plant cooldown within the first 24 hours and review of physics parameters on a cycle by cycle basis to ensure adequate shutdown margin.
>
> FCS will perform a symmetric natural circulation cooldown and depressurization in the 2 to 6 hr timeframe at a nominal rate of 75 degrees F/hr to a SG pressure of 120 psia. Review of physics parameters on a cycle by cycle basis will ensure adequate shutdown margin is provided.
>
> Objective 3 recommends procedures promote an early and extensive cooldown and depressurization of the RCS subsequent to an ELAP.
>
> Fort Calhoun will perform a symmetric natural circulation cooldown and depressurization in the 2 to 6 hr timeframe at a nominal rate of 75 F/hr to a SG pressure of 120 psia.
>
> Objective 4 recommends plant cooldown and depressurization should not be precluded based upon the possibility that a solid plant condition could ensue.
>
> Fort Calhoun FSGs will provide guidance for rapid cooldown in the 2-6 hour timeframe. The use of low pressure (nominally, 250 psia) safety injection tanks (SITs) at FCS preclude the concern about solid plant operations.

Objective 5 recommends a backup portable pump for the TDAFW pump.

Fort Calhoun will provide two independent means to provide makeup water to the SGs using pre-staged or portable FLEX pumps.

Objective 6 recommends procedures dictate the operator review SIT parameters, and using the ideal gas law, determine the RCS pressure at which the SITs would empty.

Due to the use of low pressure SITs, analysis has shown that isolation of the SITs is not required prior to stabilizing the plant at 350°F. FSGs will provide guidance to isolate the SITs prior to a resumption of a cooldown to less than 350°F.

Objective 7 recommends procedures reduce the likelihood of a stagnant loop during an asymmetric RCS cooldown.

The safety-related TDAFW Pump provides makeup to both SGs and safety-related ADVs will steam both SGs. The backup FLEX SG fill connections are capable of feeding both SGs via either the primary or secondary FLEX flow path.

The licensee has provided a Sequence of Events (SOE) in their Integrated Plan, which included the time constraints and the technical basis for the site. That SOE is based on an analysis using the industry-developed CENTS computer code. CENTS was written to simulate the response of pressurized water reactors to non-LOCA (loss of coolant accident) transients for licensing basis safety analysis.

The licensee has decided to use the CENTS computer code for simulating the ELAP event. Although the NRC staff acknowledges that CENTS has been reviewed and approved for performing non-LOCA transient analysis, the NRC staff has not examined its technical adequacy for simulating the ELAP event. A generic concern associated with the use of CENTS for ELAP analysis arose because NRC staff reviews for previous applications of the CENTS code had imposed a condition limiting the code's heat transfer modeling in natural circulation to the single-phase liquid flow regime. This condition was imposed due to the lack of benchmarking for the two-phase flow models that would be LOCA scenarios. Because the postulated ELAP scenario generally includes leakage from reactor coolant pump seals and other sources, two-phase natural circulation flows may be reached in the RCS prior to reestablishing primary makeup. Therefore, the NRC staff requested that the industry provide adequate basis for reliance on simulations with the CENTS code as justification for licensees' mitigation strategies.

To address the NRC staff's concern associated with the use of CENTS to simulate two-phase natural circulation flows that may occur during an ELAP for the licensee and other CE-designed PWRs, the Pressurized Water Reactor Owners Group (PWROG) submitted a position paper dated September 24, 2013, entitled "Westinghouse Response to NRC Generic Request for Additional Information (RAI) on CENTS Code in Support of the Pressurized Water Reactor Owners Group (PWROG)" (ADAMS Accession No. ML13297A174 (Non-Publicly Available)). This position paper provided a comparison of several small-break LOCA simulations using the CENTS code to the CEFLASH-4AS code that was previously approved for analysis of design-basis small-break LOCAs. The analyses in the position paper show that the predictions of CENTS were similar or conservative relative to CEFLASH-4AS for key figures of merit for natural circulation conditions, including the predictions of loop flow rates and the timing of the transition to reflux boiling. The NRC staff further observed the fraction of the initial RCS mass remaining at the transition to reflux boiling predicted by the CENTS code for the ELAP simulations in WCAP-17601-P to be (1) in reasonable agreement with confirmatory analysis performed by the staff with the TRACE code and (2) within the range of results observed in scaled thermal-hydraulic tests that involved natural circulation (e.g., Semi-scale Mod-2A, ROSA-IV large-scale test facility). After review of this position paper, the NRC staff endorsed a resolution through letter dated October 7, 2013 (ADAMS Accession No. ML13276A555 (Non-Publicly Available)). This endorsement contained one limitation on the CENTS computer code's use for simulating the ELAP event. That limitation is provided as follows:

- The use of CENTS in the ELAP analysis for CE plants is limited to the flow conditions prior to reflux boiling initiation. This is identified as Confirmatory Item 3.2.1.1.A in Section 4.2.

This includes providing a justification for how the initiation of reflux boiling is defined.

During the audit process, the licensee stated that the results of the FCS plant specific analysis for NSSS thermal hydraulic response following an ELAP was performed and that this analysis assumed 1 gpm unidentified leakage and 15 gpm leakage from each of the four RCP seal packages as described in general methodology used in WCAP-17601-P. As described in the Westinghouse position paper supporting use of the CENTS code, onset of two- phase natural circulation flow is expected in eight hours, and reflux boiling is expected in 15.8 hours. Per its analysis, the licensee stated that core uncovery in this scenario is expected in approximately 42 hours. FCS is planning to modify the reactor coolant pump controlled bleed off (CBO) relief isolation valve to ensure that it will remain closed during an ELAP event. This will allow FCS to reduce the assumed RCP seal leakage to approximately 1 gpm/seal, which will significantly increase the time to two-phase natural circulation flow and reflux boiling. Once the design process on the modification of the CBO has verified the viability of this modification, FCS will re-analyze the NSSS response and establish new values for two-phase and reflux boiling intervals. This is combined with Confirmatory Item 3.2.1.1.A above and in Section 4.2.

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 computer code used to perform ELAP analysis, if these requirements are implemented as described.

3.2.1.2 RCP Seal Leakage Rates

Conformance with the guidance of NEI 12-06, Section 3.2.1.5, item (3) includes consideration of reactor coolant pump seal leakage. When determining time constraints and the ability to maintain core cooling, it is important to consider loss of RCS inventory as this can have a significant impact on the SOE. Special attention is paid to the reactor coolant pump seals because these can fail in a station blackout (SBO) event and contribute to beyond normal system leakage.

During an ELAP event, cooling to the RCP's 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 emergency core cooling system, 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 an SOE in their Integrated Plan, which included the time constraints and the technical basis for their site. 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 was addressed by the Nuclear Energy Institute (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 Nos. ML13042A011 and ML13042A013 (Non-Publicly Available)).

- A position paper dated August 16, 2013, entitled "Westinghouse Response to NRC Generic Request for Additional Information (RAI) on Reactor Coolant Pump (RCP) Seal Leakage in Support of the Pressurized Water Reactor Owners Group (PWROG)" (ADAMS Accession No. ML13235A151 (Non-Publicly Available)).

After review of these submittals, the NRC staff has placed certain limitations for Combustion Engineering (CE) designed plants (with the exception of Palo Verde Nuclear Generating Station). Those limitations are provided as follows:

(1) 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 (15 gpm/seal) discussed in the PWROG position paper addressing the RCP seal leakage for CE plants. If the RCP seal leakage rate used in the plant-specific ELAP analysis is less than upper bound expectation for the seal leakage rate discussed in the position paper, justification should be provided.

On page 24 of the Integrated Plan, the licensee stated that in Phase 1 for RCS inventory control actions are taken to isolate CBO, and to initiate rapid cooldown to 350 degrees F. The licensee explained that CBO isolation reduces the loss of RCS inventory by eliminating an estimated 15 gpm/seal leakage. The only loss of RCS inventory remaining will the unidentified leakage of 1 gpm plus 1 gpm of leakage per seal, for a total loss of RCS inventory of 5 gpm. The licensee noted that the rapid cooldown provides several advantages including among them the reduction in the potential for seal failure and reduction in the leakage amount should any other leakage develop. The licensee further stated that in order to keep the isolation path closed even after air in the actuator accumulator is exhausted, a modification will be required on relief isolation valve to make it fail in the closed position.

On page 26 of the Integrated Plan the licensee stated that the objective of RCS inventory control is to compensate for the loss of RCS coolant through reactor coolant pump seals or unidentified leakage and prevent uncovering of the core. The licensee stated that FCS site specific analysis showed that time before the core is uncovered was determined to be 42 hours with the seal leakage at 15 gpm per seal. The Phase 2 coping strategy as indicated in the SOE timeline in Attachment 1A of the Integrated Plan is to start makeup to the RCS at 40 hours after the ELAP event. If the total RCS leakage rate is reduced to 5 gpm the time to core uncovery is expected to be of the order of five days. Once the viability of the modification to assure CBO isolation is confirmed, the time to core uncovery will be recalculated. Implementation of the modification to the relief isolation valve is identified as Open Item 3.2.1.2.A in Section 4.1.

The case applicable to Fort Calhoun for RCS inventory control analysis listed in Table 4.1.2.1-1 of WCAP-17601-P assumed that the RCP seal leakage commences at the pressure in the RCS at the time subcooling in the RCS cold leg is less than 50 degrees F. This assumption is based on the information in Section 4.2.2 of WCAP-17601-P, which states that the probability of seal failure greatly increases when there is less than 50 degrees F subcooling in the RCS cold legs. However, the licensee did not discuss in the Integrated Plan whether seal failure will occur or not when subcooling in the RCS cold legs is greater than 50 degrees F. The licensee did not specify and justify the seal leakage rate assumed in the ELAP analysis from the initiation of the ELAP event to the time frame when subcooling in the RCS cold legs decreases to less than 50 degrees F. This is identified as Confirmatory Item 3.2.1.2.B in Section 4.2.

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 successful closure of issues related to the Open and Confirmatory Items, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to RCP seal leakage rates, 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 1 of Attachment 1B of the Integrated Plan, the licensee stated that the decay heat model used in plant specific analysis was the same as used in WCAP 17601-P which was ANS 5.1-1979 + 2 sigma or equivalent.

During the audit process, the licensee stated that it performed a series of plant-specific evaluations for various conditions to establish plant conditions, flow rates and event timing for ELAP events. Both the plant-specific evaluations and WCAP-17601-P used ANS 5.1-1979 + 2 sigma as the decay heat model. The current FCS accident analyses of record use ANS 5.1-1971 x 1.2, plus the Babcock and Wilcox (B & W) actinides model (to account for uncertainty); however for the extended power uprate, FCS has utilized the ANS 5.1-1979 + 2 sigma model. Therefore, the licensee stated that it is considered acceptable to use this model for ELAP evaluation.

The licensee's Integrated Plan did not address the range of applicability of the following key plant parameters to the decay heat model, (a) initial power level, (b) fuel enrichment, (c) fuel burnup, (d) effective full power operating days per fuel cycle, (e) number of fuel cycles, if hybrid fuels are used in the core, and (f) fuel characteristics (addressing whether they are based on the beginning of the cycle, middle of the cycle, or end of the cycle). During the audit process the licensee clarified that because the plant-specific evaluations involved several different combinations of conditions intended to ensure that the FCS ELAP response is bounded, a simple listing of key parameters is not practical. The licensee stated that it will provide a table that identifies the key physics parameters for each of the scenarios. This is identified as Confirmatory Item 3.2.1.3.A in Section 4.2.

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 decay heat 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 page 4 of the Integrated Plan, the licensee listed the initial conditions assumed in the implementation of FLEX strategies. These initial conditions are in accordance with NEI 12-06.

During the audit process, the licensee stated that it has performed a plant-specific NSSS thermal-hydraulic evaluation that follows the methodology used in WCAP-17601-P. The comparison of the plant-specific analysis to WCAP-17601-P is provided in the Integrated Plan, Attachment 1B. The licensee stated that FCS will provide a matrix that identifies which inputs and assumptions are plant specific and which ones were derived from WCAP-17601-P. This is identified as Confirmatory Item 3.2.1.4.A in Section 4.2.

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 initial values for key plant parameters and assumptions, 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 SAMGs [Severe Accident Management Guidelines]. 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 page 15 of the Integrated Plan, the licensee provided a table listing the instrumentation that is available to monitor the ELAP event. The instrumentation is:

- Containment Pressure
- Steam generator level
- Steam generator pressure
- Pressurizer pressure
- Safety injection tank level
- Cold leg temperature
- Hot leg temperature
- Emergency feedwater storage tank level

On page 36 of its Integrated Plan the licensee stated that the SFP level indication will be changed to comply with NRC Order EA-12-051.

During the audit process the licensee stated that all instrumentation specified for ELAP mitigation is safety related instrumentation and is environmentally qualified (EQ) with the exception of the safety injection tank level indication. The EQ qualification of the instrumentation located in containment is 60 psig, 382 degrees F and 100% humidity. As noted in Section 3.2.3, it takes 257 hours for the containment pressure to reach 60 psig, assuming a 60 gpm leakage from the RCP seals. All of the instrumentation in Table 1 of the Integrated Plan is located in the containment with the exception of the EFWST level, which is located in the auxiliary building. No environmental qualification has been provided for the EFWST level instrumentation. This is identified as Confirmatory Item 3.2.1.5.A in Section 4.2.

During the audit process, the licensee stated that analysis of the FCS containment environment following an ELAP showed the containment environment is bounded by the environment caused by a main steam line break (MSLB) or a LOCA. Furthermore the licensee stated that the mitigation strategy for implementation of Phase 3 containment cooling equipment (no portable equipment is required to maintain acceptable conditions in Phase 2) will ensure that the system is deployed and functioning to adequately remove heat from containment prior to exceeding EQ limits.

The licensee further stated that following the updated analysis, FCS will assess the capability of the SIT level indication to function in the predicted environment and either demonstrate that the existing instruments will remain functional or replace the instruments with ones that meet the requirements for use in an ELAP scenario. This is identified as Confirmatory Item 3.2.1.5.B in Section 4.2.

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 monitoring instrumentation and controls, if these requirements are implemented as described.

### 3.2.1.6 Sequence of Events

NEI 12-06 discusses an event timeline and time constraints in several sections of the document, for example Section 1.3, Section 3.2.1.7 principle (4) and (6), Section 3.2.2 Guideline (1) and Section 12.1.

NEI 12-06, Section 3.2.2, in part, 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.

In order to support the objective of an indefinite coping capability, each plant will be expected to establish capabilities consistent with Table 3-2 (PWRs). Additional explanation of these functions and capabilities are provided in NEI 12-06 Appendix D, "Approach to PWR Functions."

In Attachment 1A of the Integrated Plan, the licensee has provided an SOE timeline, which included the time constraints and the technical basis for the site. The licensee stated that the SOE provides an overview of the time constraints and actions taken in response to an ELAP/LUHS at FCS. On page 6 of the Integrated Plan, the licensee stated that the sequence described is a general description of plant response and actions by station personnel. It is not intended to define exact completion times. Deployment strategies for actions to be completed in less than 8 hours have been deemed feasible within the identified time constraints based on preliminary walkdowns conducted by Engineering and Operations personnel. The licensee further stated that formal timeline walkthroughs will be completed during the FLEX equipment design and procurement process. Validation of the action times reported in the SOE is identified as Open Item 3.2.1.6.A in Section 4.1.

The licensee stated that maintaining the shutdown margin with rapid cooldown is a concern that has been addressed. FCS plant-specific studies have found that the advantages of the rapid cooldown strategy investigated for the PWROG would apply to FCS also. Rapid cooldown is accomplished by releasing steam at a faster rate from the air-assisted SG safety relief valves. Analysis has shown, as noted on page B-5 of the Integrated Plan, that the existing SG power operated relief valves (PORVs) are capable of supporting rapid cooldown at 75 degrees F/hr to about 400 degrees F. Further cooldown will be at a much slower rate and would require approximately 48 hours to cooldown to 350 degrees F.

On page 24 of its Integrated Plan the licensee described two options available to increase the steam release rate and thus speed up the cooldown. The licensee stated that it could manually open the larger safety relief valves for which tools and procedures currently exist, or to modify the SG PORVs to increase their capacity. This modification was identified as required for the extended power uprate and a conceptual design was completed. The licensee further stated that FCS is considering the implementation of this modification, but it is not essential for implementing the FLEX strategies.

The licensee also stated that it may modify the SG PORV air accumulators such that they may be recharged with nitrogen when the air is depleted in order to continue to operate the SG PORVs remotely.

The licensee stated that because the rapid cooldown requires a higher feedwater flow rate to compensate for the higher steam release rate to remove sensible heat in addition to the decay heat, it is expected that the EFWST would need to be refilled in about 5.2 hours. Refilling of the EFWST will be required before it empties, as indicated in the Phase 2 strategy for RCS cooling and heat removal. Continuation of rapid cooling will be contingent upon being able to refill the EFWST.

Further on page 25 of the Integrated Plan, the licensee stated that action to isolate the CBO relief line will be added to the existing SBO procedure. CBO isolation is indicated in the SOE timeline at T+10 minutes. The rapid plant cooldown will not be initiated until it has been determined that the event duration is expected to exceed the SBO coping period. The rapid cooldown strategy will be included in a new FLEX support procedure, which will be developed based on actions in Appendix B of the Integrated Plan. The licensee will utilize the industry developed guidance from the Owners Groups, EPRI and NEI Task team to develop these site specific procedures or guidelines to address the criteria in NEI 12-06.

As discussed in Section 3.2.1.2 of this technical evaluation report, FCS is planning to modify the reactor coolant pump CBO relief isolation valve to ensure that it will remain closed during an ELAP event. This will allow FCS to reduce the assumed RCP seal leakage to approximately 1 gpm/seal, which will significantly increase the time to two-phase natural circulation flow and reflux boiling. As discussed in Section 3.2.1.1 of this report, the NSSS response using the CENTS code with the lower RCP seal leakage rate expected after plant modification to isolate the CBO needs to be performed. This reanalysis may affect the SOE timeline presented in the Integrated Plan. Confirmation that the SOE timeline has been updated and the overall FLEX mitigation strategies reflect the updated CENTS code results is identified as Confirmatory Item 3.2.1.6.B in Section 4.2.

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 and Confirmatory Items, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to the sequence of events timeline, 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 NRC staff's review of the Integrated Plan for Fort Calhoun revealed that the Generic Concern related to shutdown and refueling requirements is applicable to the plant. This Generic

Concern has been resolved generically through the NRC endorsement of 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. During the audit process, the licensee stated that they would abide by this generic resolution. The NRC staff will evaluate the licensee's resulting program through the audit and inspection processes.

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:

> All plants provide means to provide borated RCS makeup.

On pages B-7 and B-8 of the Integrated Plan, the licensee described the rapid cooldown of the RCS. The licensee stated that one advantage of rapid cooldown is that the reduction in RCS pressure allows the SITs to inject borated water thereby helping to maintain shutdown margin. The licensee stated that the reactivity management situation is improved in the early cooldown situation because the combined negative reactivity from the SIT injection and the xenon buildup offset the positive reactivity increase resulting from the RCS temperature decrease. The licensee further stated that at a RCS hot leg temperature of approximately 350 degrees F and a RCS pressure of approximately 120 psia, a plant-specific analysis has determined that at these conditions the SITs have injected sufficient borated water to maintain adequate shutdown margin after the xenon has decayed away.

On page B-8 of the Integrated Plan, the licensee stated that a plant-specific analysis has also determined that the SITs will not inject nitrogen into the RCS until RCS pressure falls below 100 psia. Thus, the target pressure at the completion of the cooldown is 100 - 150 psia. During the audit process the licensee added that once the RCS reaches 350 degrees F, procedural guidance will direct stabilization of temperatures until the large FLEX DG can be deployed, allowing the SIT isolation valves to be energized and closed.

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 RCS under natural circulation conditions potentially involving two-phase flow is applicable to this licensee.

The PWROG 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. In an endorsement letter dated January 8, 2014

(ADAMS Accession No. ML13276A183), the NRC staff concluded that the August 15, 2013, position paper constitutes an acceptable approach for addressing boric acid mixing under natural circulation during an ELAP event, provided that the following additional conditions are satisfied:

(1) The required timing for providing borated makeup to the primary system should consider conditions with no reactor coolant system leakage and with the highest applicable leakage rate for the reactor coolant pump seals and unidentified reactor coolant system leakage.

(2) For the condition associated with the highest applicable reactor coolant system leakage rate, two approaches have been identified, either of which is acceptable to the staff:

   a. Adequate borated makeup should be provided such that the loop flow rate in two-phase natural circulation does not decrease below the loop flow rate corresponding to single-phase natural circulation.

   b. If loop flow during two-phase natural circulation has decreased below the single-phase natural circulation flow rate, then the mixing of any borated primary makeup added to the reactor coolant system is not to be credited until one hour after the flow in all loops has been restored to a flow rate that is greater than or equal to the single-phase natural circulation flow rate.

(3) In all cases, credit for increases in the reactor coolant system boron concentration should be delayed to account for the mixing of the borated primary makeup with the reactor coolant system inventory. Provided that the flow in all loops is greater than or equal to the corresponding single-phase natural circulation flow rate, the staff considers a mixing delay period of one hour following the addition of the targeted quantity of boric acid to the reactor coolant system to be appropriate.

During the audit process, the licensee stated that it performed a plant-specific evaluation that considers the reactivity effects of performing a rapid RCS cooldown. This analysis shows that the reactor will remain subcritical following a cooldown to 350 degrees F. The only concentrated boron that is added during this period comes from the SITs. The licensee explained that while the evaluation does not specifically address the 60 minute delay in reactivity effects described in the boron mixing model, a one hour delay in boron delivery from the SITs would not result in a change to the conclusion that the reactor will remain subcritical throughout the event. The licensee also stated during the audit process that borated makeup water (beyond that provided by the SITs) is not needed to assure margin to criticality during the cooldown phase. The core will remain subcritical during an ELAP and subsequent cooldown to 350 degrees F. The licensee stated that procedural direction will be provided to ensure that adequate borated water is added at least one hour prior to cooldown below 350 degrees F.

During the audit process the licensee stated that the current air assisted main steam safety valves will be replaced with new, larger capacity valves to accommodate the desired cooldown rate. Once the design for the new safety valves is complete, FCS will perform an additional case evaluation to validate that the core will remain subcritical during an ELAP, and the effects of boron mixing will be specifically addressed.

The licensee's boron mixing discussion above does address some of the considerations of the NRC staff in the review and endorsement of the PWROG position paper. That said, upcoming licensee decisions and analysis regarding the CBO isolation valve modification and completing action time validation and accompanying impacts to the Sequence of Events, may require a review of the above boron mixing conclusions. As such, resolution of this concern is identified as Confirmatory Item 3.2.1.8.A in Section 4.2.

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 core subcriticality, if these requirements are implemented as described.

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 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 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 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.
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> 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 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 7 of the Integrated Plan the licensee stated the transition from Phase 1 to Phase 2 for the core cooling function occurs by providing makeup to the EFWST from the SIRWT using a FLEX safety injection and refueling water tank (FSP) electric driven pump. Refilling of the EFWST allows the auxiliary feedwater pump to continue supplying water to the steam generators. The FSP is stored in the auxiliary building and is powered by a dedicated FLEX 200kW diesel generator also stored in the fuel handling building for rapid deployment. On page B-9 of the Integrated Plan, it states that an electrically driven submersible pump can be used as a backup if the FSP is unavailable. The submersible pump is lowered into the SIRWT through the tank's hatch. This submersible pump is also powered by the dedicated FLEX 200 kW diesel generator that powers the FSP. The submersible backup pump is stored in the auxiliary building. If the dedicated FLEX 200 kW diesel generator is not available to power the submersible pump or the FSP, the diesel driven B.5.b pump can be deployed. This pump is also stored in the auxiliary building.

On page 16 of the Integrated Plan, the licensee stated that other sources of water may be used to refill the EFWST when the SIRWST is empty and other clean sources are unavailable. One method is to use the well pump and supply well water to the EFWST. Ultimately, the Missouri River can be accessed using a fire truck alone or in combination with a portable river pump, depending on river level, to supply water to the FLEX valve station (FVS) which can direct the water to the EFWST. The layout of the proposed FSB posted on the licensee's e-portal shows one fire truck and two river drafting pumps stored in the new FSB.

On page B-37 of the Integrated Plan, the licensee described the method for supplying well water or river water directly to either of the two steam generators for cooldown when the turbine driven auxiliary feedwater (TDAFW) pump is not available. The well pump or the fire truck alone, or the fire truck in combination with the river pump, can supply water to the FVS from which the water can be directed to the steam generators.

On page 26 of the Integrated Plan, the licensee stated that for maintaining RCS inventory, the RCS can be fed in three ways. The primary approach is to use the installed charging pump (any one of the three) taking water from the SIRWT or the boric acid storage tanks (BASTs). The charging pump would be powered by the FLEX 200kW DG deployed to the truck bay of the fuel handling building. An alternate approach is to use the FSP drawing on the SIRWT and the third approach is to use the river water using the fire truck alone, or the fire truck in combination with the river pump. The FSP and river water pumps discharge to the FVS which then directs the flow into the RCS.

On page 35 of the Integrated Plan, the licensee stated that for maintaining SFP cooling, the SFP can be fed in three ways. The FSP drawing on the SIRWT, the alternate submersible pump or the B.5.b pumps drawing on the SIRWT, and the fire truck and river draft pump drawing on the Missouri River. All three configurations connect to the FVS located in the fuel handling building. From the FVS the water is directed to the SFP operating deck via a combination of hose and hard pipe directly into the pool.

Fuel for portable equipment will be provided from the emergency diesel generator tank FO-1 or the diesel generator day tanks, using portable fuel transfer pumps and tanks as currently credited for other ELAP/LUHS scenarios. Tank FO-1 contains a minimum of 16,000 gallons of fuel oil. Additionally, several hundred gallons of fuel are available in the diesel generator day tanks and base tanks. During the audit process, the licensee stated that a fuel storage tank will also be provided in the FSB.

Additional details of the fuel requirements for the portable pumps and generators are provided in Section 3.2.4.9 of this report.

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 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 SFP 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.

On page 34 in the Integrated Plan regarding maintaining spent fuel pool cooling during the initial phase, the licensee stated that a plant specific evaluation has been performed, showing that minimum time to boil in the spent fuel pool is approximately 19 hours (7 hours for full core offload) and approximately 100 hours for boil-off to reach 8 ft above the active fuel (40 hours for full core offload). The licensee stated that there are no Phase 1 actions required.

On page 35 in the Integrated Plan, the licensee stated that a FCS specific SFP analysis was performed which determined that makeup water will be required at a flow rate of at least 17.6 gpm when the pool starts to boil. In Attachment 1A in the Integrated Plan, the SOE timeline shows that makeup to the spent fuel pool will be established at 16 hours after the ELAP. This timing provides margin to the 19 hours for the onset of pool boiling. The time constraint on this action is 100 hours which is when the SFP water level reaches eight feet above the top of the fuel racks. Additionally, the licensee stated that maintaining or increasing the water level in the pool will maintain the radiation levels in the fuel pool area of the auxiliary building at tolerable levels.

Additionally, it is noted in the Integrated Plan that that the evaporation and/or boiling of the SFP will cause high humidity and steam inside the FHB and ventilation will have to be provided. During the audit process the licensee stated that it will install ventilation pathways in the FHB walls or roof to ensure that heat and vapor generated due to boiling in the SFP do not preclude habitability and equipment functionality within the building. A conceptual design for the location and configuration of the vents is posted on the licensee's e-portal. Since the damper forms part of the auxiliary buildings radiological boundary it will be classified as a safety related system designed for seismic and tornado loads.

On page 35 of the Integrated Plan, the licensee stated that for maintaining SFP cooling, the SFP can be fed in three ways. The FSP drawing on the SIRWT, the alternate submersible pump or the B.5.b pumps drawing on the SIRWT, and the fire truck and river draft pump drawing on the Missouri River. All three configurations connect to the FVS located in the auxiliary building. From the FVS the water is directed to the SFP operating deck via a combination of hose and hard pipe directly into the pool. On page C-18 of the Integrated Plan the licensee describes a modification to install piping that directly fills the SFP without requiring access to the operating deck of the SFP.

On page B-50 in the Integrated Plan, the licensee stated that for SFP cooling, the Phase 2 FLEX strategy provides cooling making up for boil-off from the SFP. To return the SFP to a sub-cooled state and establish a recirculation cooling flow path, two separate Phase 3 strategies are provided: 1) establish cooling water to the SFP heat exchanger, and 2) utilize a portable SFP heat exchanger. The licensee stated that the preferred means of establishing SFP recirculation cooling is to use the installed SFP cooling system and provide cooling water to the SFP heat exchanger. Once power is restored to 4160 Vac bus using the RRC supplied DG, a SFP cooling pump can be started. FCS has specified that the RRC supply self-powered, low pressure high capacity pumps rated at 1,200 gpm/120 psi that would be used to supply cooling water to the SFP heat exchanger by drafting from the UHS. Phase 3 tie-in points will be established. If resources and equipment are available and the SFP cooling system is intact, this strategy may be implemented in Phase 2 in lieu of relying on SFP makeup for cooling, using the Phase 2 FLEX 200 kW diesel generator and B.5.b equipment for cooling 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 SFP cooling strategies, 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. For example: containment pressure control/heat removal utilizing containment spray or repowering hydrogen igniters for ice condenser containments.

On page 30 in the Integrated Plan, the licensee stated that an FCS specific analysis shows that the containment design limits will not be challenged until approximately 10 days after the ELAP event. The licensee stated that there are no Phase 1 actions required to maintain containment at this time that need to be addressed.

On page 31 in the Integrated Plan, the licensee stated that a FCS specific containment analysis showed that a containment pressure of 5.4 psig is reached in 24 hours. During the audit process, the licensee stated that analysis of the FCS containment environment following an ELAP showed that it would take 257 hours for the containment pressure to reach 60 psig, assuming a 60 gpm leakage from the RCP seals (15 gpm per pump). Based on this analysis the licensee stated that the containment environment during an ELAP is bounded by the environment caused by a main steam line break (MSLB) or a loss of coolant accident (LOCA). Furthermore the licensee stated that the mitigation strategy for implementation of Phase 3 containment cooling equipment (no portable equipment is required to maintain acceptable conditions in Phase 2) will ensure that the system is deployed and functioning to adequately remove heat from containment prior to exceeding design limits.

During the audit process, the licensee stated that its containment response for an ELAP was performed using the Westinghouse proprietary code CONTRANS. The RCS heat losses to containment and the mass and energy released from the RCP seals were calculated by the Westinghouse CENTS code. The case was allowed to run for 1,000,000 seconds so the containment pressure at 24 hours and the time to reach 60 psig could be evaluated.

During the audit process the licensee stated that FCS is planning a modification to the RCP controlled bleed off relief isolation valve. This modification would reduce assumed RCS leakage via the RCP seals from 15 gpm per pump to an assumed 1 gpm per pump. If this modification is determined to be viable, the licensee stated that the plant-specific containment analysis will be updated to assess containment conditions following an ELAP. The licensee expected that the lower leakage rate will lead to significantly improved containment conditions and the containment pressure would remain below the design pressure for much longer. The licensee further indicated that containment isolation is not an issue as it would be achieved automatically. Therefore, no Phase 2 actions are required for maintaining containment.

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On page 33 in the Integrated Plan, the licensee stated that containment cooling may be required after 10 days following the event (or a considerably longer time as determined by a re-analysis of the containment if the CBO is isolated). The licensee stated that one way of accomplishing containment cooling is the use of the containment cooler using approximately1200 gpm of river water and providing power to the containment cooler fan by an RRC supplied DG. This is the preferred means of containment heat removal that FCS will pursue. Alternately, the licensee stated that containment spray may be used to reduce containment temperature and pressure. Higher flow rates will be required to perform this function. On Attachment 1 in the Integrated Plan, the SOE timelines shows initiation of containment cooling, using equipment provided by the RRC, at time 72 hours after the ELAP. This provides considerable margin before reaching time constraint associated with challenging the containment design limits at 250 hours.

On page B-49 of the Integrated Plan, the licensee further described the preferred means of establishing containment heat removal by restoring a containment fan cooling unit to service. Upon restoration of power to the plant's 4160 Vac bus using the RRC supplied DG, a containment cooling fan can be started to establish air flow within containment. FCS has specified that the RRC supply self-powered, low pressure high capacity pumps rated at 1,200 gpm/120 psi that would be used to supply cooling water to the operational containment cooling unit. This flow rate is adequate to remove the heat load from a design basis accident. The water will be introduced to the component cooling water (CCW) piping downstream of the inlet CCW/RW interface valves. The outlet CCW/RW interface valves would be opened to provide a cooling water return path to the river.

On page 50 of the Integrated Plan, the licensee stated that if it is determined that the containment cooling units cannot be used for heat removal, a containment spray (CS) pump can be used to reduce containment pressure and temperature using the normal CS flow path once power is restored to 4160Vac bus. In this scenario, initiation of CS must be coordinated with alignment of shutdown cooling (SDC), as the safety injection and containment spray systems are interconnected when on SDC.

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, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to maintaining containment, 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 functionality can be maintained. 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.

On page 12 in its Integrated Plan, the licensee stated that the core cooling will be accomplished with the actuation and operation of the TDAFW pump. Per FCS USAR Section 9.4.2, this pump has a self contained lube oil system and is not reliant on external cooling water sources.

On page 26 of the Integrated Plan, the licensee stated that for maintaining core inventory, the RCS can be fed using the installed charging pumps. No information was provided as to the cooling water needs, if any, required by the pumps. This is identified as Confirmatory Item 3.2.4.1.A in Section 4.2.

No other plant equipment used in Phase 1 or Phase 2 coping strategies potentially relying on external water for cooling has been identified.

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 equipment cooling with cooling water, 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 40 of the Integrated Plan, the licensee stated that under ELAP conditions the basic support of the safety functions required is that the environment in the required rooms/areas should support the personnel occupancy and/or the equipment functionality. During Phase 1, the areas of concern outside the containment are the TDAFWP room, EFWST room and the Main Control Room (MCR). Additionally, battery room ventilation was addressed during the audit process.

Auxiliary Building

During the NRC audit process, the licensee stated that the TDAFW is located in the auxiliary building in a high ceiling enclosure located below grade. Based on the existing EQ analysis, FCS expects that the room configuration will ensure acceptable environmental conditions following an ELAP without the need for portable ventilation or other modifications. As part of the design process for ensuring AFW water is continuously available following an ELAP, FCS will evaluate the environmental conditions in the vicinity of the TDAFW pump to ensure continuous equipment operation and acceptable human performance. This is identified as Confirmatory Item 3.2.4.2.A in Section 4.2.

On page 41 of the Integrated Plan, the licensee stated that in addition to the areas identified in Phase 1 coping, areas in use during Phase 2 will be the FHB (canal drain pump room, corridor where FLEX pumps are deployed and the truck bay) and auxiliary building room where the FVS is deployed. The licensee stated that environment in these areas will be analyzed and the results and resulting actions will be provided in a subsequent six-month update. This is combined with Confirmatory Item 3.2.4.2.A in Section 4.2.

Main Control Room

In the Integrated Plan the licensee addressed the impact of the environmental conditions expected in the main control room (CR) during Phase 1 on the electrical equipment. On page 41 of the Integrated Plan, the licensee stated that the reactor protective system panels and engineered safety feature panels were designed for, and the instrumentation was tested at, 120 degrees F. Based on the FCS Station Technical Specification Section 2.12, "Control Room Ventilation System," the temperature inside the control cabinets is at most 15 degrees F warmer than the temperature of the control room due to heat produced by the electronic circuitry. Therefore, the temperature in the· control room during normal operation is limited to a maximum of 105 degrees F to ensure operability of the control cabinets. During the audit process, the licensee stated that preliminary results from sensitivity runs using the GOTHIC code, established for FCS design basis control room heatup calculations, show that it is very unlikely that CR ventilation will be needed prior to re-establishing power to the CR ventilation fans. During the audit process the licensee stated that the control room heatup calculation is expected to be complete by March, 2014. This is identified as Confirmatory Item 3.2.4.2.B in Section 4.2.

The SOE timeline in Attachment 1A in the Integrated Plan indicates that at nine hours post ELAP, CR ventilation and lighting is to be restored using 200kW FLEX portable diesel generator connected to the station switchgear. A new FLEX portable 480 Vac switchgear and a new transfer switch will be provided to restore ventilation to the control room. Alternately, temporary ventilation using smoke ejector fans and lighting using light strings can be established powered by a portable 120V generator.

Battery Room

During the audit process, the licensee stated that the environmental conditions associated with BDB conditions in the battery room will be evaluated as part of the design process for the FLEX electrical equipment modifications. Heating and/or ventilation needs to ensure equipment performance will be defined in the detailed design for FLEX electrical systems. This is identified as Confirmatory Item 3.2.4.2.C in Section 4.2.

During the NRC audit process, with regards to hydrogen buildup in the battery room during charging, the licensee stated that re-powering of the battery room ventilation (or an alternate ventilation method) will be included as part of the design process for FLEX electrical equipment modifications. The process will consider the timeframe in which ventilation must be restored and, if necessary, provisions to provide temporary ventilation while the battery charger is being powered from the FLEX diesel generator will be established. When the design is complete, FCS will provide the design documentation or a summary of significant factors. This is identified as Confirmatory Item 3.2.4.2.D in Section 4.2.

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 – equipment room 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.

During the audit process the licensee addressed the issue of boron precipitation due to cold temperatures. The licensee stated that design basis conditions for FCS do not require heat tracing of safety related systems. For instance, the boric acid mixing tank (BAMT) 3.5 wt% maximum boron concentration has a solubility limit of 50 degrees F. All other borated water sources are of lower boron concentration than the BAMT. Currently, it is assumed that the SIRWT will provide borated water at approximately 2100 ppm as RCS makeup, which should be sufficient to maintain shutdown margin as the RCS is cooled down to less than 200 degrees F. At this concentration, the licensee stated boron precipitation is not an issue.

During the audit process, the licensee stated that the initial source of water used for SG, SFP and RCS makeup is the SIRWT. This tank holds a nominal 300,000 gallons of water, is located almost completely below grade and has a technical specification minimum temperature of 50 degrees F. Given this configuration, the licensee stated that freezing of this water source is not considered feasible. The emergency feedwater storage tank supplying the TDAFW pump is located in the upper mechanical penetration room of the auxiliary building, adjacent to the main steam lines. The licensee stated that the heat radiated from these lines and the stacks of the steam dump lines used for decay heat removal will ensure that the emergency feedwater supply to the TDAFW pump will remain available. The only installed equipment and piping that will be utilized in the FLEX response is the auxiliary feedwater system and portions of the SI and charging system piping. All of the associated components and piping are located within the auxiliary building, with the vast majority being located in rooms that are below grade. The licensee further clarified that the considerations regarding the SIRWT and the EFWST include the associated instrumentation needed to monitor key parameters for the FLEX equipment.

.

During the audit process, the licensee stated that after the SIRWT is emptied, other borated water for RCS makeup will come from a mobile boration skid supplied by the Regional Response Center, which will be equipped with heaters to ensure that boron remains in solution.

During the audit process, the licensee stated that the FLEX well is not expected to freeze, as the water supply will be well below the frost line. If the UHS is utilized, FLEX debris clearing equipment will be available to ensure an opening in the ice can be provided to accommodate a suction hose.

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 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.

On pages 8, 41, B-22 and B-24 of the Integrated Plan, the licensee stated that FCS expects to restore power to one MCR ventilation unit and the control room lighting panel within nine hours of the ELAP event. The lighting panel would be powered from the 200 kW FLEX diesel generator (FDG) that will be deployed in the FHB truck bay. During the audit process, the licensee stated that if CR lighting cannot be restored before the MCR emergency lighting battery packs are depleted, the small diesel generator that will be used to re-power one battery charger will also be sized to provide power to portable fans. Although not specifically discussed on page B-24, the licensee clarified that this alignment would also be used to maintain MCR lighting.

Also during the audit process the licensee stated that FCS will store portable lighting for the control room in a cage located adjacent to the electrical switchgear room (robust structure).

However, the Integrated Plan did not address lighting needs in other areas of the auxiliary building where deployment of FLEX strategies will take place nor did the plan address need for lighting in outdoor areas where FLEX equipment is required to be deployed. This is identified as Confirmatory Item 3.2.4.4.A in Section 4.2.

The NRC staff has reviewed the licensee communications assessment (ADAMS Accession Nos. ML12307A118 and ML13057A115) in response to the March 12, 2012 50.54(f) request for information letter for FCS and, as documented in the staff analysis (ADAMS Accession No. ML13141A608) 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 (8) regarding communications capabilities during an ELAP. Confirmation will be required that upgrades to the site's communications systems have been completed. This has been identified as Confirmatory Item 3.2.4.4.B in Section 4.2.

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 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.

On page B-44 of its Integrated Plan, the licensee stated that current procedural guidance is provided for offsite logistical support at the owner controlled area access point. The licensee's Integrated Plan did not otherwise address access to the protected area and internal locked areas during the ELAP event. This has been identified as Confirmatory Item 3.2.4.5.A in Section 4.2.

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 access to protected and internal 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.

Section 9.2 of NEI 12-06 states,

> 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.

As discussed in Section 3.2.4.2 in this report, the licensee has not completed the environmental conditions in all of the critical areas for using FLEX equipment and installed plant equipment during the ELAP event. While some assessments have been made as to equipment availability under ELAP environmental conditions, the impact of these environmental conditions on operator accessibility and habitability has not been completely addressed. The potential adverse impact on habitability within the auxiliary building from boiling in the SFP is being addressed by FCS by installation of new manually operated dampers to provide a new vent path from the pool area. This is discussed in Section 3.2.2 of this report. In the first six month update dated August 28, 2013, the licensee indicated that control room heatup calculation and evaluation of environmental conditions after extended loss of ac power (ELAP) in critical FLEX deployment areas are yet to be done. This is combined with Confirmatory Item 3.2.4.2.A in Section 4.2.

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 personnel habitability/accessibility in an elevated temperature environment, 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 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.

The licensee has identified three robust sources of water that can be credited for use in the FLEX strategies. These are the emergency feed water storage tank, the safety injection and refueling water storage tank, and the Missouri River. As described on page16 of the Integrated Plan, core cooling during Phase 1 is through the use of the TDAFW pump. The TDAFWP actuation and functioning is automatic. The pump draws water from the EFWST and feeds the SGs. The EFWST is a seismic Category I design, has a minimum storage capacity of 55,000 gallons and is located in the safety related auxiliary building. The water from the EFWST is expected to be exhausted in 5.2 hours after start of the ELAP when doing a rapid cooldown.

Water from the SIRWT will then be used to refill the EFWST to continue core cooling. The SIRWT is designed to seismic Category I criteria, contains a minimum of 283,000 gallons, and is protected from external hazards as it is located in the basement of the auxiliary building near the SFP. On page 8 of the Integrated Plan the licensee stated that based on makeup needs to the SGs and SFP and using conservative assumptions for available water from the SIRWT, the SIRWT will be depleted in approximately 24 hours. Means have been provided to refill the SIRWT through the use of available clean water sources on the site or the river water.

The Integrated Plan describes on page B-10, several other sources of clean water that are available at the site and the operator can be directed through the new FLEX procedure to use them if they survive the BDBEE. These cleaner water sources do not meet the criteria of NEI 12-06 and hence cannot be credited in the mitigation strategies. However, if any of these sources survive the BDBEE, their use will be less harmful to the plant equipment than the use of river water and, hence, are preferable. The licensee stated that the priority will be on using clean water sources before resorting to the Missouri River.

The third robust source of cooling water is the Missouri River. Water from the river can be used to refill the SIRWT and directly feed the SGs (when the TDAFW pump is unavailable).

On page C-26 in the Integrated Plan, the licensee stated that it is considering installing a well in order to access water that will be cleaner than the river water. The well can potentially be located to the east of the auxiliary building truck bay, between the east wall of the truck bay and the containment. The well pump can receive power from the FLEX DG that will be deployed within the truck bay. The well water can be substituted for any other clean water source, however as the licensee noted on page 17 of the Integrated Plan only the river (UHS) water can be credited per the NEI 12-06 guidelines.

Since the SIRWT water is borated, FCS is investigating the impact of chemistry of the water being fed into the SGs on corrosion of components in the flow path and heat exchange capacity of the SGs. The licensee stated that based on the results of a similar analysis at another plant, FCS expects that the results of the plant specific analysis to confirm acceptable performance. The water chemistry investigation will also look into the impact of the water chemistry from the various other water sources being considered for use in the FLEX strategies. This is identified as Confirmatory Item 3.2.4.7.A in Section 4.2.

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 B-18 in the Integrated Plan, the licensee stated that one of the two 1E battery chargers will be powered by the 200 kW FLEX diesel generator (FDG) deployed in the fuel handling building truck bay. If the 200 kW FDG cannot be deployed within 8 hours, the dc bus can be supplied with power using a backup 10 kW FLEX DG. Dc power is essential in the FLEX mitigation strategies for powering the essential instruments. FCS is currently equipped with two sets of 1E batteries. Each will last about 8 hours with the existing loads on them.

On page C-19, in Appendix C, in the Integrated Plan the licensee stated FCS will install new power cables from the new portable 200 kW FLEX diesel generator to directly power one of the three charging pumps, main control room exhaust fans and the main control room lighting panel, battery chargers, and the well pump .

During the audit process, the licensee stated that appropriate, coordinated current interrupting devices (i.e., safety related, double-isolation circuit breakers and/or fuses) will be used to provide fault protection and electrical separation between Class 1E (safety related) buses that may be cross-tied to provide power to credited installed equipment. FCS does not intend to power any portable FLEX equipment from the station electrical distribution system. At the onset of the ELAP, the safety related emergency diesel-generators are assumed to be unavailable to supply the safety related buses. FLEX portable generators are then used in response to an ELAP in FLEX strategies. At the point when ELAP mitigation activities require tie-in of FLEX generators, in addition to existing electrical interlocks, procedural controls, such as inhibiting EDG start circuits and breaker rack-outs, will be employed to prevent simultaneous connection of both the FLEX DGs and safety related EDGs to the same ac distribution system or component. Note that should the safety related EDGs become available during the event, they could be restarted to provide power to their associated busses to repower loads where safe and appropriate; this transition from FLEX portable sources to installed sources will also be procedurally controlled. Electrical protection when Phase 3 equipment is aligned will be determined after the specifications for Phase 3 generators have been established.

The Integrated Plan did not provide information regarding the technical basis for the selection and size of the FLEX generators to be used in support of the coping strategies. Supporting information should be provided to address both Phase 2 and 3 power requirements. The Integrated plan did not have any electrical single line drawings demonstrating the planned fault protection and electrical separation approaches. This is identified as Confirmatory Item 3.2.4.8.A in Section 4.2.

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 electric power sources and isolation, 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, initial condition (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.

On page B-44 in the Integrated Plan, the licensee stated that, initially, fuel for portable equipment will be provided from the emergency diesel generator tank FO-1 or the diesel generator day tanks, using portable fuel transfer pumps and tanks as currently credited for other ELAP/LUHS scenarios. Although the exact fuel usage rate cannot be calculated until FLEX equipment design is completed, FO-1 contains a minimum of 16,000 gallons of fuel oil. Additionally, several hundred gallons of fuel are available in the diesel generator day tanks and base tanks. The licensee stated that given that the minimum volume of fuel in FO-1 provides at least 4 days of operational capability for the EDGs under design basis accident conditions, it is clear that this capacity will be adequate for several days of supply of fuel until replenishments can be provided from offsite sources. Current procedural guidance is provided for replenishment of diesel fuel from tank trucks at the owner controlled area access point.

During the audit process, the licensee stated that a fuel storage tank will also be provided in the FSB. This fuel supply will be adequate to ensure that the diesel generators support the FSB for up to 72 hours, and provide an initial fuel fill for equipment stored in the building. The licensee stated that it will provide documentation of total fuel consumption needs when FLEX equipment designs are finalized. This is identified as Confirmatory Item 3.2.4.9.A in Section 4.2

With respect to supplying fuel oil to the deployed FLEX portable equipment, the licensee stated during the audit process that a hard pipe system will be established from FO-1 to the fuel handling building truck bay, along with portable fuel carts and fuel transfer pumps to support FLEX equipment operation. This modification is described on page C-28 in the Integrated Plan. Fuel quality will be assured because FO-1 is tested routinely to support Technical Specification surveillance requirements.

During the audit process, the licensee stated that current emergency plan procedure EPIP-TSC-2 already provides guidance for arranging a fuel truck/tanker with a pump to be stationed near the plant at a higher elevation. As part of the development of the Phase 3 response plan, the licensee will establish supplier agreements for delivery of consumables, including diesel fuel oil. Watercraft that can be used to transport diesel fuel and other consumables from staging areas to the plant will be stored in the FSB and controlled within the FLEX program as support equipment. The quality of the fuel that will be stored in the FSB will be verified by preventive maintenance procedures that will be established as part of the modification process.

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 portable equipment fuel, 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 AOVs and MOVs. 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 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 7 in the Integrated Plan, the licensee stated that initial shedding of non-vital loads to extend battery life (this is an existing SBO action which will assure at least 8 hours of station battery availability) is a required action. On page C-13 the Integrated Plan it is stated that there are two existing 1E 125Vdc buses (DC-Bus-1 and DC-Bus-2) at FCS. The capacity of the storage batteries in the two separate dc systems is adequate for up to 8 hours operation of control and instrument devices. To achieve an 8 hour battery life, significant manual shedding of non-vital dc loads is required. FCS is considering a modification to install a Non-1E battery / charger system and relocate non-essential loads to the new Non-1E battery. This will extend the 1E battery life to 24 hours required for mitigating a postulated ELAP event. The licensee will need to update the FLEX strategy documentation if this change is pursued. This evaluation considers that this is a possible change only at this time and its implementation is undecided.

This is identified as Confirmatory Item 3.2.4.10.A in Section 4.2.

On page 7 of its Integrated Plan in the discussion of the SOE timeline actions, the licensee identified SBO actions associated with dc bus load-shedding activities that will be taken in response to an ELAP, to ensure that station batteries provide at least 8 hours of battery availability. Fifteen minutes after occurrence of the ELAP, initial shedding of non-vital loads to extend battery life will be performed in accordance with established SBO procedures. Between the first and second hour after initiating SBO procedures, the licensee stated that it will assess the condition of the EDG and distribution system to determine whether electrical power can be restored within four hours, which is the FCS design SBO coping period. At seven hours after initiating the SBO procedures, the licensee stated that power must be established to at least one 125 Vdc bus using a portable diesel generator in order to prevent battery depletion. This action is required to be performed in order to prevent battery depletion prior to 8 hours.

During the audit process, the licensee stated that the FCS batteries are sized to provide dc power to emergency loads for 8 hours following a design basis event. As part of the evaluation of battery sizing an 8 hour dark plant event is evaluated. This event is an extension of the 4 hour SBO analysis required to satisfy 10CFR50.63. The dark plant load profile was used in the development of the FLEX strategies for ensuring at least one battery charger is re-energized before the station batteries become depleted.

The basis for the minimum dc bus voltage of 105V is the lowest allowed battery voltage of 105Vdc, which corresponds to the minimum cell voltage as provided by the battery manufacturer. The acceptability of this minimum voltage is verified by performance of design basis voltage drop calculations to ensure that the equipment required to operate during the dark plant scenario will operate at the minimum voltage including voltage drop to the equipment.

During the audit process, the licensee stated that FCS does not intend to perform any additional load shedding beyond that already performed for a design basis SBO. All actions taken to perform the load shed must be performed within 2 hours, with specific actions staged to meet the current battery load profile. These load shed actions are performed prior to any assumed FLEX deployment actions by the associated operator. These actions have been verified and validated as part of the EOP/AOP generation program to ensure that they can be performed in station blackout conditions. Following load shed, both batteries will normally remain in service until at least one battery charger can be re-powered. If only one battery is re-powered, the other battery will be unloaded to prevent damage due to potential excessive discharge. Adequate equipment redundancy exists to ensure at least one train of equipment necessary for safe shutdown will remain available.

During the audit process, the licensee stated that the battery loads shed as part of the SBO load shed process are non-safety related. Major loads include the main turbine dc lube oil pump, the main generator dc seal oil pump and various station emergency lighting panels (credited lighting is via local battery pack lights). If the main turbine dc lube oil pump is secured prior to turbine rotation being stopped, the turbine bearings may be damaged; however there is no safety significance if this occurs. Actions are directed to vent the main generator prior to securing the dc lube oil pump to avoid potential release of hydrogen to the turbine building. Several components powered from two non-safety related 120Vac distribution panels are also de-energized. The station battery load profile calculation evaluates the components de-energized from these panels and the verification and validation process for the EOP/AOP program demonstrates that the loss of these components does not affect SBO coping capabilities

During the audit process, the licensee addressed the issue whether load shed activities will interfere with required valve positioning or operator action capability that may be credited in establishing ELAP response strategies, including specifically those actions related to isolating RCS leakage paths, including the CBO. The licensee stated that it does not intend to perform any load shed activities beyond those already established for SBO coping. Those actions are provided in the current SBO procedure and have been verified and validated to ensure they do not interfere with positioning of valves needed for maintaining safe shutdown conditions during a station blackout. The components de-energized by the SBO load shedding activities are non-safety related and do not involve any valves that may be operated to isolate RCS leakage paths. The RCP controlled bleed off relief isolation valve is being modified to ensure that the valve will remain closed in an ELAP scenario. The modification will include an evaluation to ensure that the valve can still be closed when SBO load shed is considered.

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 power, 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, the paragraph following Guideline (15) states in part:

> 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 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., 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.

[1] Testing includes surveillances, inspections, etc.

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.

Diversity equivalent to N+1 capability is provided by the FSP, the submersible pump and the B.5.b pump for supplying water from the SIRWT to the EFWST for cooling the core until water in the SIRWT is exhausted at approximately 24 hours after the ELAP occurs. To provide further core cooling a well or the Missouri River would be accessed to either refill the SIRWT or inject well water or river water directly into the steam generators or the RCS via the FLEX valve station. However, as stated on page 17 of the Integrated Plan, the well is not a qualified water source and has not been credited as a coping strategy in Phase 2 at this time (see discussion on water sources in Section 3.2.4.7 of this report). The Missouri River is accessed using a fire truck alone or in combination with a river drafting pump. The FSB conceptual layout drawing, posted on the licensee's e-portal, shows one fire truck and two river drafting pumps stored in the seismic and missile protected section of the FSB. The planned provision of one fire truck to access the UHS does not seem to meet the N+1 criterion of NEI 12-06 for Phase 2 coping. Although the diesel driven river drafting pump has similar performance characteristics as the fire truck mounted pump, it is not clear that the river drafting pump by itself can achieve the mitigation function and thus be credited as backup to the fire truck. The well currently being evaluated by FCS would be a diverse alternate strategy for the indefinite supply of water. The conceptual design of the proposed well is posted on the licensee's e-portal. It would be designed for seismic and tornado missile loads. The implementation approach for providing the required redundancy to access an indefinite supply of water through spare equipment or a diverse strategy is identified as Confirmatory Item 3.3.1.A in Section 4.2.

On page 10 in the Integrated Plan, the licensee stated that standard industry preventive maintenance (PM) will be developed to establish maintenance and testing frequencies based on type of equipment and will be within EPRI guidelines. Testing procedures will be developed based on the industry PM templates.

The NRC staff reviewed the licensee's Integrated Plan and determined 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 NRC's staff endorsement letter 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 developing a program for maintaining FLEX equipment in a ready-to-use status. The NRC staff will evaluate the resulting program through the audit and inspection processes.

During the audit process, FCS informed the NRC of their plans to abide by this generic resolution and their plans to address potential plant specific issues associated with implementing this resolution that were identified during the audit process.

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 equipment maintenance and testing, if these requirements are implemented as described.

3.3.2 Configuration Control.

NEI 12-06, Section 11.8 provides that:

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 10 in the Integrated Plan, the licensee stated that, FCS will implement an administrative program for FLEX to establish responsibilities and testing and maintenance requirements. A plant system designation will be assigned to FLEX which will require configuration controls associated with systems. Unique identification numbers will be assigned to all FLEX components included in the system. Equipment associated with these strategies will be procured as commercial equipment with design, storage, maintenance, testing, and configuration control as outlined in JLD-ISG-2012-01, Section 6 and NEI 12-06, Section 11. Installed structures, systems and components pursuant to 10 CFR 50.63(a) will continue to meet the augmented quality guidelines of Regulatory Guide 1.155, "Station Blackout".

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 provides that:

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]

2. Periodic training should be provided to site emergency response leaders[3] 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 11 in the Integrated Plan regarding training for FLEX implementation, the licensee stated that training materials for FLEX will be developed for all station staff involved in implementing FLEX strategies. These programs and controls will be implemented in accordance with the Systematic Approach to Training.

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 OFF SITE 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

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[2] The Systematic Approach to Training (SAT) is recommended.
[3] Emergency response leaders are those utility emergency roles, as defined by the Emergency Plan, for managing emergency response to design basis and beyond-design-basis plant emergencies.

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 page 11 of its Integrated Plan, the licensee stated that FCS will utilize the nuclear industry established RRCs. Each RRC will hold five sets of equipment, four of which will be able to be fully deployed when requested and the fifth set will have equipment in a maintenance cycle. Equipment will be moved from an RRC to a local assembly area. 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 stated that FCS has signed a contract to participate in the RRC arrangement.

On page B-46 of its Integrated Plan, the licensee stated that the FCS Phase 2 FLEX implementation strategies are intended to allow for indefinite operation, with the exception of maintaining the containment function and logistical support for consumable supplies, especially fuel and water. However, an eventual transition to a long term cooling strategy is necessary to achieve a stable cold shutdown condition and minimize liquid and gaseous releases to the environment. It is anticipated that the first piece of equipment provided by the RRC will be delivered within 24 hours of notification of the RRC and that full deployment will be achieved in 72 hours. However, it is anticipated that only logistical support for consumables such as fuel and other supplies will be needed in the 72 hour timeframe. The current FCS Phase 2 FLEX equipment and interconnections are designed to maintain all key parameters for at least 7 days, which will provide adequate time to complete the connection of the RRC supplied equipment.

The licensee's plan 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, the plan failed to provide any information as to how conformance with NEI 12-06, Section 12.2 Guidelines 2 through 10 will be met. This has been identified as Confirmatory Item 3.4.A in Section 4.2.

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 off site resources, if these requirements are implemented as described.

## 4.0 OPEN AND CONFIRMATORY ITEMS

### 4.1 OPEN ITEMS

| Item Number | Description | Notes |
|---|---|---|
| 3.2.1.2.A | Seal Leakage Rates - Confirm the viability of the modification to the CBO relief isolation valve and any impacts on the FLEX mitigation strategies in light of core uncovery times. | |
| 3.2.1.6.A | Sequence of Events - Confirm the final Sequence of Events timeline following validation of the action times. | |

### 4.2 CONFIRMATORY ITEMS

| Item Number | Description | Notes |
|---|---|---|
| 3.1.1.1.A | Protection of FLEX equipment (seismic hazard) - Confirm that all FLEX equipment stored in the auxiliary building and the new FSB are seismically restrained to ensure equipment is not damaged during a seismic event and that the FLEX equipment is not damaged by non-seismically robust equipment due to seismic interactions. | |
| 3.1.1.2.A | Deployment of FLEX equipment (seismic hazard) - Confirm that deployment pathways for the FLEX portable equipment are not susceptible to soil liquefaction. | |
| 3.1.1.3.A | Procedural Interfaces (seismic) - Confirm the licensee develops (1) methods and locations for alternate monitoring of key parameters; (2) guidance on critical actions to perform until alternate indications can be obtained; and (3) guidance on control of critical equipment without control power. | |
| 3.1.1.4.A | Off-site Resources - Confirm the location of the off-site staging area(s) and acceptability of the access routes considering the seismic, flooding, high wind, snow, ice and extreme cold hazard. | |

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| 3.1.2.2.A | Deployment (flood) - The method of accessing the ultimate heat sink, the Missouri River, using FLEX equipment during high river levels or after flood waters inundate the site up to the current design basis flood elevation of 1014 foot elevation needs to be addressed. The plan does not identify the deployed location of the fire truck or river drafting pump nor how they are accessed and monitored by plant operators, considering the site's flooded condition. | |
| 3.1.3.1.A | Protection of FLEX Equipment (high wind hazard) - Confirm the design code used for the FSB for the high wind hazard and the method of protection of the N+1 FLEX equipment from tornado borne missiles. | |
| 3.2.1.1.A | CENTS - Verify the use of CENTS in the ELAP analysis for FCS is limited to the flow conditions before reflux boiling initiates. This includes providing a justification for how the initiation of reflux boiling is defined. Confirm that the reanalysis for the case with the CBO isolated conforms to the above limitations. | |
| 3.2.1.2.B | Seal Leakage Rates - Confirm the selection and justification for the seal leakage rates assumed in the ELAP analysis from the initiation of the ELAP event to the time frame when subcooling in the RCS cold legs decreases to less than 50 degrees F. Confirm the calculated maximum temperature and pressure, and minimum subcooling in the RCS cold legs during the ELAP before isolation of the CBO. Confirm the seal leakage rates per RCP before and after isolation of the CBO used in the ELAP reanalysis for determination of the sequence of events and associated time limes. | |
| 3.2.1.3.A | Decay Heat - Confirm the key physics parameters used for each of the decay heat evaluation scenarios to ensure that the FCS ELAP response is bounded. | |
| 3.2.1.4.A | Initial Values for Key Plant Parameters and Assumptions – Confirm / identify which inputs and assumptions are plant specific and which ones were derived from WCAP-17601. | |
| 3.2.1.5.A | Monitoring Instrumentation and Controls - Confirm suitability of EFWST level monitoring instrumentation considering the environmental conditions in the auxiliary building following an ELAP event. | |
| 3.2.1.5.B | Monitoring Instrumentation and Controls - Confirm suitability of existing SIT level instrumentation and the need for its replacement considering the environmental conditions in the containment following an ELAP event. | |
| 3.2.1.6.B | Sequence of Events- The NSSS response using the CENTS code with the lower RCP seal leakage rate expected after plant modification to isolate the CBO needs to be performed. Confirm whether this reanalysis affected the SOE timeline and if so that the SOE timeline has been updated and the overall FLEX mitigation strategies reflect these results. | |
| 3.2.1.8.A | Core Sub-Criticality – Confirm analysis continues to align with the generic resolution for boron mixing under natural circulation conditions potentially involving two-phase flow, in accordance with | |

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| | the Pressurized-Water Reactor Owners Group position paper, dated August 15, 2013 (ADAMS Accession No. ML13235A135 (non-public for proprietary reasons)), and subject to the conditions provided in the NRC endorsement letter dated January 8, 2014 (ADAMS Accession No. ML13276A183) following SOE and FLEX mitigation strategy impacting changes. | |
| 3.2.4.1.A | Equipment Cooling (Water) - Confirm if the installed charging pumps require external source of cooling water to function. | |
| 3.2.4.2.A | Equipment Cooling (Ventilation) - Confirm the environmental conditions in the vicinity of and access to all deployed FLEX equipment in the auxiliary building, to ensure continuous equipment operation and acceptable human performance. | |
| 3.2.4.2.B | Equipment Cooling (Ventilation) - Confirm the environmental conditions in the main control room and the need for ventilation prior to re-establishing power to the CR ventilation fans using the FLEX DG at approximately 9 hours after the ELAP as indicated on the SOE timeline. | |
| 3.2.4.2.C | Equipment Cooling (Ventilation) - Confirm the acceptability of the battery room temperatures (extreme hot or extreme cold) on battery performance. | |
| 3.2.4.2.D | Equipment Cooling (Ventilation) - Confirm the acceptability of the hydrogen buildup in the battery room during charging. | |
| 3.2.4.4.A | Lighting- Confirm the lighting provisions for all areas within the auxiliary building where FLEX equipment is deployed as well as the outdoor areas where FLEX equipment is deployed. | |
| 3.2.4.4.B | Communications - Confirm that upgrades to the site's communications systems have been completed. | |
| 3.2.4.5.A | Protected and Internal Locked Area Access – Confirm how the provisions for access to protected areas and internally locked areas are incorporated into the FLEX mitigation strategies. | |
| 3.2.4.7.A | Water Sources – Determine the impacts of chemistry of the various water sources on site for potential use in the FLEX strategies on plant equipment and FLEX strategies. | |
| 3.2.4.8.A | Electrical Power Sources- Confirm the technical basis for the selection and size of the FLEX generators to be used in support of the coping strategies and the planned approach for fault protection and electrical separation between existing power sources and the FLEX power sources. | |
| 3.2.4.9.A | Portable Equipment Fuel – Confirm the total fuel consumption needs when FLEX equipment designs are finalized. | |
| 3.2.4.10.A | Load Reduction to Conserve DC Power- Confirm if the non-1E battery modification becomes a plan revision to extend the battery life of the existing Class 1E batteries and that any changes to the FLEX mitigation strategies have been incorporated. | |
| 3.3.1.A | Use of Portable Pumps- Confirm that the number of FLEX pumping equipment for accessing the UHS during the Phase 2 coping strategies meets the intent of the N+1 capability. One fire truck and two river drafting pumps are provided to access the UHS. Confirm whether the river drafting pumps alone can achieve the mitigation strategy objectives (without the use of the | |

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| | fire truck) during both the flooded and non-flooded site conditions. Alternately, confirm implementation of a qualified well as a diverse alternate source of a long term water supply. | |
| 3.4.A | Off-Site Resources – Confirm how conformance with NEI 12-06, Section 12.2 guidelines 2 through 10 will be met. | |

If you have any questions, please contact James Polickoski, Mitigating Strategies Project Manager, at 301-415-5430 or at james.polickoski@nrc.gov.

Sincerely,

***/RA by Victor Cusumano for/***

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

Docket No. 50-285

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

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