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

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Duke Energy Carolinas, LLC
Oconee Nuclear Station Units 1, 2, and 3
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1.0 BACKGROUND

Following the events at the Fukushima Dai-ichi nuclear power plant on March 11, 2011, the U.S. Nuclear Regulatory Commission (NRC) established a senior-level agency task force referred to as the Near-Term Task Force (NTTF). The NTTF was tasked with conducting a systematic, methodical review of NRC regulations and processes to determine if the agency should make additional improvements to these programs in light of the events at Fukushima Dai-ichi. As a result of this review, the NTTF developed a comprehensive set of recommendations, documented in SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," dated July 12, 2011. These recommendations were enhanced by the NRC staff following interactions with stakeholders. Documentation of the staff's efforts is contained in SECY-11-0124, "Recommended Actions to be Taken without Delay from the Near-Term Task Force Report," dated September 9, 2011, and SECY-11-0137, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," dated October 3, 2011.

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

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

On February 17, 2012, the NRC staff provided SECY-12-0025, "Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami," to the Commission, including the proposed order to implement the enhanced mitigation strategies. As directed by SRM-SECY-12-0025, the NRC staff issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events."

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

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

As described in Interim Staff Guidance (ISG), JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," the NRC staff considers that the development, implementation, and maintenance of guidance and strategies in conformance with the guidelines provided in NEI 12-06, Revision 0, subject to the clarifications in Attachment 1 of the ISG are an acceptable means of meeting the requirements of Order EA-12-049.

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

2.0 EVALUATION PROCESS

In accordance with the provisions of Contract NRC-HQ-13-C-03-0039, Task Order No. NRC-HQ-13-T-03-0001, Mega-Tech Services, LLC (MTS) performed an evaluation of each licensee's Integrated Plan. As part of the evaluation, MTS, in parallel with the NRC staff, reviewed the original Integrated Plan and the first 6-month status update, and conducted an audit of the licensee documents. The staff and MTS also reviewed the licensee's answers to the NRC staff's and MTS's questions as part of the audit process. The objective of the evaluation was to assess whether the proposed mitigation strategies conformed to the guidance in NEI 12-06, as endorsed by the positions stated in JLD-ISG-2012-01, or an acceptable alternative had been proposed that would satisfy the requirements of Order EA-12-049. The audit plan that describes the audit process was provided to all licensees in a letter dated August 29, 2013 from Jack R. Davis, Director, Mitigation 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 mitigation 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 mitigation 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. ML13063A065), and as supplemented by the first six-month status report in letter dated August 29, 2013 (ADAMS Accession No. ML13246A009), Duke Energy Carolinas, LLC (hereinafter referred to as the licensee or Duke) provided Oconee Nuclear Station's (ONS's or Oconee's) Integrated Plan for Compliance with Order EA-12-049. The Integrated Plan describes the strategies and guidance under development for implementation by Duke 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 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 the Integrated Plan, in a discussion regarding determination of applicable extreme external hazards, the licensee stated that the Safe Shutdown Earthquake (SSE) peak ground acceleration is 0.10g for structures founded on rock and 0.15g for Class 1 structures founded on overburden. The licensee stated that these values constitute the design basis of ONS and that in accordance with NEI 12-06 ONS will consider seismic hazards in the FLEX strategies.

On page 3 of the Integrated Plan, with regard to seismic re-evaluation, the licensee stated that the NRC's 10 CFR 50.54(f) Recommendation 2.1, Seismic Reevaluation (ADAMS Accession No. ML12056A047) is assumed not to result in changes to the current seismic design basis and that it is assumed in ONS's Integrated Plan that the seismic re-evaluation does not adversely impact the equipment that forms a part of ONS's FLEX strategy. The licensee further stated that any changes to the seismic design basis may require a change to the plans in ONS's response to Order EA-12-049.

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 hazard 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 pages 12, 18, 22, 27, and 34 of the Integrated Plan, the licensee stated that structures to provide protection of the FLEX equipment will be constructed to meet the requirements identified in NEI 12-06, Section 11 and that the structures will be built prior to the FLEX implementation date. The licensee captured this activity in ONS's open item 21. The licensee also stated that ONS is developing procedures and programs to address storage structure requirements, deployment path requirements, and FLEX equipment requirements relative to the hazards applicable to ONS; the licensee captured this activity in ONS's open item 4.

On page 3 of the Integrated Plan, the licensee provided additional information with regard to structures, systems and components (SSCs) that are considered to be seismically robust. The licensee stated that SSCs will be considered seismically robust if they (1) are constructed to ONS QA-1 or Category I criteria; (2) meet the requirements to be robust relative to the SSE using Seismic Qualification Utility Group (SQUG) procedures; (3) meet the requirements to be robust relative to the SSE using Electrical Power Research Institute (EPRI) report 1012023, *Experience Based Seismic Verification Guidelines for Piping Systems*; (4) meet the requirements to be robust relative to the SSE using EPRI 1019199, *Experience Based Seismic Verification Guidelines for Piping and Tubing Systems*; (5) meet the requirements to be robust relative to the SSE using other industry recognized codes like American Water Works Association (AWWA) D100; or (6) are demonstrated via a shake table.

During the audit it was noted that the design guidance, procedures and methodology listed by the licensee differ from what is listed in NEI 12-06, Section 5.3; and the licensee did not provide any comparison of its credited guidance with what is recommended in NEI 12-06. The licensee was asked to provide a more detailed explanation of how the guidance in NEI 12-06, Section 5.3.1 will be implemented by ONS.

In response, the licensee stated that:

(1) ONS intends to construct a single structure for storage of FLEX equipment that meets ASCE 7-10 requirements for the seismic hazard and the station's design basis for all other external hazards, and the structure will be located above the flood plain;
(2) ONS may store portable equipment which supports only the Upstream Dam Failure Flood Strategy outside of the seismically designed storage building, but that this equipment is not required to be protected from other design basis events since it will be relied on only for the Upstream Dam Failure Flood Strategy; and
(3) ONS intends to secure or anchor FLEX equipment and any other large items in a manner that prevents seismic interactions and that the preferred option includes strapping mobile equipment to floor anchors.

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 during a seismic event 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 of 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 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.

ONS's Integrated Plan includes nine conceptual sketches showing equipment staging areas and general hose or pipe routings to provide inventory make up to the steam generators (SGs) and

SFPs with water sources being either the intake canal or Chemical Treatment Pond 1 (CTP-1). On page 7 of the Integrated Plan, the licensee described its strategies for deploying portable equipment in all modes. The licensee stated that the deployment routes shown in the conceptual sketches will be utilized to transport FLEX equipment to the deployment areas and that identified paths and deployment areas will be accessible during all modes of operation. The licensee stated that this deployment strategy will be included within an administrative program in order to keep pathways clear or to implement actions to clear the pathways. The licensee stated that connections for portable equipment will be sized for all modes and that portable FLEX equipment will have appropriate capacity for all modes.

On pages 13 and 19 of the Integrated Plan, the licensee provided additional information about how the portable equipment will be deployed. The licensee stated that for its Phase 2 core cooling or inventory make up strategy, equipment to be deployed outside will be stored in a FLEX equipment storage building and that some equipment to complete its primary strategy at inside connections may be pre-staged in the auxiliary building. The licensee stated that FLEX hoses used in its core cooling strategy will be stacked in hose trailers for easy flaking, that towing vehicles and debris clearing machinery will be deployed from the FLEX equipment storage building, and that pumps, hoses, fittings and generators will be trailer mounted for ease of deployment.

During the audit the licensee was asked to provide further explanation of how ONS will implement the guidance in NEI 12-06, Section 5.3.2. In response, the licensee provided the following additional information:

(1) The licensee stated that ONS is finalizing the soils core sampling work to locate the FLEX equipment storage building; and ONS has evaluated by formal calculation that liquefaction is not likely. Additionally, ONS intends to identify multiple deployment pathways providing reasonable assurance of a viable route.
(2) The licensee stated that in general each of the strategies involve tie-ins that allow access from an outside staging area directly into the Auxiliary Building, thus avoiding non-robust structures; and at a minimum one connection point for each strategy will be accessible through seismically robust structures.
(3) The licensee stated that water sources for reactor coolant system (RCS) makeup are the SFP and borated water storage tank (BWST), both of which are robust structures and that the water source for SG makeup and SFP makeup is Lake Keowee which relies on seismically stable dams and dikes.
(4) The licensee stated that no on-site electric power is required for Phase 2 deployment.
(5) The licensee stated that ONS plans to dedicate FLEX towing vehicles and debris clearing machinery and house them in the FLEX storage building. The licensee also stated that non-emergency use of the equipment may be allowed if acceptable administrative controls can be established and that this is being tracked by ONS's open item 3 from the Integrated Plan.

The licensee's first response addresses NEI 12-06, Section 5.3.2, consideration (1). However, ONS's proposed FLEX equipment deployment routes should be reviewed when they are finalized to ensure that they include adequate consideration of potential soil liquefaction or other conditions that could impede movement following a severe seismic or other BDB event. This is identified as Confirmatory Item 3.1.1.2.A in Section 4.2.

The Auxiliary Building is designed as a Seismic Class 1 structure, as stated in ONS's UFSAR Section 3.2.1.1.1, and the licensee stated that at a minimum one connection point for each strategy will only require access through seismically robust structures; this conforms to NEI 12-

06, Section 5.3.2, consideration (2).

The licensee’s third response confirms that all of the water sources relied on by ONS for mitigation of a seismic event are seismically robust. Based on the licensee’s statement, NEI 12-06, Section 5.3.2, consideration (3) is not applicable.

The licensee’s fourth response confirms that ONS does not require on-site electrical power to support FLEX equipment deployment, thereby making NEI 12-06, Section 5.3.2, consideration (4) not applicable.

The licensee’s fifth response conforms to the recommendation in NEI 12-06, Section 5.3.2, consideration (5).

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 Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to deployment of FLEX equipment following a seismic event 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 beyond-design-basis 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. This reference source should include control room and non-control room readouts and should also provide guidance on how and where to measure key instrument readings at containment penetrations, where applicable, using a portable instrument (e.g., a Fluke meter). Such a resource could be provided as an attachment to the plant procedures/guidance. Guidance should include critical actions to perform until alternate indications can be connected and on how to control critical equipment without associated control power.
>
> 2. Consideration should be given to the impacts from large internal flooding sources that are not seismically robust and do not require ac power (e.g., gravity drainage from lake or cooling basins for non-safety-related cooling water systems).
>
> 3. For sites that use ac power to mitigate ground water in critical locations, a strategy to remove this water will be required.
>
> 4. Additional guidance may be required to address the deployment of FLEX for those plants that could be impacted by failure of a not seismically robust downstream dam.

On pages 10, 12, 16 and 18 in the Integrated Plan discussion of key reactor parameters, the licensee listed instrumentation in its standby shutdown facility (SSF) and in the main control rooms (MCRs) credited in its Phase 1 and Phase 2 strategies for monitoring and maintaining core cooling, heat removal, and RCS inventory following a seismic event. On pages 14 and 20 of the Integrated Plan, the licensee stated that the key reactor parameters for its Phase 3 mitigation strategy are the same as used for its Phase 2 strategy.

Although the licensee listed instrumentation required for implementation of its mitigation strategies, the licensee did not state whether this is the minimum required instrumentation, nor did the licensee state whether it intends to compile a reference source for the plant operators that provides approaches to obtaining necessary instrument readings to support the implementation of the coping strategy or 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).

During the audit the licensee was asked to explain whether the instrumentation listed in the Integrated Plan is the minimum required set of instruments and whether it intends to compile a reference source providing guidance for operators to obtain instrument readings under ELAP conditions as described in NEI 12-06, Section 5.3.3.

In response the licensee stated that:

(1) instruments listed in ONS's Integrated Plan, with the exception of Reactor Building[1] Normal and Emergency Sump Levels, are the minimum required instruments needed to support key actions associated with ELAP mitigation strategies and that the Reactor Building Normal and Emergency Sump Levels, while not required, are included to aid in recognition and diagnosis of unexpected RCS leakage and containment conditions and do not complicate the repower strategies; and
(2) a reference source for plant operators will be developed and this is being tracked by ONS's open item 4 from the Integrated Plan.

The licensee's responses confirm that ONS conforms to the guidance in NEI 12-06, Section 5.3.3, consideration 1. However, ONS's reference source providing guidance for operators to obtain instrument readings under ELAP conditions should be reviewed when it is fully developed to confirm that it adequately addresses the recommendations in NEI 12-06, Section 5.3.3, consideration (1). This is identified as Confirmatory Item 3.1.1.3.A in Section 4.2.

With regard to considerations related to internal flooding, on page 4 of the Integrated Plan, the licensee stated that the SSF is credited for mitigation of a seismic event resulting in a circulating water pipe break which floods the Turbine Building. Otherwise, the licensee's Integrated Plan included no consideration or mention of the potential for internal flooding. The licensee's Integrated Plan also does not document considerations related to normal use of ac power to mitigate ground water or potential failure of a downstream dam that might require additional guidance to address deployment of equipment.

During the audit the licensee was asked to provide additional discussion of NEI 12-06, Section 5.3.3, considerations 2, 3, and 4. In response, the licensee provided the following information:

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[1] The three Reactor Buildings at ONS are the Containment Buildings, which contain the reactor coolant system.

(1) With regard to internal flooding, ONS's FLEX strategies do not rely on any components or connection points in the Turbine Building basement or ground floor subject to flooding from an inside circulating water pipe break. An existing abnormal procedure addresses Auxiliary Building internal flooding. In addition, ONS's FLEX strategies do not require passage or work in areas of the Auxiliary Building impacted by internal flooding.
(2) With regard to ground water, ONS's FLEX strategies do not require mitigation of ground water to be successful.
(3) With regard to downstream dam failures, there are no effects on the ONS mitigation strategy due to downstream dam failures and that downstream dams have been designed to have an adequate factor of safety under the same conditions of seismic loading as used for design of Oconee.

The licensee's responses confirm that ONS's mitigation strategy adequately address NEI 12-06, Section 5.3.3, considerations 2, 3, and 4, respectively.

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 Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to procedural interfaces related to 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 8 of the Integrated Plan, in a description of ONS's Regional Response Center (RRC) plan, the licensee stated that the industry will establish two RRCs to support utilities during a BDBEE and that each RRC will hold 5 sets of equipment, 4 of which will be able to be fully deployed when requested while the fifth set will have equipment in a maintenance cycle. The licensee stated that equipment will be moved from an RRC to a local assembly area, established by the Strategic Alliance for FLEX Emergency Response (SAFER) team and the utility, communications will be established between the affected nuclear site and the SAFER team, and required equipment will be moved to the site as needed. The licensee stated that 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 and that a contract has been signed between the site and the Pooled Equipment Inventory Company to provide Phase 3 services and equipment. In Attachment 5 of the Integrated Plan, the licensee listed development of a SAFER Response Plan (RRC playbook) as open item 9.

On page 35 of the Integrated Plan, the licensee stated that establishment of off-site fuel oil logistics is also included in its open item 9; and on page 40 in the list of Phase 3 response equipment and commodities, the licensee stated that its open item 9 also includes analysis to determine radiation protection equipment requirements, analysis to determine commodity requirements (food and potable water), and determination of transportation equipment needed to move large skids or trailer mounted equipment provided from off site.

The licensee's discussion of obtaining off-site resources conveys a general intention to follow developing industry practices with regard to obtaining Phase 3 mitigation equipment and commodities from an off-site RRC. However, the licensee's Integrated Plan does not include identification of a local staging area for materials delivered from offsite or provide a description of the methods to be used to deliver the materials to the site.

During the audit the licensee was asked to describe its considerations related to obtaining off-site resources following a BDB seismic event. In response, the licensee stated that ONS's preferred method of equipment and consumables delivery is by road and there are multiple highway routes that access the site, but under the most limiting scenarios, all shipments may require airlift delivery to an on-site drop area. The licensee further stated that specific details of the RRC playbook have not been established and that a playbook developed by a SAFER team and the utility will address the considerations for moving off-site resources.

The licensee's response confirms that ONS's strategy conforms to the guidance in NEI 12-06, Section 5.3.4. However, the licensee's playbook developed by the SAFER team and the utility should be reviewed when fully developed to confirm that details for delivery and staging of off-site resources are acceptable. 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 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 considerations for using off-site resources following a seismic event 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 in the section of the Integrated Plan regarding determination of applicable extreme external hazards, the licensee stated that ONS has extensive licensing consideration, analysis, correspondence, and pending actions with respect to flooding and that there are two separate external flooding events that potentially put water in ONS's yard. The licensee stated that one of the current licensing basis external floods is a local intense precipitation event defined by the UFSAR Section 2.4.2.2 and the other flooding event is defined in the June 22, 2010, Confirmatory Action Letter (CAL) 2-10-003 (ADAMS Accession No. ML12363A086) as a postulated failure of Jocassee Dam, which is upstream of ONS's site. The licensee stated that both of these modeled scenarios produce flooding in ONS's yard and that the maximum external flood levels in the yard are bounded by the postulated upstream dam failure. The licensee stated that ONS includes consideration of a flooding event in its FLEX strategies.

On page 4 in the Integrated Plan, in a description of key site assumptions, the licensee stated that the flood re-evaluation pursuant to the 10 CFR 50.54(f) letter of March 12, 2012 is not completed and is not assumed in the Integrated Plan. The licensee stated that a maximum flood level of 10 feet (Elevation 806') will be utilized in the development of ONS's mitigation strategies. The licensee identified re-analysis of the local intense precipitation event as its open item 1 and re-analysis of the upstream dam failure event as its open item 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 provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to screening for a 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.

As described in Section 3.1.2 of this evaluation, above, the licensee stated that a maximum flood level of 10 feet (Elevation 806′) will be used in developing its mitigation strategies.

On pages 12, 18, 22, 27, and 34 of the Integrated Plan, the licensee described the location of a storage facility for its portable Phase 2 mitigation equipment by stating that ONS intends to locate the FLEX storage facilities above currently identified flood levels unless it is better informed by ongoing flood hazard re-analysis and flooding mitigation modification plans.

The licensee's statement regarding elevations above which Oconee intends to locate the storage facilities for its Phase 2 mitigation equipment conforms to the guidance in NEI 12-06, Section 6.2.3, consideration 1.a.

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 and storage of FLEX equipment based on consideration of a 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 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 cool down, borating the RCS, 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, 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.

ONP has two separate, limiting external flooding events. One is a local intense precipitation event identified on page 2 of the Integrated Plan and described in ONS's UFSAR Section 2.4.2.2. The other is a postulated sunny-day failure of the Jocassee dam, upstream of the ONS site, identified on page 2 of the Integrated Plan and described in the NRC's Safety Evaluation dated January 28, 2011, (ADAMS Accession No. ML12363A088), which evaluated the licensee's response to CAL 2-10-003. The licensee stated that each of these events will result in flooding in the ONS yard, and that the maximum flood level is bounded by the postulated upstream dam failure.

On pages 6 and 7 of the Integrated Plan, the licensee described activities related to deployment of portable equipment during a flood condition. The licensee stated that FLEX Support Guidelines (FSGs) will be developed to direct deploying FLEX equipment and strategies. The licensee stated that repowering of the reactor coolant makeup (RCMU) pumps, which are normally powered by the SSF, will require new analysis to determine time requirements and that installation of the portable makeup pump supplying makeup from the borated water storage tank (BWST) will require new analysis. The licensee also stated that time requirements to deploy and connect the portable instrumentation panel, portable lighting and ventilation fans will be determined. In its first six-month Integrated Plan update, dated August 29, 2013, (ADAMS Accession No. ML13246A009) the licensee stated that it is evaluating potential changes to the RCS makeup strategy and that the changes, if implemented, would eliminate the SSF RCMU pump repower strategy and implement train-specific diesel powered pump strategies. Open Item 3.2.1.6.A related to this potential change is discussed in Section 3.2.1.6 of this evaluation and listed in Section 4.1.

ELAP mitigation actions proposed by the licensee for a flooding event are broadly described above based on information in the licensee's Integrated Plan. However, the licensee's

Integrated Plan provides relatively little detailed discussion related to deployment of portable mitigation equipment during a limiting flooding event.

The licensee did not address deployment considerations that might be important for a regional flood with long persistence, such as might be caused by intense precipitation of long duration. During the audit the licensee was asked to provide additional discussion of how its mitigation strategy includes the considerations recommended in NEI 12-06, Section 6.2.3.2.

In response, the licensee provided the following additional information:

(1) With regard to flooding caused by local intense precipitation (LIP), ONS will utilize symptom-based procedures to mitigate any effects from intense precipitation. Should an ELAP occur, this event is bounded by the mitigation strategy for a seismic event and all other events where loss of ac power occurs without warning. Based on the current licensing basis precipitation event, Oconee would not anticipate an ELAP or loss of access to the UHS and, therefore, may not take extensive anticipatory actions. The persistence of prohibitive flood levels on site for extensive durations is not postulated. Consistent with the Phase 1 coping capability for other events with no advanced warning, ONS's SSF will remain available and consistent with the Phase 2 source for SG and SFP makeup water, the ONS intake canal will remain available. The Phase 1 coping period accommodates complications related to deploying Phase 2 portable equipment, the FLEX equipment storage building will be located above flooding levels, and the Phase 2 SG makeup portable pump's deployment location avoids areas susceptible to flooding due to a LIP event.
(2) With regard to connection points for portable equipment stated in NEI 12-06, Section 6.2.3.2, consideration 5, ONS has sufficient advance warning of the dam-failure flooding event to connect and route hoses and open valves that are below flood level prior to the site inundation.
(3) With regard to water extraction, NEI 12-06, Section 6.2.3.2, consideration 7, ONS does not currently anticipate a need for water extraction pumps to enable FLEX strategies.

Based on information presented in ONS's Integrated Plan, in the six-month update to that plan, and in the audit responses, ONS's plans and actions to address the considerations in NEI 12-06, Section 6.2.3.2 are evaluated as follows:

(1) The licensee has determined that ONS's licensing basis flooding event provides a minimum of 2.86 hours warning time, and its Abnormal Procedure for External Flood Mitigation uses this time to take anticipatory mitigation actions. This conforms to the guidance in NEI 12-06, Section 6.2.3.2, consideration (1).
(2) The licensee stated that ONS intends to identify multiple deployment pathways providing reasonable assurance of a viable route. The licensee also stated that it does not postulate an on-site flood at prohibitive levels for an extensive duration; however, it did not identify a technical basis substantiating the claim that persistent, prohibitive flooding will not occur. To show conformity with NEI 12-06, Section 6.2.3.2, consideration 2, the licensee should provide additional technical basis to support its claim that persistent, prohibitive flooding levels will not occur at the ONS site. This is identified as Confirmatory Item 3.1.2.2.A in Section 4.2.
(3) In the Integrated Plan the licensee stated that during a flooding event ONS's Phase 2 core cooling by feeding the SGs will be achieved with a high capacity, low head portable diesel driven pump and that the pump suction will be from CTP-1 (rather than from the plant intake canal (from Lake Keowee) or the buried condenser circulating water piping, which are the normal UHS). During the audit the licensee also stated that CTP-1 was selected as the

source of water for core cooling during a flooding event because it is located above the maximum predicted flood level. These provisions adequately address NEI 12-06, Section 6.2.3.2, consideration 3.

(4) During the audit the licensee provided additional information related to its considerations of fuel supply for Phase 2 FLEX equipment. The licensee stated that for the Upstream Dam Failure Event, the SSF fuel oil will not be considered available for FLEX and that a fuel oil consumption analysis will determine the volume of fuel oil required to be staged above the peak flood elevation to sustain Phase 2 strategies until the RRC can establish deliveries. The licensee further stated that an open item associated with this, as described in Section 3.2.4.9 of this evaluation, will verify that there is sufficient on-site fuel oil to operate through Phases 1 and 2 until off-site deliveries are established and that consumption rate analysis will determine the priority and quantities needed for indefinite coping. This information provided by the licensee is adequate to demonstrate conformance to NEI 12-06, Section 6.2.3.2, consideration 4.

(5) As noted earlier, the licensee stated that ONS has sufficient advance warning of the dam-failure flooding event to connect and route hoses and open valves that are below flood level prior to the site inundation. This statement is adequate to demonstrate conformance with NEI 12-06, Section 6.2.3.2, consideration 5.

(6) ONS's limiting flood event is not storm-driven flooding; so NEI 12-06, Section 6.2.3.2, consideration 6, is not applicable at ONS.

(7) Based on the licensee's statement noted earlier that ONS does not need water extraction pumps to implement its FLEX strategies, NEI 12-06, Section 6.2.3.2, consideration 7, is not applicable at ONS.

(8) ONS does not credit reliance on temporary flood barriers to mitigate the effects of external flooding; so, NEI 12-06, Section 6.2.3.2, consideration 8 is not applicable at ONS.

(9) As noted earlier in Section 3.1.1.2 of this evaluation, the licensee stated that ONS plans to dedicate FLEX towing vehicles and debris clearing machinery and house them in the FLEX storage building which is to be located above the maximum predicted flood level. This provision adequately addresses NEI 12-06, Section 6.2.3.2, consideration 9.

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 Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to deployment of FLEX equipment during a flooding event 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 8 of the Integrated Plan, in its discussion of programmatic controls, the licensee stated that the FLEX strategies and basis will be maintained in overall FLEX basis documents; and on page 57 of the Integrated Plan, the licensee listed an open item stating that a FLEX basis document needs to be developed.

On page 10 of the Integrated Plan, the licensee stated that guidance to perform flood actions is contained in an approved abnormal operating procedure (AOP) and in an engineering manual directive.

On page 11 of the Integrated Plan with regard to flood events, the licensee stated that guidance to perform actions is contained in the AOP, "External Flood Mitigation," and that additional guidance must be developed.

On multiple pages in the Integrated Plan, the licensee confirmed that procedures or guidance exist or will be developed to support implementation of its mitigation strategy by stating that site-specific procedures and/or FSGs will be developed using industry guidance to address the criteria in NEI 12-06, Section 11.4.

The licensee identified several open items that will require closure before procedures and guidance for its flood mitigation strategies are fully developed; and the licensee stated that activities are in progress to develop its procedures, including potential changes to its current External Flood Mitigation procedure. The licensee stated that its procedure development will be based on the guidance in NEI 12-06, Section 11.4, which provides guidance for coordinating new BDB event mitigation procedures with existing site procedures. The licensee does not credit the use of temporary flood barriers or extraction pumps in its flood mitigation strategy.

Based on the licensee's statements regarding its process for procedure development and its identification of related open items, the licensee's plans conform to the guidance in NEI 12-06, Section 6.2.3, with regard to procedural interfaces related to a flooding event.

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 related to a flooding event 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 licensee's Integrated Plan for ONS includes several statements related to obtaining and using offsite resources during or following a flooding event.

On page 14 of the Integrated Plan with regard to Phase 3 general coping strategy to maintain core cooling and heat removal, the licensee stated that a Phase 3 strategy for off-site resources will have to be developed for flood to establish logistics for delivery and purification/filtration of raw water to the site for replenishing CTP-1 at an estimated rate of approximately 700,000 gallons per day within approximately 6 days. The licensee also stated that ONS's open item 4 (implement programmatic controls per NEI 12-06) will establish FSGs to continue water makeup to CTP-1 using off-site resources.

On page 35 of the Integrated Plan, the licensee described an open item related to flood mitigation logistics. This open item is to establish fuel oil delivery logistics, and it is included in ONS's open item 9 (development of an RRC playbook).

The licensee's Integrated Plan documents no additional specific considerations related to determining the best means for ONS to obtain resources from off-site following a flood. The Integrated Plan also documents no specific considerations related to how a persistent flood could affect where equipment delivered from offsite could be staged for use on site. This is combined with Confirmatory Item 3.1.1.4.A.

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 Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to considerations for using off-site resources during or following a flooding event 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 occurrence 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 2 of the Integrated Plan the licensee discussed its screening for high wind hazards. The licensee stated that using Figures 7.1 and 7.2 from NEI 12-06, it was determined that the

ONS site is in Region 3 which indicates tornado winds should not exceed 179 mph and that hurricane winds could produce 140 mph peak gusts. The licensee stated that ONS will consider a high wind hazard.

A review was performed to compare the location of ONS, in Oconee County, South Carolina, against the maps shown in Figures 7-1 and 7-2 of NEI 12-06. The review confirmed the licensee's statements that based on the location of the plant and the screening process described in NEI 12-06, tornado winds should not exceed 179 mph, and hurricane winds should not exceed 140 mph peak gusts. The review determined that the licensee's screening for high wind hazards conforms to the guidance in NEI 12-06, Section 7.

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 winds hazards if these requirements are implemented as described.

3.1.3.1 Protection of FLEX Equipment – High Wind Hazard

NEI 12-06, Section 7.3.1 states:

> These considerations apply to the protection of FLEX equipment from high wind hazards:
>
> 1. For plants exposed to high wind hazards, FLEX equipment should be stored in one of the following configurations:
>
>   a. In a structure that meets the plant's design basis for high wind hazards (e.g., existing safety-related structure).
>
>   b. In storage locations designed to or evaluated equivalent to ASCE 7-10, *Minimum Design Loads for Buildings and Other Structures* given the limiting tornado wind speeds from Regulatory Guide 1.76 or design basis hurricane wind speeds for the site.
>
>   - Given the FLEX basis limiting tornado or hurricane wind speeds, building loads 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 multiple pages of the Integrated Plan (pages 12, 18, 22, 27, and 34), the licensee provided general statements describing protection of FLEX portable mitigation equipment from the effects of severe storms with high winds. The licensee stated that structures to provide protection of the FLEX equipment will be constructed to meet the guidance in NEI 12-06, Section 11 and that the structures will be built prior to the FLEX implementation date. The licensee also stated that ONS procedures and programs are being developed to address storage structure requirements, deployment path requirements, and FLEX equipment requirements relative to the hazards applicable to ONS.

The licensee provided no additional discussion related to storage and protection of its portable mitigation equipment from the potential effects of severe storms with high winds.

During the audit the licensee was asked to provide additional information explaining how it intends to comply with the guidance in NEI 12-06, Section 7.3.1. In response, the licensee stated that it will build a single structure for storage of FLEX portable equipment and that the structure will be designed to withstand the design basis wind hazards for ONS's site. The licensee also stated that this is being tracked by its open item 21 from the Integrated Plan.

The licensee's statement conforms to the guidance in NEI 12-06, Section 7.3.1, consideration 1.a.

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 and storage of FLEX equipment during a high winds event if these requirements are implemented as described.

3.1.3.2 Deployment of FLEX Equipment – High Wind Hazard

NEI 12-06, Section 7.3.2 states:

> There are a number of considerations which apply to the deployment of FLEX equipment for high wind hazards:
>
> 1. For hurricane plants, the plant may not be at power prior to the simultaneous ELAP and LUHS condition. In fact, the plant may have been shut down and the plant configuration could be established to optimize FLEX deployment. For example, the portable pumps could be connected, tested, and readied for use prior to the arrival of the hurricane. Further, protective actions can be taken to reduce the potential for wind impacts. These factors can be credited in considering how the baseline capability is deployed.
>
> 2. The ultimate heat sink may be one of the first functions affected by a hurricane due to debris and storm surge considerations. Consequently, the evaluation should address the effects of ELAP/LUHS, along with any other equipment that 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.

As previously noted in Section 3.1.3.1 of this evaluation, on multiple pages in the Integrated Plan the licensee made general statements related to deployment of FLEX portable mitigation equipment during or following a high wind event. The licensee stated that ONS procedures and programs are being developed to address storage structure requirements, deployment path requirements, and FLEX equipment requirements relative to the hazards applicable to ONS.

On page 7 of the Integrated Plan, the licensee stated that deployment routes shown in attached sketches will be utilized to transport FLEX equipment to the deployment areas and that identified paths and deployment areas will be accessible during all modes of operation. The licensee stated that this deployment strategy will be included within an administrative program to require that identified pathways be kept clear or that actions to clear the pathways be implemented when needed. The licensee stated that connections for portable equipment will be sized for all modes and that the portable FLEX equipment will have appropriate capacity for all modes.

As noted earlier in Section 3.1.1.2 of this evaluation, on several pages of the Integrated Plan the licensee stated that towing vehicles and debris clearing machinery are deployed from the FLEX equipment storage building. This statement by the licensee implies that ONS will have debris clearing machinery immediately available if there is a need to remove debris from deployment paths following a hurricane or tornado. On page 40 of the Integrated Plan, the licensee also included debris clearing equipment in its list of Phase 3 response equipment and commodities to be obtained from the RRC.

During the audit the licensee was asked to provide additional information describing its considerations related to deployment of FLEX equipment following or during a high wind event, specifically addressing the considerations in NEI 12-06, Section 7.3.2. In response, the licensee stated that ONS prepares for high wind events as covered in existing procedural guidance and that the new FSGs will coordinate with the existing procedures; the licensee further stated that this is being tracked by ONS's open item 4 from the Integrated Plan. The licensee also stated that flood analysis confirms that lake storm surge due to high winds does not overtop any dams or dikes at the ONS site and that ONS does not anticipate deploying FLEX portable equipment prior to or during a high wind event.

The information provided by the licensee in the Integrated Plan, in the six-month update to that plan, and in the audit responses is evaluated against the considerations set forth in NEI 12-06, Section 8.3.2, as follows:

(1) The licensee stated that it does not anticipate deploying portable equipment prior to a high wind event. For a plant such as ONS which is located somewhat inland and away from coastal areas, this is judged to be a reasonable approach and conforms to the guidance in consideration 1.
(2) Based on the licensee's statement that storm-driven lake surges will not overtop any of ONS's on-site dams or dikes, it is reasonable to expect that the UHS would not be greatly affected by storms with high winds. The licensee's statement adequately addresses consideration 2.
(3) As earlier noted in this evaluation, the licensee has stated that it will have a means to move FLEX equipment and machinery capable of moving debris located on site in the FLEX equipment storage building. This statement by the licensee adequately addresses considerations 3 and 4.
(4) Because ONS is located inland and not directly on the Atlantic Coast, it is not expected to experience the full, sustained force of a severe hurricane, and special considerations, beyond having available the equipment described in item (3) above, are judged to provide reasonable conformance with consideration 5.

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 during a high winds event if these requirements are implemented as described.

3.1.3.3 Procedural Interfaces – High Wind Hazard

NEI 12-06, Section 7.3.3, states:

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

procedures.

As noted in Section 3.1.3.2, above, the licensee stated that ONS does prepare for high wind events as covered in existing procedural guidance and that the new FSGs will coordinate with the existing procedures. This statement conforms to the guidance in NEI 12-06, Section 7.3.3.

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 related to a high winds event if these requirements are implemented as described.

3.1.3.4 Considerations in Using Offsite Resources – High Wind Hazard

NEI 12-06, Section 7.3.4 states:

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

The licensee's descriptions of its considerations related to obtaining and using offsite resources have been discussed earlier in Sections 3.1.1.4 and 3.1.2.4 of this evaluation, and the licensee did not provide any additional information specifically considering utilization of offsite resources during or following a high wind event.

Confirmatory Item 3.1.1.4.A, related to development of the licensee's RRC playbook, is discussed in Section 3.1.1.4 and includes confirmation that delivery and staging of off-site resources are acceptable for all BDBEEs, including high wind events. No additional confirmatory item has been created for this topic.

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 Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to obtaining and using off-site resources during or following a high winds event 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 35th Parallel should provide the capability to address extreme snowfall with snow removal equipment. Finally, all sites except for those within Level 1 and 2 of the maximum ice storm severity map contained in Figure 8-2 should address the impact of ice storms.

On page 2 of the Integrated Plan, the licensee discussed its assessment of snow, ice and extreme cold hazards applicable for ONS. The licensee stated that in accordance with NEI 12-06, Section 8, ONS will consider between 8 and 10 inches of snow and is classified as Level 5 (most severe) in ice storm severity, meaning that there is potential for catastrophic destruction to power lines and/or existence of extreme amounts of ice.

A review was performed to compare the location of ONS, in Oconee County, South Carolina, against the maps shown in Figures 8-1 and 8-2 of NEI 12-06. Figure 8-1 shows a record 3-day snowfall in the range of 8 to 10 inches for the ONS site; and Figure 8-2 shows that the ONS site is in an area classified as having a maximum ice storm severity of Level 5, with a potential for catastrophic destruction to power lines and/or existence of extreme amounts of ice. The review also determined that the ONS site is located near, but south of the 35th parallel. The licensee's screening of ONS for applicability of snow, ice, and extreme cold hazards conforms to the guidance in NEI 12-06, Section 8.2.1.

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

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

NEI 12-06, Section 8.3.1 states:

> These considerations apply to the protection of FLEX equipment from snow, ice, and extreme cold hazards:
>
> 1. For sites subject to significant snowfall and ice storms, portable FLEX equipment should be stored in one of the two configurations.
>
>   a. In a structure that meets the plant's design basis for the snow, ice and cold conditions (e.g., existing safety-related structure).
>
>   b. In a structure designed to or evaluated equivalent to ASCE 7-10, *Minimum Design Loads for Buildings and Other Structures* for the snow, ice, and cold conditions from the site's design basis.
>
>   c. Provided the N sets of equipment are located as described in a. or b. above, the N+1 equipment may be stored in an evaluated storage location capable of withstanding historical extreme weather conditions such that the equipment is deployable.
>
> 2. Storage of FLEX equipment should account for the fact that the equipment will need to function in a timely manner. The equipment should be maintained at a temperature within a range to ensure its likely function when called upon. For example, by storage in a heated enclosure or by direct heating (e.g., jacket water, battery, engine block heater, etc.).

On multiple pages in the Integrated Plan (pages 13, 19, 23, 27, and 34), the licensee provided general statements describing protection of portable FLEX equipment from applicable hazards, including the effects of snow, ice, and extreme cold. The licensee stated that structures to provide protection of the FLEX equipment will be constructed to meet the requirements identified in NEI 12-06, Section 11 and that the structures will be built prior to the FLEX implementation date. The licensee also stated that ONS's procedures and programs are being developed to address storage structure requirements, deployment path requirements, and FLEX equipment requirements relative to the hazards applicable to ONS.

The licensee provided no additional discussion specifically related to storage and protection of its portable mitigation equipment from the potential effects of snow, ice, and extreme cold.

During the audit the licensee stated that ONS intends to construct a single structure for storage of FLEX portable mitigation equipment that meets ASCE 7-10 for a seismic hazard and the station's design basis for all other external hazards. This statement conforms to the guidance in NEI 12-06, Section 8.3.1, consideration 1.a with regard to snow, ice, and extreme cold hazards.

Because the ONS site is located south of the 35^{th} parallel, its site is not in a region of persistent cold that could greatly affect protection and storage of portable mitigation equipment. The more likely adverse effects would be on logistics and deployment of the equipment which could be hampered by a severe ice storm. Based on considerations related to the relatively mild winter climate at ONS, the reviewer believes that the licensee's general statements related to storage and protection of portable mitigation equipment from the effects of extreme cold and the additional information obtained during the audit provide reasonable assurance that ONS's plans will conform to the guidance in NEI 12-06, Section 8.3.1, with respect to the storage and protection of portable equipment from the effects of snow, ice and extreme cold.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to storage and protection of FLEX equipment from the effects of snow, ice, and extreme cold hazards 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.

As already noted in Section 3.1.4.1 of this evaluation, on multiple pages in the Integrated Plan the licensee made a general statement regarding deployment of portable mitigation equipment potentially affected by applicable hazards, including an event involving snow, ice and extreme cold.

On page 7 of the Integrated Plan, the licensee stated that deployment routes shown in attached sketches will be utilized to transport FLEX equipment to the deployment areas. The licensee also stated that the deployment routes will be accessible during all modes of operation. The licensee stated that this deployment strategy will be included within an administrative program in order to keep pathways clear or to implement actions to clear the pathways.

As noted earlier in Section 3.1.1.2 of this evaluation, on several pages of the Integrated Plan the licensee stated, that towing vehicles and debris clearing machinery will be deployed from the FLEX equipment storage building. Because ONS is located south of the 35^{th} parallel, extreme, persistent snowfall and snow accumulation should not present impedances to deployment of portable mitigation equipment using standard towing vehicles and debris clearing equipment. However, ONS is in an area where catastrophic ice storms may occur, and ice on roadways or equipment deployment paths could present challenges to deployment of ONS's portable mitigation equipment. The licensee's Integrated Plan did not discuss any specific considerations related to challenges that might be produced by local ice storms. The licensee's Integrated Plan also did not identify any considerations related to manual operations that might be required of plant personnel in conditions of snow, ice or extreme cold.

During the audit, the licensee was asked to provide additional information addressing its considerations related to the guidance in NEI 12-06, Section 8.3.2. In response, the licensee stated that after a firm location for the FLEX storage building is established an assessment will be performed with respect to potential debris and condition hazards along proposed deployment paths. The licensee stated that this assessment will be used as input for selecting debris clearing machinery, tools, and supplies and identifying optional deployment pathways. The licensee also stated that no additional protective clothing provisions beyond normal expectations for working outdoors in winter weather are currently planned.

The licensee's response adequately addresses the guidance in NEI 12-06, Section 8.3.2, considerations 1 and 2; and consideration 3 is not applicable because sustained cold winter temperatures that could cause freezing of the UHS or create frazil ice do not occur in South Carolina, where ONS is located.

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 during an event involving snow, ice, and extreme cold hazards 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 [of] the FLEX equipment. This includes both access to the transport path, e.g., snow removal, and appropriately equipped vehicles for moving the equipment.

As discussed above in Section 3.1.4.3, the licensee currently has on-going activities to identify primary and alternate equipment deployment paths and to identify potential hazards along those paths together with the machinery and equipment needed to maintain or clear the paths, if needed. The licensee's activities described in the earlier discussion adequately address the considerations in NEI 12-06, Section 8.3.3.

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 related to an event involving snow, ice, and extreme cold hazards 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.

General considerations related to obtaining and using offsite resources that the licensee documented in the Integrated Plan have been discussed earlier in Sections 3.1.1.4 and 3.1.2.4 of this evaluation. The licensee did not provide any additional information specifically addressing utilization of offsite resources during an event involving snow, ice, or extreme cold.

Based on discussions included in the Integrated Plan, the licensee did not provide sufficient information to conclude that ONS's considerations of utilizing offsite resources during an event involving snow, ice, or extreme cold conform to the guidance of NEI 12-06, Section 8.3.4, or provide an acceptable alternative to that guidance.

Confirmatory Item 3.1.1.4.A, related to development of the licensee's RRC playbook, is discussed in Section 3.1.1.4 and includes confirmation that delivery and staging of off-site resources are acceptable for all BDBEEs, including conditions of snow, ice, and extreme cold. No additional confirmatory item has been created.

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 Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to using off-site resources during an event involving snow, ice, and extreme cold hazards if these requirements 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 2 of the Integrated Plan the licensee stated that in accordance with NEI 12-06, Section 9, all sites will consider temperatures in excess of 110 degrees Fahrenheit. The licensee also stated that the applicable extreme external hazards at ONS are seismic, flood, high winds, extreme cold, and extreme high temperature.

The licensee's statements conform to the guidance in NEI 12-06, Section 9.2, with regard to applicability of extreme high temperature challenges at ONS.

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 hazards 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.

As already noted in this evaluation, on multiple pages of the Integrated Plan the licensee provided general statements confirming its intention to provide appropriate protection for the portable FLEX equipment that might be affected by applicable external hazards, including an extreme high temperature event.

The licensee provided no additional discussion specifically related to storage and protection of its portable mitigation equipment from the potential effects of extreme high temperature.

ONS is located near the northwest corner of South Carolina, in a relatively temperate region of the United States. Based on this location, protection of equipment from harmful effects potentially caused by extreme high ambient temperatures should not require extraordinary measures to create and maintain a controlled temperature environment for FLEX equipment storage. On this basis, the reviewer considers the licensee's general statements related to storage and protection of portable mitigation equipment to provide reasonable assurance that ONS's plans conform to the guidance in NEI 12-06, Section 9.3.1.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to FLEX equipment storage and protection from high temperature hazards 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 already noted in this evaluation, on multiple pages of the Integrated Plan the licensee provided general statements that ONS is developing procedures and programs to address storage structure requirements, deployment path requirements, and FLEX equipment requirements relative to the external hazards applicable ONS, including an extreme high temperature event.

Also, as noted in Section 3.1.3.1 of this evaluation, the licensee linked its statement of guideline compliance specifically to NEI 12-06, Section 11, "Programmatic Controls"; and this implies that the licensee intends to follow the guidance of NEI 12-06, Section 9.3.2, with regard to deployment of FLEX portable equipment during an extreme high temperature event.

ONS is located near the northwest corner of South Carolina, in a relatively temperate region of the United States. Based on this location, deployment of portable equipment during an event involving extreme high temperatures should not require extraordinary measures either to protect the equipment or to support operations required by plant personnel during the deployment activities. Normal design limits for outside conditions at the site and standard industrial safety practices to avoid personnel heat stress during work activities should be adequate to support deployment of the portable mitigation equipment during an extreme high temperature event. On this basis, the reviewer considers that the licensee's general statements related to deployment of portable mitigation equipment during an extreme high temperature event to provide reasonable assurance that ONS's plans will conform to the guidance in NEI 12-06, Section 9.3.2.

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 provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to FLEX equipment deployment during an event involving high temperature hazards 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.

In the Integrated Plan, the licensee documented no specific considerations related to procedural enhancements that might be affected by an extreme high temperature event.

However, on the basis already discussed in Sections 3.1.5.1 and 3.1.5.2 of this evaluation, the reviewer considers that the licensee's general statements related to procedural enhancements and conformance to the guidance in NEI 12-06 to provide reasonable assurance that ONS's plans will conform to the guidance in NEI 12-06, Section 9.3.3.

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 that might be affected by an event involving high temperature hazards 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 discussed in NEI 12-06, Section 1.3, plant specific analysis will determine the duration of each phase.

3.2.1 Reactor Core 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 emergency feedwater (EFW) system to provide 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 RCS inventory control and maintenance of long-term subcriticality through the use of low leakage reactor coolant pump seals and/or borated high pressure RCS makeup with a letdown path. In mode 5 (cold shutdown) and mode 6 (refueling) with SGs not available, this approach relies on an on-site pump for RCS makeup and diverse makeup connections to the RCS for long-term RCS makeup with borated water and residual heat removal from the vented RCS.

As described in NEI 12-06, Section 3.2.1.7 and JLD-ISG-2012-01, Section 2.1, strategies that have a time constraint to be successful should be identified and a basis provided that the time can be reasonably met. NEI 12-06, Section 3, provides the performance attributes, general criteria, and baseline assumptions to be used in developing the technical basis for the time constraints. Since the event is a beyond-design-basis event, the analysis used to provide the technical basis for time constraints for the mitigation strategies may use nominal initial values (without uncertainties) for plant parameters, and best-estimate physics data. All equipment used for consequence mitigation may be assumed to operate at nominal setpoints and capacities. NEI 12-06, Section 3.2.1.2, describes the initial plant conditions for the at-power mode of operation; Section 3.2.1.3 describes the initial conditions; and Section 3.2.1.4

describes boundary conditions for the reactor transient.

Acceptance criteria for the analyses serving as the technical basis for establishing the time constraints for the baseline coping capabilities are 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. The acceptance criteria 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.

ONS provided two scenarios for cooldown during an ELAP event. One scenario is applicable when the ELAP is a sudden and unexpected event that provides no warning time (e.g., an ELAP caused by a seismic event or by a sudden tornado event). The second scenario is applicable when the ELAP is caused by site flooding due to a postulated, sudden upstream dam failure. Based on the licensee's evaluation for a flooding event caused by sudden failure of Jocassee Dam, the loss of ac power at ONS does not occur until 2.86 hours after the dam failure occurs, and between the time of dam failure and the loss of normal and emergency ac power, ONS operators perform a number of key actions anticipating the loss of all normal and emergency ac power. Key actions required for cool down during Phase 1 of the ELAP event are described on page 9 of ONS's Integrated Plan and are summarized below.

Seismic Event ("T=0" event):
For the seismic event (or any other event except flooding) where a sudden and unexpected loss of normal and emergency ac power occurs, the licensee stated that at the initiation of the event, operators will enter the Emergency Operating Procedure (EOP). An operator on each affected unit will be dispatched to the SSF, and the control room supervisor (CRS) will transfer to the Station Blackout (SBO) tab of the EOP and attempt to regain power by running the restoration of power enclosure. The licensee stated that the FSGs will be implemented when the EOP enclosure actions fail to restore power and it becomes apparent that power restoration is not achievable in the near term. The SSF is designed to operate for 72 hours, as described in ONS's UFSAR, Section 9.6.3.2, but the licensee stated that Phase 1 reliance on the SSF will only be as long as needed to deploy the Phase 2 FLEX equipment. The licensee also stated that while Phase 1 coping capabilities using the SSF remain viable, they will continue to be used. The licensee stated that an operator at the SSF will align the SSF auxiliary service water (ASW) system within 14 minutes and that this is a time-critical action (TCA) that has been validated using licensed operators. The SSF ASW pump will take suction from the condenser circulating water (CCW) intake crossover line and discharge to both SGs on each unit. The licensee stated that RCS pressure will be maintained between 1950 and 2250 psig with an RCS temperature of 550 to 555 degrees Fahrenheit and that when the determination is made to enter the FSGs due to an ELAP, the SSF operator will isolate letdown and begin an RCS cool down using the SSF ASW and SG atmospheric dump valves (ADVs). The licensee further stated that the ADVs are manual valves located in the turbine building 5th floor and that an assessment will be completed to verify the seismic robustness of the ADVs and adequate accessibility after a seismic event. The licensee stated that pressure will be maintained and cool down rate will be established, limited only by the ability to maintain pressurizer level on scale.

Flooding Event:
The licensee stated that at the initiation of the event, which is a Condition A declaration[2] of Jocassee Dam failure, operators will enter the approved AOPs for flood mitigation, that all three

[2] ONS's External Flooding Procedure defines "Condition A" to mean that a failure at the dam has occurred or is about to occur.

units will begin shutdown, and that operations will run three AOP enclosures simultaneously. The licensee stated that the CRS enclosure trips the unit, borates the RCS to Cold Shutdown (CSD) conditions, closes core flood tank (CFT) isolation valves, increases level in the pressurizer and in the SGs, and begins plant cool down to 240 – 250 degrees Fahrenheit. The Operations Shift Manager (OSM) enclosure activates the operational support center/ technical support center (OSC/TSC), classifies the event, conducts site assembly, requests increased staffing, and directs SFP monitoring; and the Work Control Center Senior Reactor Operator (WCC SRO) enclosure dispatches operators and maintenance to align a portable pump at CTP-1 and notifies Security of the event. The licensee stated that a change will be made to the WCC SRO enclosure to notify Maintenance's Single Point of Contact (SPOC) to pre-stage FLEX portable instrumentation in the penetration room.

On page 4 of the Integrated Plan the licensee described the extent to which it is following the guidance in JLD-ISG-2012-01 and NEI 12-06. The licensee identified deviations from JLD-ISG-2012-01 and NEI 12-06 by stating:

> Conformance with NEI 12-06 is expected with the following exception:
>
> > The exception that the Standby Shutdown Facility (SSF) Diesel Generator will be considered available for Phase 1 coping until Phase 2 FLEX equipment has been deployed and is capable of being placed into operation, was presented to the NRC on November 8, 2012 (Reference 50). [Reference 50 refers to a presentation available at ADAMS Accession No. ML13004A365.]

The licensee noted that NEI 12-06, Section 3.2.1.3, condition (2), states, "All sources of emergency on-site AC power and Station Blackout (SBO) alternate AC power sources are assumed to be not available and not imminently recoverable," and NEI 12-06, Section 3.2.1.3, condition (6) states, "Permanent plant equipment that is contained in structures with designs that are robust with respect to seismic events, floods, and high winds, and associated missiles, are available."

On page 4 of the Integrated Plan, the licensee provided information to support its plan to credit the SSF diesel generator (DG) by stating that the SSF is robust as described in NEI 12-06, Section 3.2.1.2, condition (6) and that the SSF is credited for (a) the safe shutdown requirements for fire protection; (b) a seismic event resulting in a circulating water (CW) pipe break which floods the Turbine Building lower levels (internal flood); (c) physical security concerns; and (d) SBO when turbine driven emergency feedwater (TDEFW) is unavailable.

The licensee stated that the SSF DG is provided solely for operation of SSF equipment and is disconnected from the normal and emergency electrical distribution systems. The licensee stated that the SSF RCMU system provides seal injection and seal cooling to the RCP seals independent of the high pressure injection (HPI) system and that the SSF auxiliary service water (ASW) system provides auxiliary feedwater flow independent of the main feedwater, emergency feedwater, and station auxiliary service water systems. However, as described on page 17 of the Integrated Plan, if the SSF RCMU pumps are not available, the licensee's alternate Phase 2 strategy for providing makeup to the RCS uses low-capacity, high-head portable pumps taking suction from the missile-protected portion of the BWST and discharging into existing vent lines on the HPI injection header.

The licensee stated that the SSF system is normally aligned to 4160V switchgear for house loads from the Unit 2 main feeder bus; that during emergency operation the SSF electrical equipment is independent of plant electrical equipment; that SSF pumps are independent of plant equipment; and that ONS's Phase 1 coping strategy assumes, during an ELAP event, that all three units' TDEFW pumps are instantly unavailable at the beginning of the event (time = 0). The licensee also noted that, if available, any one TDEFW pump could be aligned to any or all three units.

The licensee stated that during an SSF mitigated event, the SSF is not connected to the offsite or onsite emergency ac power systems and that procedures, protective relaying, and interlocks ensure SSF systems are only supplied from the SSF. The licensee further stated that the full capability of Phase 2 using portable equipment/strategies will be deployed with the time critical aspects beginning upon recognition of an ELAP event.

During the audit the licensee was asked to explain whether it considers ONS's proposed Phase 1 strategy crediting the SSF diesel generator for Phase 1 coping to be only a departure from the guidance in NEI 12-06, as acknowledged in the Integrated Plan, or whether it considers the proposed strategy also to be a departure from the requirements of NRC Order EA-12-049.

In response, the licensee stated that it considers reliance on the SSF for Phase 1 coping to be a departure from the guidance in NEI-12-06, but not a departure from the requirements from NRC Order EA 12-049. The licensee stated that emergency ac power is provided from two Keowee Hydro Units and a 100 kV dedicated transmission from the Lee Combustion Turbine site. The licensee stated that the SSF does not repower the station essential or nonessential switchgear or the main feeder buses. The licensee further stated that since the SSF is credited with mitigating the 4 hour SBO, reliance on it for Phase 1 coping is considered to be an alternate method as described in NEI 12-06.

To support its position that ONS's strategy should be considered an acceptable alternative to the guidance in NEI 12-06, the licensee provided additional discussion as summarized below:

> The applicable requirement from the Order is specified in EA-12-049, Item (2) of Attachment 2, as, "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 this Order."
>
> JLD-ISG-2012-01 (with respect to EA-12-049) states that licensees should establish and maintain current estimates of their capabilities to maintain core and SFP cooling and containment functions assuming a loss of alternate current (ac) electric power to the essential and nonessential switchgear buses except for those fed by station batteries through inverters.
>
> The SSF does not repower the station essential or nonessential switchgear or the main feeder buses. SSF equipment is disconnected from the normal and emergency distribution system. The SSF, and particularly the SSF ASW system for decay heat removal, is credited for the 4 hour SBO coping time.
>
> Since the SSF is credited with mitigating the 4 hour SBO, reliance on it for Phase 1 coping is considered an alternate method as described in NEI 12-06. The SSF provides independent functions beyond the loss of normal and emergency ac power sources, does not repower the station essential or nonessential switchgear, and is robust with respect to BDBEEs as noted in the Integrated Plan.

> Oconee believes that the SSF design provides a unique approach in that the associated diesel generator does not attempt to repower any plant equipment or to utilize any of the plant power distribution infrastructure to power dedicated SSF equipment.

Key points of the licensee's discussion state that:

(a) Mitigation equipment powered by the SSF DG is not connected to ONS's normal or emergency ac power distribution system.
(b) The SSF DG does not auto-start or attempt to auto-connect to ONS's normal or emergency ac distribution system.
(c) The SSF and its associated equipment are designed to be robust against all external hazards applicable at ONS when no warning time of an impending ELAP is available.

The reviewer compared the licensee's strategy for use of the SSF with the guidance in NEI 12-06, Section 3.2.2, Guideline (13), which states that regardless of installed coping capability, all plants will include the ability to use portable pumps to provide reactor pressure vessel (RPV), RCS, and SG makeup as a means to provide diverse capability beyond installed equipment. The reviewer noted, as discussed in more detail in Section 3.2.1.9 of this report, that ONS's mitigation strategy includes transition from use of the equipment powered from the SSF to use of portable pumps for both SG makeup and RCS boration and makeup. On this basis, the reviewer determined that the licensee's mitigation strategy is consistent with the guidance related to use of portable pumps in NEI 12-06, Section 3.2.2, Guideline (13).

During the audit, the licensee stated that ONS's operators will follow normal symptom-based procedures until directed into FSG response and that if a source of feedwater remains available following an event, ONS procedures will always preferentially exhaust that capability prior to feeding with lake water using either the SSF or Phase 2 portable pumps. The licensee stated that ONS did conceptually consider modifications that do not rely on the SSF DG, but that the changes considered were major modifications and were not as proven and did not have designs as robust as the SSF; the licensee further stated that the modifications potentially created more risk for ONS's mitigation strategy and were judged possibly to render the strategy unsuccessful.

The licensee stated that the SSF is robust for all hazards except a bounding Jocassee Dam failure. The licensee stated that ONS has a mitigation strategy for "T=0 events" that plans to use the SSF for Phase 1 coping for approximately 24 hours and that the Jocassee Dam failure mitigation strategy can be successful if the SSF is available only for 3 hours. The licensee stated that to the extent that installed plant equipment is available, ONS will always preferentially use those capabilities, including the SSF, following symptom-based procedures. The licensee stated, that if a flooding event progresses to reliance on the SSF (onsite flooding) but not to the point of inundating the SSF, the SSF will continue to be used and that additionally a portable SG makeup capability will also be available. The licensee stated that for a Jocassee Dam failure event, Oconee will always respond to a Condition A declaration by deploying the portable SG makeup pump, deploying the alternate instrumentation repower strategy, and deploying operators to man the SSF and portable SG makeup pump within the first three hours. The licensee further stated that, if the flood is less limiting than expected, the scenario will still follow the path of shutting down the units and aligning Phase 2 equipment before the flood potentially inundates the site as described for the bounding flood event. The licensee stated that a symptomatic approach will be followed to identify possible SG feed and RCS makeup sources and to utilize those sources in a pre-determined order of preference. The licensee stated that the SSF will be utilized as needed until some other limitation requires the operators to swap to Phase 2 equipment and secure the SSF.

For the “T=0” events, the licensee proposes to use the SSF diesel generator (effectively, a permanently installed, pre-staged diesel generator) coupled with the remainder of the SSF equipment. The reviewer considers this strategy to be an alternate approach to the guidance in NEI 12-06, condition (2), which states that all installed sources of emergency on-site ac power and SBO alternate ac power sources are assumed to be not available and not immediately recoverable. The licensee’s alternate strategy using the SSF diesel generator to mitigate “T=0” ELAP events was judged acceptable by NRC staff during the audit process.

For the ELAP event caused by failure of the upstream dam, the licensee stated that after notification of the dam failure 2.86 hours will be available before loss of off-site and on-site emergency ac power, with loss of the SSF occurring at 3.0 hours. During this time period the licensee will take key actions in anticipation of the expected ELAP. As described earlier, these actions include shutting down the reactors and borating them to CSD conditions, increasing levels in the pressurizers and SGs, closing CFT isolation valves, and beginning plant cooldown. The preparatory actions also include dispatching personnel to deploy and align portable SG makeup pumps and instrumentation in anticipation of loss of all ac power. For events where a warning time is available, guidance in NEI 12-06 provides that this time may be used to implement preparatory actions anticipating the expected ELAP event. On this basis, the reviewer considers the licensee’s proposed strategy for mitigating an ELAP event caused by upstream dam failure to conform to the guidance in NEI 12-06.

The licensee’s approach described above, as currently understood, provides an acceptable alternative to 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 reactor core cooling and heat removal, and RCS inventory control strategies if these requirements are implemented as described.

3.2.1.1 Computer Code Used for the ELAP Analysis

NEI 12-06, Section 1.3 states, in part:

> Plant-specific analyses will determine the duration of each phase.
>
> 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 off- site.

On pages 5 through 7 of the Integrated Plan, the licensee described its SOE timeline and discussed key actions in its mitigation strategy, and on pages 41 through 43 the licensee provided additional SOE timeline details. The licensee provided two separate SOE timelines, as described in Section 3.2.1.6 of this evaluation.

In the list of references on page 55 of the Integrated Plan, the licensee included WCAP-17601-P, “Reactor Coolant System Response to the Extended Loss of AC Power Event for Westinghouse, Combustion Engineering and Babcock & Wilcox NSSS Designs” (ADAMS Accession No. ML13042A011 and ML13042A013 (Non-Publicly Available)). WCAP-17061-P is a proprietary report prepared by the Pressurized Water Reactor Owners Group (PWROG) to document generic analyses that were intended to provide a broadly representative assessment of the expected coping times for domestically operating pressurized-water reactor licensees in response to an ELAP event. On page 44 of the Integrated Plan, in Attachment 1B, "NSSS Significant Reference Analysis Deviation Table," the licensee presents a comparison of four key assumptions used in report WCAP-17601-P with similar assumptions used in ONS's ELAP evaluation. As discussed further below, analytical demonstration of the efficacy of the licensee's planned mitigating strategy does not rely on the WCAP-17601-P analysis. However, the Integrated Plan did not describe the specific analysis done to determine the duration of each phase of the ELAP mitigation strategy, as recommended by NEI 12-06, Section 1.3; nor did the integrated plan submittal discuss the specific computer codes and methods used to develop the SOE timelines for Oconee.

Several licensee-identified open items track site-specific analyses that are being performed; however, the computer code(s) to be used and the level of detail to be addressed in the analyses were unclear. Licensee-identified open item 7 states that FLEX basis documents need to be developed. Licensee-identified open item 10 states that a cooldown analysis by the licensee's safety analysis group is pending. Licensee-identified open item 13 states that an analysis is needed to confirm that one 3000-gallon-per-minute (gpm) Hale[3] pump located near the B.5.b pump staging area will provide sufficient flow to three units for SG heat removal. Licensee-identified open item 15 states that an analysis is needed to confirm that one 3000-gpm Hale pump located at the CTP-1 external flood mitigation (EMF) staging area will provide sufficient flow to three units for SG heat removal.

During the audit the licensee was asked to identify and describe the computer codes to be used in developing its plant-specific analyses that will determine the duration of each phase of the ELAP mitigation strategy. In response, the licensee stated that the ONS FLEX analyses are performed using NRC approved methods for UFSAR Chapters 6 and 15 and that ONS's mitigation strategy is evaluated using RELAP5 and RETRAN for the RCS response and FATHOMS and GOTHIC for the containment response. The licensee further stated that the WCAP-17601-P analyses use existing AREVA methods, that ONS's FLEX analyses use existing Duke methods, and that both methods use RELAP5/MOD2-B&W.

The NRC staff reviewed information provided by the licensee during the initial audit discussion and made a series of observations that are noted below. A subsequent discussion was conducted regarding several items as summarized below:

(1) Initially, the licensee did not provide sufficient detail regarding the roles of the specific thermal-hydraulic codes used for ONS's ELAP analysis. For example, the RELAP5 and RETRAN codes could, conceptually, both be used to simulate the entire ELAP event. The information initially provided by the licensee did not make clear which specific analyses had been performed with which specific codes, and, particularly, which specific analyses and codes are credited with demonstrating the success of the mitigating strategies proposed for Oconee.

    A subsequent audit discussion was held with the licensee, which adequately clarified that the current ELAP analysis for ONS relies upon the RELAP5/MOD2-B&W code. The

[3] Hale is the name of a fire pump manufacturer. The licensee typically refers to this specific portable pump as the "Hale pump."

licensee stated that ONS currently plans to use the RETRAN code if future updates to the ELAP analysis become necessary.

(2) Initially, the licensee did not fully specify the specific versions of RELAP5 and RETRAN that were used for ONS's ELAP analysis.

A subsequent audit discussion was held with the licensee, which clarified that the licensee's usage of "RELAP5" is intended to refer to the RELAP5/MOD2-B&W code. However, the licensee was not able to confirm during the subsequent discussion whether its usage of "RETRAN" is intended in all cases to refer to RETRAN-3D. However, because as the RETRAN analysis represents a potential future plan rather than the analysis needed presently to ensure compliance with the Order, the lack of specificity regarding the version of the RETRAN code was not designated a confirmatory item in the current review.

(3) Insufficient description and justification were provided regarding the specific evaluation model(s) (as defined in Section 15.0.2 of the NRC's Standard Review Plan) used in the ELAP analysis for ONS. The information provided by the licensee during the audit mentioned that existing AREVA and Duke methods were used for the ELAP analysis for Oconee. However, it was not clear whether the ELAP analysis credited for ONS used an evaluation model that is consistent with specific approved topical reports (see, e.g., Section 15.1.2 of ONS's UFSAR). Furthermore, because of differences between the postulated ELAP event and the loss of coolant accident (LOCA) and non-LOCA transients in ONS's current licensing basis, it is not clear that existing evaluation models for such transients are comprehensive and fully appropriate for analysis of an ELAP event. An illustration of this statement is that the ELAP evaluation models outlined in WCAP-17601-P share a number of similar features with, but are not identical to, the corresponding vendors' small-break LOCA evaluation models. Therefore, adequate description and justification for the specific evaluation model(s) used in the ELAP analyses for ONS is necessary. Provision of additional information to resolve this issue is designated Open Item 3.2.1.1.A in Section 4.1.

(4) The licensee did not commit to making the ELAP analyses for core cooling, reactor coolant system inventory, shutdown margin, and containment integrity available for NRC staff audit review. The licensee stated during the audit that the analyses for the ELAP event were not yet completed and that summaries will be made available for NRC staff review. However, making the ELAP analyses directly available for NRC staff audit review is necessary in light of the unique nature of ONS's analysis and the limited description concerning the governing analytical methodology. Furthermore, the analysis case discussed during the audit, which includes a significantly larger RCS leakage rate that is intended to establish confidence in the proposed mitigating strategies, should also be made available for NRC staff audit review. Provision of additional information to resolve this issue is designated Confirmatory Item 3.2.1.1.B in Section 4.2.

(5) The licensee did not provide sufficient justification to demonstrate that the RETRAN code (i.e., presumably RETRAN-3D) constitutes an adequate method for the analysis of an ELAP event for ONS.

RETRAN-3D is a general-purpose, industry-developed thermal-hydraulic code that is based on the one-dimensional homogenous equilibrium model (the "-3D" appellation refers to the code's capability for three-dimensional neutron kinetics). As documented in its safety evaluation of the EPRI topical report NP-7450(P), Revision 4, (ADAMS Accession No. ML010470342), the NRC staff has reviewed the RETRAN-3D code and deemed its use acceptable, under specified limitations and conditions, for performing licensing-basis analysis of certain transients other than loss-of-coolant accidents. As described in ONS's UFSAR (e.g., Section 15.1.2), Duke has further obtained NRC staff approval for the use of RETRAN-3D to analyze certain licensing-basis non-LOCA transients and accidents in conjunction with prescribed evaluation models.

As related above, discussion with the licensee at an advanced stage of the audit process revealed that, while the current ELAP analysis has been performed with the RELAP5/MOD2-B&W code, the licensee plans at present to perform future analyses with RETRAN-3D (or another version of the RETRAN code). A detailed evaluation of the licensee's proposed application of the RETRAN-3D code for future ELAP analysis exceeds the scope of the present review.

However, the NRC staff stated during the audit that application of RETRAN-3D for ELAP analysis is beyond the scope of prior reviews that accepted application of RETRAN-3D for the analysis of certain licensing-basis transients. Therefore, confirmation of the acceptability of RETRAN-3D for ONS's ELAP analysis would be necessary. Based on the licensee's expectation that the RCS loops would remain in single-phase natural circulation throughout the ELAP event, the level of justification required would be reduced relative to the general case involving two-phase flows. Dependent upon the scope of the licensee's intended use of the RETRAN-3D code in the ELAP analysis and available margins, some or all of the following information may be useful in demonstrating the applicability of RETRAN-3D for ELAP analysis:

i. Confirmation of similar predicted results for the ELAP transient using the RETRAN-3D code as compared to predictions generated by one or more thermal-hydraulic codes that have been previously used for generic analysis of the ELAP transient (e.g., RELAP5/MOD2-B&W). Such a comparison could include the timing of key events in the transient and plots of key parameters.

ii. Ensuring that RETRAN-3D models for key phenomena that may be associated with the prediction of the ELAP transient for ONS (e.g., seal leakage critical flow, heat transfer in applicable flow regimes, the drift flux model, evaporation and condensation, level swell, natural circulation, and boric acid transport) are adequately validated for the intended application.

iii. Confirmation that the ONS evaluation model uses input assumptions and boundary conditions that are appropriate for an ELAP event and that the proposed evaluation model either conforms to applicable limitations and conditions specified in NRC staff safety evaluations on RETRAN-3D, or that any deviations are acceptable.

iv. Identification of any RETRAN-3D models active during simulation of the ELAP event that were not reviewed during the NRC staff's review of topical report NP-7450(P), Revision 4, and confirmation that these models are acceptable for ELAP analysis.

As the licensee's planned use of RETRAN-3D for any future revisions to the ELAP analysis for ONS is beyond the scope of the present audit review, the staff did not designate this issue as an open item.

(6) The licensee was not able to confirm during the audit whether the RCS would remain in single-phase natural circulation flow during the analyzed ELAP event scenarios with and without advanced warning. Based on preliminary results, the licensee expected that single-phase natural circulation flow would be preserved in both cases, but deferred confirmation until its thermal-hydraulic analysis are finalized.

During the audit, the licensee stated that it will use the RELAP5 and RETRAN (as discussed in specific above) computer codes for simulating the ELAP event. Although the RELAP5/MOD2-B&W code has been reviewed and approved for performing LOCA and non-LOCA transient analysis, the NRC staff had not previously examined the technical adequacy of this code for simulating an ELAP event. In particular, the ELAP scenario is differentiated from typical design-basis small-break LOCA scenarios in several key respects, including the absence of normal emergency core cooling system (ECCS) injection and the substantially reduced leakage rate, which places significantly greater emphasis on the accurate prediction of primary-to-secondary heat transfer, natural circulation, and two-phase flow within the RCS. As a result of these differences, concern associated with the use of the RELAP5/MOD2-B&W code for ELAP analysis arose regarding the modeling of two-phase flow within the RCS and heat transfer across the steam generator tubes as single-phase natural circulation transitions to two-phase flow and boiler condenser cooling. Likewise, based on the preceding discussion, similar concerns were identified relative to the use of RETRAN-3D for ELAP analysis. As a result of these limitations associated with the validation of the associated thermal-hydraulic code models, the NRC staff concluded that reliance on the RELAP5/MOD2-B&W and RETRAN-3D codes in the ELAP analysis for B&W plants should be limited at the present time to flow conditions prior to boiler-condenser cooling initiation. Demonstration that ONS's ELAP analysis conforms to this position has been identified as Confirmatory Item 3.2.1.1.C 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 computer codes used to perform ELAP analysis if these requirements are implemented as planned.

3.2.1.2 RCP Seal Leakage Rates

NEI 12-06, Section 1.3 states:

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

During an ELAP event, as described in NEI 12-06, cooling to the RCP seal packages will be lost and water at high temperatures may degrade seal materials, leading to excess seal leakage from the RCS. Without ac power available to the ECCS, inadequate core cooling may eventually result from the leakage out of the RCP seals. ELAP analysis credits operator actions to align high-pressure RCS makeup sources and replenish the RCS inventory in order to ensure the core remains 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 leakage rates will result in a shorter time period for operator actions to align water sources for high-pressure RCS makeup.

On page 15 of the Integrated Plan, the licensee described the actions needed to maintain or re-establish RCP seal cooling following a seismic event where normal and emergency ac power are lost. The licensee stated that the SSF is designed to operate for 72 hours, as described in UFSAR Section 9.6.3.2, and that the SSF will only be relied upon as long as needed to deploy the Phase 2 FLEX equipment. The licensee stated that the operator at the SSF will align the SSF's RCMU system to supply the RCP seals within 20 minutes and that this is a time-critical action which has been validated using licensed operators. The licensee stated that activation of the SSF within the required time maintains RCP seal function. The licensee further stated that the SSF RCMU pump will take suction from the SFP and discharge to the RCP seal injection lines to provide boration of the RCS along with RCS makeup and RCP seal cooling. The licensee stated that a minimum RCP seal leakage of 8 gpm per reactor (i.e., 2 gpm per reactor coolant pump) will be assumed in the analysis and that this value for RCP seal leakage is consistent with WCAP-17601-P, Section 4.4.3, for RCP seals that do not experience overheating.

The licensee also described considerations related to ensuring adequate RCP seal cooling is maintained during a flooding event caused by an upstream dam failure. The licensee stated that, because of the advanced warning and conservative time assumed before the loss of plant components (3 hours), the RCS will be fully borated using normal plant equipment before this equipment is lost, and the pressurizer level will be increased to accommodate normal RCS leakage. The licensee again stated that a minimum RCP seal leakage of 8 gpm per reactor will be included in the analysis of the flooding event.

During the audit the licensee was asked to provide additional information supporting its claim that RCP seals will not experience overheating during ELAP events. In response, the licensee stated that the SSF RCMU pump provides seal cooling within 20 minutes, and that this precludes seal damage from overheating. The licensee stated that each RCP contains a sufficient volume of cold water such that, at normal seal leak off flow rates, seal temperatures remain acceptable. The licensee stated that analyses with extreme seal leak off rates show peak temperatures just above 400 degrees Fahrenheit persist for less than 15 minutes, and that this is acceptable based on the O-ring provider's acceptance criteria. The licensee further stated that the action time to establish seal cooling within 20 minutes is the current licensing basis. The licensee also stated that for the postulated Jocassee Dam break, adequate time exists (3 hours) to cool down the primary system using normal station equipment on all three units to preclude seal damage.

The licensee provided the following, additional information in response to questions regarding its RCP seal leakage assumptions and ELAP analysis:

- For T=0 events, RCP seal return [which may sometimes be referred to as controlled bleed off] and RCS letdown is isolated from the SSF within T+15 minutes per the existing AP [abnormal procedure]. For the postulated Jocassee Dam break, RCP seal return and RCS letdown is isolated using the dam break procedure.

- Based on the mitigation actions described above in response to [the earlier audit question], a minimum RCS leakage of 2 gpm per RCP plus 1 gpm of unidentified leakage (9 gpm total per unit) will be included in the base case of the ELAP cool down analysis, consistent with Section 4.4.3 of WCAP-17601-P for seals that do not experience overheating. The ONS cool down analysis will include a case run with RCP seal leakage significantly larger than expected to establish confidence in the strategies. The RCP seal leakage rates are calculated consistent with the WCAP-17601-P approach. Critical flow through a break area is sized to allow the selected flow rate at normal operating conditions. The Oconee analyses do not consider the decrease in cold leg temperature at the end of Phase 1 when seal cooling ends. This is being tracked by open item 10 from the Integrated Plan.

- Oconee has the following RCPs and seal packages:
  (a) Unit 1 - Westinghouse 93-A RCPs with FlowServe N-9000 3-stage RCP seals with the Abeyance feature
  (b) Units 2 & 3 – Bingham 28X28X41 RQV RCPs with Sulzer RQV875B 3-stage, cartridge seal assemblies

  Given that ONS does not have any high leakage seals and the planned mitigation strategies discussed in response to [an earlier part] of this question prevent seal overheating, the minimum RCP seal leakage of 9 gpm per unit is considered conservative for the ONS FLEX scenarios.

Based upon the information provided during the audit, the audit review identified the need for further information regarding the isolation of the RCP seal return and RCS letdown using the Jocassee dam break procedure. The means of isolating these flowpaths and the associated timeframe was not clear from the information provided during the audit. Provision of this additional information is designated as Confirmatory Item 3.2.1.2.A in Section 4.2 of this report.

Providing adequate justification for the assumed RCP seal leakage rates during an ELAP event was identified as a generic concern for PWRs by the NRC staff. This concern was partially addressed by the industry in the following submittals:

- WCAP-17601-P, Revision 1, “Reactor Coolant System Response to the Extended Loss of AC Power Event for Westinghouse, Combustion Engineering and Babcock & Wilcox NSSS Designs” dated January 2013 (ADAMS Accession No. ML13042A011 and ML13042A013 (Non-Publicly Available)).
- A position paper dated August 16, 2013, entitled “Westinghouse Response to NRC Generic Request for Additional Information (RAI) on Reactor Coolant (RCP) Seal Leakage in Support of the Pressurized Water Reactor Owners Group (PWROG)” (ADAMS Accession No. ML13235A151 (Non-Publicly Available)).

After reviewing these submittals, the NRC staff placed certain limitations on B&W-designed plants with respect to RCP seal leakage rates. Those limitations and their applicability are discussed below in light of design-specific information pertaining to the reactors at ONS:

(1) B&W plants use a variety of RCPs, seals, and motors. Some plants rely on procedures to maintain RCS temperatures below the design temperatures of the

limiting components (i.e., elastomers), and thus, keep RCP seal leakage low. For those plants, information should be provided to justify that the procedures are effective to keep the RCS temperatures within the limits of the seal design temperatures, and to address the adequacy of the seal leakage rate (2 gpm/seal) used in the ELAP analysis.

As described above, the licensee stated that RCP seal temperature would be maintained at an acceptably low value by establishing injection flow to the RCP seals via the SSF RCMU pump within 20 minutes of event initiation. Considering the information provided by the licensee during the audit, the remaining issues below were identified:

(i) Identification of the maximum seal temperature experienced when the normal seal leakage rate is considered.
(ii) Identification of the maximum seal temperature acceptance criterion set by the vendor for each of the reactor coolant pump seal designs used at Oconee.
(iii) Identification of the seal leakage rate that leads to a seal temperature just above 400 degrees Fahrenheit for less than 15 minutes.
(iv) Description of the existing evaluation methodology used to determine the temperature of the fluid adjacent to the RCP seal during a loss of seal cooling, such as would occur during an ELAP.
(v) Identification of the maximum fluid temperature adjacent to the reactor coolant pump seal as determined in the RELAP5/MOD2-B&W thermal-hydraulic analysis of the ELAP event and discussion of whether it is consistent with the existing evaluation.

Provision of this additional information is designated as Confirmatory Item 3.2.1.2.B in Section 4.2 below.

(2) Some plants have installed low-leakage seals to maintain the initial maximum leakage rate of 2 gpm/seal for the ELAP analyses of the RCS response. For those plants, a discussion of the information (including seal leakage testing data) should be provided to justify the use of 2 gpm/seal in the ELAP analysis.

A leakage rate of 2 gpm/seal was assumed for all RCP / seal combinations deployed at ONS. However, reference to an adequate technical basis supporting the assumed seal leakage rate was not presented during the audit. In particular, no reference was made to acceptable seal leakage testing data for each of the RCP / seal combinations deployed at ONS, as had been requested during the audit. Because the RCP / seal combination at ONS, Unit 1, is discussed separately below, this discussion will focus on the Bingham 28X28X41 RQV RCPs with Sulzer RQV875B 3-stage, cartridge seal assemblies that are installed at ONS, Units 2 and 3. Additionally, the potential for higher leakage rates than expected due to seal degradation resulting from increased cooldown stresses was not addressed during the audit. Provision of adequate justification for the assumed seal leakage rates for the Bingham RCPs with Sulzer seal assemblies is designated as Confirmatory Item 3.2.1.2.C in Section 4.2 below.

(3) If the seals are changed to a low-leakage seal design, the acceptability of the use of the new seal design should be addressed, and the RCP seal leakage rates for use in the ELAP analysis should be provided with acceptable justification.

(4) If Westinghouse RCPs are used with non-Westinghouse RCP seals, the acceptability of the use of the non-Westinghouse RCP seals in the Westinghouse RCPs should be addressed, and the RCP seal leakages rates for use in the ELAP analysis should be provided with acceptable justification.

Limitations (3) and (4) are both related to the RCP seals installed at ONS Unit 1. Specifically, as noted above, Unit 1 employs Westinghouse 93-A RCPs with FlowServe N-9000, 3-stage RCP seals with the Abeyance feature. Reference to an adequate technical basis supporting the assumed leakage rate for this RCP / seal combination was not presented during the audit. In particular, no reference was made to applicable seal leakage testing data for this RCP / seal combination. Additionally, the potential for higher leakage rates than expected due to seal degradation resulting from increased cooldown stresses was not addressed during the audit. Provision of adequate justification for the assumed seal leakage rates for the Westinghouse 93-A RCPs with Flowserve N-9000 seals with the Abeyance feature is designated as Confirmatory Item 3.2.1.2.D in Section 4.2 below.

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

3.2.1.3 Decay Heat

NEI Section 3.2.1.2 under initial plant conditions states in part:

> The initial plant conditions are assumed to be the following:
>
> 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.

ONS's Integrated Plan did not document details of the licensee's ELAP analysis sufficient to confirm that the assumed initial conditions and the decay heat model provide reasonable assurance that the ONS's ELAP analyses conform to the guidance in NEI 12-06, Section 3.2.1.2.

During the audit, the licensee provided additional information, stating that the initial conditions for the ELAP event are typical hot, full-power conditions with an end-of-cycle core to maximize decay heat. The licensee stated that boundary conditions applied are consistent with ONS's plant equipment performance characteristics and that the decay heat model used is ANSI/ANS-5.1-1979 with 2 sigma uncertainty plus heavy actinides calculated for the current ONS cores at end-of-cycle. The licensee further stated that a summary of the analysis performed will be made available for NRC staff review. Open Item 3.2.1.1.A, discussed previously, has further requested that the licensee make the analysis itself available for NRC staff audit review.

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 the decay heat model used for ELAP analysis if these requirements are implemented as planned.

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 event times determined 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.

The licensee's proposed mitigation strategies have been evaluated against the initial conditions recommended in NEI 12-06, Section 3.2.1.3:

1. NEI 12-06, Section 3.2.1.3, condition (1) states that no specific initiating event is used. However, the licensee's proposed strategies do assume specific initiating events. The licensee's SOE follows one path if the ELAP is sudden and unexpected, with no warning time available for anticipatory actions. The licensee's SOE follows a different path for a flooding event caused by a postulated complete and sudden failure of Jocassee Dam, which is upstream from the ONS site; for this event the licensee's evaluations show that loss of all normal and emergency ac power at the ONS site does not occur until 2.86 hours after a Condition A declaration of Jocassee Dam failure, at which time flood waters overtop the intake canal dike and begin flooding the ONS yard.

   NEI 12-06, Table 4-1, provides a listing of challenges posed by external hazards and identifies potential considerations related to mitigation of an ELAP caused by the listed events. Table 4-1 states that there will be no warning time for seismic events; however, for external flooding events, Table 4-1 states that substantial warning time is possible. The licensee stated that for all ELAP events except the external flooding event, ONS's initial Phase 1 mitigation actions will be directed by its strategy for the "T=0 event."

   NEI 12-06, Section 6.2.3.2, describes considerations related to deployment of FLEX equipment during a flooding event. Consideration (1) states:

   > For external floods with warning time, the plant may not be at power. In fact, the plant may have been shutdown 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, isolating accumulators, isolating RCP seal leak off, obtaining dewatering pumps, creating temporary flood barriers, etc. These factors can be credited in considering how the baseline capability is deployed.

   During the audit, the reviewer examined ONS's existing Abnormal Procedure for External Flood Mitigation and confirmed that it contains directions for immediate actions to shut down the reactor, initiate cool down, and borate the RCS when a Condition A failure of Jocassee

Dam is declared. These actions are key elements of the licensee's mitigation strategy for a flood-caused ELAP event. Because these actions conform to the guidance in NEI 12-06, Section 6.2.3.2, consideration (1), they are acceptable.

2. NEI 12-06, Section 3.2.1.3, condition (2) states that all installed sources of emergency on-site power and SBO alternate ac power sources are assumed to be unavailable and not imminently recoverable. However, the licensee's ELAP scenarios do not conform to this NEI 12-06 condition.

   At the start of the "T=0 event," the licensee assumes instantaneous loss of all normal off-site ac power sources, together with loss of all emergency ac power from the Keowee Hydro Station, which is the credited source for ONS's emergency ac power. However, the licensee does not assume loss of capability to provide ac power available from the SSF DG. For the bounding flood event the licensee assumes that ac power from normal sources will be available until flood waters enter the ONS yard, which the licensee stated is no earlier than 2.86 hours after Condition A declaration of Jocassee Dam failure, and that ac power from the SSF DG will remain available unit 3.0 hours after the dam failure, at which time the flood waters would enter the SSF. This departure from the guidance in NEI 12-06 has been evaluated earlier as described in Section 3.2.1 of this report and has been found to provide an acceptable alternative to the guidance in NEI 12-06.

3. NEI 12-06, Section 3.2.1.3, condition (3) states that 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 available. The licensee credited various sources for cooling and makeup water. Initially in the seismic-caused ELAP, the SSF RCMU pumps provide RCS makeup. There are three SSF RCMU pumps, one in each Reactor Building, powered from the SSF diesel generator. These pumps take suction from the SFPs and provide borated water from the SFP to the RCS through the RCP seal injection lines; the 72-hour mission time of the SSF is based on draw-down of water in the SFP. If the SSF RCMU pumps are not available, the licensee's alternate strategy for providing makeup to the RCS uses low-capacity, high-head portable pumps taking suction from the missile-protected portion of the BWST. In the flood-caused ELAP, similar methods would be used for RCS makeup after the ELAP occurs; however, 2.86 hours is credited to be available after dam failure and before the ELAP. During this time interval, when normal ac power is still available to plant equipment, the operators borate the RCS to cold shutdown conditions, close the core flood tank isolation valves, and increase levels in each unit's pressurizer and SGs. For the seismic-caused ("T=0") ELAP, SG makeup ultimately is provided using a portable diesel-driven pump with suction from the intake canal. For the flood-caused ELAP, SG makeup ultimately is provided using a portable diesel-driven pump taking suction from CTP-1, with water in CTP-1 replenished using embedded CCW system water for the next 5.75 days. The SFP is a safety-related structure that is protected from applicable external hazards; however, the licensee did not directly address to what extent the other sources of makeup water for the SGs (the intake canal or CTP-1) are robust with respect to hazards applicable at the ONS site.

   During the audit the licensee provided additional information related to NEI 12-06, Section 3.2.1.3, condition (3). The licensee stated that the source of water for the intake canal, Lake Keowee, relies on seismically stable dams and dikes. Based on consideration of the licensee's statement, the use of the intake canal is acceptable for all external events, except the limiting flood event which could over-fill Lake Keowee and make the intake canal unavailable. For the limiting flood event, the licensee stated during the audit that ONS uses

CTP-1 as the source of makeup water during the flooding event because CTP-1 is located above the maximum flood level and will remain available during a flood. CTP-1 was not identified as a Seismic Category 1 feature and the licensee does not credit it to be available following a design basis seismic event.

During the audit the licensee was asked to discuss how ONS complies with each of the key assumptions listed in NEI 12-06, Section 3.2.1.2 and Section 3.2.1.3. In response, the licensee stated that ONS complies with each of the key assumptions in NEI 12-06, Sections 3.2.1.2 and 3.2.1.3, for plant conditions with the exception of condition (2) in Section 3.2.1.3. The licensee stated that the SSF does not meet the requirements of condition (2), but that the alternate approach presented previously (in ADAMS Accession No. ML13004A365) addresses this matter.

As described above, the licensee's deviation from NEI 12-06, Section 3.2.1.3, condition (2) has been evaluated earlier in this report and found to provide an acceptable alternative to the NRC's endorsed guidance in NEI 12-06.

The licensee was asked whether analysis performed in WCAP-17601-P (or other generic analysis) is credited to justify the efficacy of the Integrated Plan and, if so, to justify any deviations between the actions and timings of the ONS Integrated Plan relative to those assumed in the referenced analysis case. In response to this question the licensee stated that ONS's Phase 1 strategy uses equipment not considered in WCAP-17601-P and that ONS's strategy is a combination of existing strategies using ONS's SSF equipment and the strategies presented in WCAP-17601-P. Further discussion with the licensee during the audit confirmed that the licensee is not relying upon generic ELAP analysis, such as those in WCAP-17601-P; rather, plants-specific ELAP analysis has been performed to model the mitigating strategies proposed for Oconee. Therefore, significant deviations between the inputs and assumptions for the ELAP analysis and Oconee's plant design and mitigating strategy are not expected. The initial values and assumptions in these analyses will be evaluated in conjunction with Open Item 3.2.1.1.A and Confirmatory Item 3.2.1.1.B.

During the audit it was noted that the cooldown rate following a seismic-induced ("T=0") ELAP event will be limited such that level will be maintained in the pressurizer and that the strategy appears to involve a symmetric cooldown that remains above 525 degrees Fahrenheit, followed by an asymmetric cooldown to the range of 240 to 250 degrees Fahrenheit. The licensee was asked to clarify whether this cooldown rate limitation applies to both the seismic and the flooding scenarios; and, if different cool down strategies are used, to explain the basis for the difference. The licensee was also asked to clarify the approximate cooldown rate that is expected to support maintaining pressurizer level and to provide a basis for that rate in each scenario.

In response, the licensee stated that for the flood event the cooldown rate is governed by ONS's External Flood Mitigation Procedure (AP/47) and that for a Condition A dam failure event the reactor is tripped and then cooled down at a maximum rate less than or equal to 100 degrees Fahrenheit per hour down to 280 degrees Fahrenheit, and then at a rate less than or equal to 50 degrees Fahrenheit per hour to approximately 240 degrees Fahrenheit.

The licensee stated that for the "T=0" (seismic) event, the Phase 1 cooldown rate is limited by the mass added by the 29 gpm SSF RCMU pump and that the RCS is cooled to accommodate the mass added when maintaining a constant pressurizer level. The licensee stated that the cooldown rate to accommodate 20 gpm makeup net is between 15 and 20 degrees Fahrenheit per hour over the initial 10 hours of the event and that the majority of the cool down is accomplished in Phase 1 before asymmetric cooling is aligned.

Based on the licensee's statements and the evaluations of the licensee's conformance to NEI 12-06 as presented above, the licensee's treatment of key plant parameters and assumptions in ONS's ELAP analysis is acceptable.

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, including an acceptable alternative to the guidance, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to initial values and assumptions used for ELAP analysis if these requirements are implemented as planned.

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. 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 10 of the Integrated Plan, the licensee identified the installed instrumentation that ONS will use during Phase 1 coping to maintain core cooling and heat removal during an ELAP.

For the "T=0" event (seismic event) the licensee stated that ONS will use the following SSF dedicated instrumentation which has indications in the SSF control room: (1) RCS pressure; (2) RCS hot-leg and cold leg temperatures (RCS T_{hot} and T_{cold}); (3) pressurizer level; (4) SG level; (5) ASW flow; and (6) five core exit thermocouples. The licensee stated that the following MCR instruments powered from battery-backed vital panel boards will also remain available: (1) RCS wide range pressure; (2) RCS hot leg temperature; (3) pressurizer level; (4) SG level; (5) SG pressure; (6) core exit thermocouples; and (7) reactor vessel level indication system (RVLIS). The licensee further stated that a load shedding analysis will be performed to determine the length of time this MCR instrumentation will remain available.

The licensee stated that based on the advanced warning of a flood, instrumentation normally used to support core cooling and heat removal will be available for Phase 1 coping.

On page 16 of ONS's Integrated Plan, the licensee identified installed instrumentation that it will use during Phase 1 coping to maintain RCS inventory control during an ELAP. The instruments in the SSF listed for RCS inventory control were the same as listed to maintain core cooling and heat removal, except that SG level and ASW flow were not listed for RCS inventory control. The instruments in the MCR listed for RCS inventory control were the same as listed to maintain core cooling and heat removal, except that SG level and pressure were not included in the list, and excore nuclear instruments NI-1 and NI-2, and reactor building normal and emergency sump levels were included in the list.

On page 12 of the Integrated Plan, the licensee listed the MCR instrumentation needed in Phase 2 of its strategy to maintain core cooling and heat removal. The same instrumentation as used in Phase 1 was listed, with the addition of RCS T_{cold} indication, which the licensee stated will need a separate re-power action. On page 14 of the Integrated Plan, the licensee stated that Phase 3 of its strategy to maintain core cooling and heat removal will require the same instrumentation as Phase 2.

On page 18 of the Integrated Plan, the licensee listed the MCR instrumentation needed in Phase 2 of ONS's strategy to maintain RCS inventory control; and the list was the same as in Phase 1, with three additions: (1) RCS T_{cold} indication was added, with a statement that a separate re-power would be needed; (2) RCS high point vent valve position indication was added, requiring a separate re-power; and (3) RCS head vent valve position indication was added, requiring a separate re-power. On page 20 of the Integrated Plan, the licensee stated that Phase 3 of its strategy to maintain inventory control will require the same instrumentation as Phase 2.

On page 21 of the Integrated Plan with regard to containment instrumentation following a seismic event, the licensee stated that an indication of containment pressure during Phase 1 coping is not required based on preliminary reviews of existing containment response analysis for a loss of ac power event.

On page 22 of the Integrated Plan, the licensee listed instrumentation needed to monitor key containment parameters. For the "T=0" event (seismic event), the licensee identified the wide range reactor building pressure instrument but noted that it is not considered a priority item based on preliminary review of existing containment response analysis. For the flood event the licensee stated that indication of wide range reactor building pressure will be available using portable instrumentation in the east electrical penetration room.

On page 25 of the Integrated Plan with regard to SFP instrumentation, the licensee listed SFP primary level and SFP alternate level instrumentation to be installed in accordance with NRC Order EA-12-051 and NEI 12-02.

During the audit the licensee was asked to explain whether the instruments listed in the Integrated Plan are the minimum set of instruments needed to implement its FLEX strategies. In response the licensee stated that the instruments listed in the Integrated Plan, with the exception of the reactor building normal and emergency sump levels, are the minimum required instruments needed to support key actions associated with ONS's ELAP mitigation strategies. The licensee further stated that the identified minimum instrumentation will be used to support operator actions required to maintain core cooling and heat removal, RCS inventory control, containment and SFP cooling as described in NEI 12-06.

The set of instruments listed by the licensee in the Integrated Plan included all of the instrumentation listed in NEI 12-06, Section 3.2.1.10; and on this basis the listed instruments conform to the endorsed NEI guideline. Additional available instrumentation discussed during the audit, such as that associated with normal and emergency sump levels exceeded the suggested guidance in NEI 12-06 and provide valuable information that can aid operators in estimating cumulative RCS inventory loss and otherwise diagnosing the condition of the plant. However, during the audit, the licensee provided information that indicated that SG pressure indication may not be provided, at least during Phase 1 of the ELAP response. Citing Section 9.6.4.6.2 of ONS's UFSAR, the licensee stated that reactor coolant system heat removal can be directly monitored by RCS parameters and controlled by steam generator level without steam generator pressure indication. The cited section of ONS's UFSAR includes the following statement:

> Reactor coolant system (RCS) heat removal for achieving mode 3 with an average Reactor Coolant temperature ≥ 525°F can be directly monitored by RCS parameters and controlled by SG level without SG pressure indication, provided that SG pressure is regulated.

Because the planned cooldown in ONS's mitigating strategy would result in reactor coolant system temperatures below 525 degrees Fahrenheit, it is not apparent from Section 9.6.4.6.2 of ONS's UFSAR why SG pressure indication is not necessary to support the ELAP mitigating strategy. Confirmation that SG pressure indication will be available to support the cooldown directed by the ELAP mitigating strategy, or provision of an adequate basis that such indication is unnecessary even at average reactor coolant temperatures below 525 degrees Fahrenheit is identified as Confirmatory Item 3.2.1.5.A in Section 4.2.

During the audit the licensee was asked to justify that the listed instrumentation and associated instrument indications or setpoints credited in ONS's ELAP analysis are sufficiently reliable and accurate in the potentially harsh containment conditions to support required actions for mitigation of the ELAP event. In response to this question, the licensee stated that the instruments located in the containment and needed to support key actions for FLEX strategies are the same instruments that are qualified and credited for mitigation of other events resulting in degraded containment conditions. The licensee further stated that an analysis to document containment response for a FLEX ELAP event will be performed and that results of that analysis will be evaluated to determine potential impacts to the credited instrumentation. The licensee's response is acceptable because the subject instruments are already qualified for some harsh containment environments and additional analysis will be performed to confirm their adequacy or identify changes needed to support an ELAP event.

During the audit the licensee was asked to explain why instrumentation to monitor temperature inside the containment is not listed as vital instrumentation, because there is potential that the operators will need to monitor containment temperature to ensure that applicable limits are not exceeded for penetrations seals or other equipment. In response to the request the licensee stated that an analysis to document containment response for a FLEX ELAP event will be performed and results of this analysis will be evaluated to determine potential impacts to containment penetration seals and other equipment used in the mitigation strategies. The licensee stated that this is being tracked by open item 26 from the Integrated Plan. The licensee needs to confirm that as a result of containment analysis (licensee-identified open item 26), there will be no impact on the credited instrumentation. 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 successful closure of issues relating to 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 planned.

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.”

On pages 5-7 and pages 41-44 of the Integrated Plan, the licensee described two SOE timelines. The first SOE timeline is for response to a seismic event (or any undesignated event) which occurs without warning and causes loss of ac power at time zero; the licensee refers to this as a “T=0 event.” For this event the normal and emergency ac power sources are assumed to become unavailable at time zero and to remain unavailable throughout the event.

The second SOE timeline is for response to a design basis flooding event (postulated sunny-day failure of Jocassee Dam upstream of the ONS site). For this event, a sudden failure of Jocassee Dam occurs at time zero, and a Condition A declaration of the dam failure is made. However, loss of ONS’s normal and emergency ac power sources is assumed not to occur until flood water from the failed dam enters the ONS yard. On page 43 of the Integrated Plan, in the detailed SOE time line for flood response, the licensee stated that at 2.86 hours (2 hours, 51.6 minutes) after the Condition A declaration of Jocassee Dam failure, the flood will crest the intake canal dike and begin flooding ONS’s yard; and at this time normal and emergency ac power is lost.

In the Integrated Plan, the licensee provided an evaluation and an event mitigation scenario that assumes its SSF DG is available to provide ac power for up to 72 hours (the mission time of its SSF) following an ELAP caused by a seismic event; and during the limiting flooding event the licensee assumes that sudden failure of Jocassee Dam occurs at time zero, but that ac power remains available (from offsite, or via its emergency power feeds from Keowee Dam, and from the SSF diesel generator) for 2.86 hours, at which time the flood would crest the intake canal dike and begin flooding the ONS yard.

In the SOE timeline for seismic response, with ELAP at time zero, two time-critical actions are identified within the first 20 minutes of the event: (1) Feed to the SGs is required to be established within 14 minutes; and (2) Cooling water supply to the RCP seals is required to be established within 20 minutes. These actions are implemented from the SSF which is designed to Seismic Category I criteria and assumed by the licensee to survive the initiating event, including availability of the SSF diesel generator.

In the SOE timeline for flood response, with Jocassee Dam break at time zero and ELAP occurring at time equal 2.86 hours, there are several key actions performed in the time period of 60 seconds to 3.0 hours. The control room supervisor for each unit is responsible to (1) trip the unit; (2) borate the RCS to cold shutdown conditions; (3) close the CFT isolation valves; (4) increase the level in the pressurizer and SGs; and (5) begin plant cool down. These actions are included in ONS's current External Flood Mitigation procedure, and are not identified as new time-critical ELAP time constraints.

During the audit, the licensee was asked to more clearly describe the SOE timeline for its flood response and to clarify exactly when all ac power, including the SSF DG, is assumed to be lost in this event. In response, the licensee stated that in ONS's FLEX strategies for the flood caused by a postulated Jocassee Dam break, the SSF DG is assumed to be lost at 3 hours after the Condition A declaration of dam failure and that for this strategy, operation of the SSF DG is not relied upon after the onset of flooding. The licensee stated that for the bounding flood scenario, flood waters are expected to inundate the SSF at 3 hours and recede to approximately 1 foot in the ONS yard at 8 hours, for a total on-site duration of 5 hours. The licensee stated that its Flood Response SOE time line includes an action to provide makeup to the RCS using either the repowered SSF RCMU pump with suction from the SFP or a portable low-capacity, high-head pump taking suction from the missile protected portion of the BWST. This action begins at 8 hours, when the flood water has receded from the site, and continues out to 72 hours when Phase 3 equipment is expected to be onsite and available for use.

During the audit the licensee was asked to explain why ONS developed ELAP SOE time lines based on specific postulated causes and to justify that the SOE timelines presented in ONS's Integrated Plan bound ELAP events that might result from different external events or unanticipated events.

In response to this question, the licensee stated that the separation of the "T=0" events and the Jocassee Dam break event in the Integrated Plan was driven by the three-hour advanced warning for the flood event which allows time to take preemptive measures. The licensee stated that other "T=0" ELAP events are bounded by ONS's seismic strategies because they occur with no warning and are initially treated like any other event using a symptomatic approach. The licensee further stated that, for situations such as an ELAP with unspecified causes, ONS will be forced onto using the SSF and a determination will be made that ONS has entered an ELAP condition, at which time FSGs will direct the completion of Phase 1 actions as well as the deployment of Phase 2 equipment.

During the audit the licensee was asked questions concerning the viability and the actions required to repower the SSF RCMU pumps following a flood event, as described in Action Item 6 on ONS's flood response SOE timeline. In response to these questions, the licensee noted that in the first six-month update to ONS's Integrated Plan, ONS identified a new open item 33 to reevaluate the strategy to repower the RCMU pumps and to consider this strategy for elimination by implementing train-specific diesel-powered pump strategies. The licensee further stated that no additional SSF equipment is relied upon to mitigate the Jocassee Dam break subsequent to the onset of flooding and that, in accordance with current procedures, RCP seal return and RCS letdown are isolated from the SSF. Because the licensee's strategy to repower the RCMU pumps following a flood event is being evaluated for possible elimination, the licensee's closure of its open item 33 should be reviewed when completed to confirm that changes in mitigation strategy that may be introduced by this open item are acceptable. The licensee should either (1) develop a successful mitigating strategy that does not rely on repowering the SSF RCMU pumps following recession of floodwaters or (2) provide adequate justification that the SSF RCMU pumps can reliably be repowered following recession of floodwaters. This is identified as Open Item 3.2.1.6.A in Section 4.1.

During the audit the licensee was asked to further discuss the events and actions taken in the 3 hours between when Jocassee Dam failure occurs and before SSF function is lost as flood waters in the ONS yard begin overtopping the flood wall around the SSF. In response to this question the licensee provided the following additional information:

When a Condition A (actual damage) is declared at Jocassee Dam, the operators will enter ONS's External Flood Mitigation procedure (AP/47) and the procedure will direct the following actions:

1) Notify the WCC SRO to run a procedure enclosure to have the SPOC and nuclear equipment operators align a Hale pump from CTP-1 to the existing station ASW header.
2) At the same time the OSM is running an enclosure that, among other things, classifies the event and activates the TSC
3) At the same time, the MCR crew is:
    a) Tripping the reactor
    b) Aligning HPI to BWST
    c) Reducing to 1 RCP/loop
    d) Beginning cool down to the range of 240 to 250 degrees Fahrenheit at a maximum rate less than or equal to 100 degrees Fahrenheit per hour
    e) Increasing pressurizer level to the range of 200 to 220 inches
    f) Making preparations to feed the SGs using a FLEX portable pump
    g) Increasing SG levels to the loss of sub-cooling margin setpoint using the motor driven EFW pumps
    h) Isolating the CFTs
    i) Adding 3100 gallons of fluid to the RCS from the concentrated boric acid storage tank
    j) Energizing the station standby bus from Keowee emergency transformer CT-4
4) When the flood inundates the site at about 3 hours, Phase 2 actions begin.

The licensee was asked whether the potential for heat transfer from containment to the CFT volume was considered in determining the pressure (or time) at which the CFTs should be isolated in accordance with the methodology in Attachment 1 of the PWROG Core Cooling Interim Position Paper dated November 9, 2012. The licensee also was asked to clarify whether consideration was given to isolating the CFTs after a significant fraction of their usable volume injects into the RCS, and why strategies involving make up from the SFP are preferable to reliance on some fraction of the CFT inventory for primary system makeup.

In response to these questions, the licensee stated that the "T=0" event mitigation strategy uses the SSF equipment during Phase 1 and that the SSF includes an RCMU pump to add RCS inventory, a letdown line to reduce RCS inventory, an ASW pump to provide feedwater to the

SGs, and necessary equipment to power a subset of the pressurizer heaters. The licensee stated that the SSF is intended to maintain the RCS at an average temperature of approximately 550 degrees Fahrenheit, with a pressurizer level between limits which are nominally 220 inches to 240 inches, at an RCS pressure between 1950 and 2250 psig, and with a SG water level of about 240 inches extended startup range for a 72 hour mission time. The licensee stated that the SSF ASW pump is capable of feeding all six ONS SGs at main steam relief valve pressure, and ASW flow is initially controlled to maintain a constant RCS pressure, then to maintain a desired SG water level once cold leg temperatures have decreased sufficiently.

The licensee stated that the SSF RCMU pump provides seal cooling in a timely fashion to preclude seal damage and that in-leakage from the RCMU pump adds RCS inventory which must be managed. The licensee stated that the normal SSF procedures use the SSF letdown line to maintain pressurizer level within an operating band and manage RCS inventory by returning liquid to the SFP. The licensee further stated that during ELAP events this letdown line is not utilized and RCS inventory control is accomplished by modulating the ADVs to achieve a constant pressurizer level through a slow cool down. The licensee stated that in Phase 1 the operator will be controlling ASW flow to maintain a desired SG water level, ADVs to maintain a constant pressurizer level, and the available heaters to maintain RCS pressure and that for events that do not include a faulted steam line, these actions ensure RCS pressure remains above CFT pressures.

The licensee stated that for Jocassee Dam flood scenarios, the existing procedures ensure that the reactors are subcritical to as low an RCS temperature as 70 degrees Fahrenheit by injection of concentrated boron and that the CFTs are isolated prior to a loss of power resulting from the flood. The licensee further stated that RCP seal leakage is a function of RCS pressure and that, while the SSF RCMU pump operates, RCP seal leakage to containment is SFP fluid. The licensee stated that decreasing RCS pressure will reduce leakage to containment. The licensee further stated that remaining at elevated pressure in the RCS does not present a vulnerability and that increased pressure preserves subcooling margin and single phase natural circulation flow. The licensee also stated that RCS subcooling must be managed to avoid approaching the nil ductility temperature limits.

The licensee stated that all of this is being tracked by ONS's open item 10 from the Integrated Plan, "Cool Down Analysis by the Safety Analysis Group."

Additional information provided by the licensee with regard to preventing nitrogen injection from the core flood tanks (CFTs) into the RCS did not address the staff's concern because the response did not discuss whether the analysis for preventing nitrogen injection followed the methodology in Attachment 1 to the PWROG's core cooling interim position paper, nor did it describe an equivalent or alternative acceptable methodology. Initially, the licensee's response seemed to suggest that the RCS would be maintained at elevated temperatures and pressures for mitigating an ELAP. However, as described in the licensee's response to an audit question and elsewhere in the documentation reviewed during the audit, for ELAP scenarios with and without advanced warning, a cooldown and depressurization of the RCS is implemented. With the understanding that a depressurization of the RCS will occur as part of ONS's mitigation strategy, definition of a termination point for the plant cooldown is necessary to ensure that nitrogen injection from the CFTs is prevented. This termination point would necessarily be determined from analytical calculations. Although the licensee's response discussed equipment that could be used to control the plant cooldown, it did not appear to discuss the specific information requested during the audit regarding the methodology for establishing a cooldown /

CFT isolation strategy that directs the manipulation of plant equipment in a manner that would prevent nitrogen injection into the RCS. The licensee will need to provide an adequate technical basis to conclude that nitrogen from the CFTs will not be injected into the RCS. This is designated as Open Item 3.2.1.6.B in Section 4.1 of this report.

During the audit the licensee was asked to provide additional justification for certain action times specified on ONS's SOE timeline. Specifically, the licensee was asked (1) to provide the basis for concluding that it is sufficient to restore makeup to the secondary side of the SGs within 14 minutes and to clarify whether the SGs' secondary side will continue to absorb adequate heat from the primary to prevent lifting of a pressurizer relief or safety valve; and (2) to provide the basis for concluding that it is sufficient to restore cooling to the RCP seals within 20 minutes and to clarify the basis for concluding that the RCP seals would not be damaged due to a 20 minute interruption in cooling immediately after the reactor trip.

With regard to the first question, the licensee stated that this 14-minute time period is the current licensing basis for the SSF and that ONS's Time Critical Action procedure, Enclosure 30, "Mitigate SSF Events," shows that the SSF ASW pump start is completed within 14 minutes, RCP seal return and letdown are isolated within 15 minutes, and RCMU pumps are started within 20 minutes. The licensee further stated that these actions do not prevent lifting pressurizer relief or safety valves. When further analyses are completed, the licensee should provide additional information that either supports a conclusion that pressurizer relief or safety valves do not lift during the ELAP event or that lifting of the valve(s), if it occurs, is acceptable. This is identified as Open Item 3.2.1.6.C in Section 4.1 of this report.

With regard to the second question, the licensee stated that these time frames were established to support ONS's current licensing basis for the SSF and that analyses of extreme seal leak off rates show peak temperatures just above 400 degrees Fahrenheit persist for less than 15 minutes, which is acceptable based on the O-ring provider's acceptance criteria.

During the audit the licensee was asked to provide justification that the RCS can be adequately cooled down and maintained in natural circulation under ELAP conditions with seal leakage when local actions are necessary to control the SG makeup flow and the ADV position. The licensee was asked to clarify the means of communication between the MCR and local equipment operators for the SG makeup pumps and ADVs to effect symmetric cool down of the RCS. The licensee was asked to clarify whether thermal-hydraulic sensitivity calculations have been performed to demonstrate that natural circulation and stable primary-to-secondary heat transfer can be reliably maintained within the RCS when reasonably expected deviations from the intended cooldown rate are independently imposed by each primary loop. The licensee was also asked to clarify whether any interruption in makeup flow to the SGs is anticipated during the transition from the installed SSF pump to the FLEX pump and whether analysis has been performed to demonstrate that the transition will not impair natural circulation and stable primary-to-secondary heat transfer.

In response to these questions, the licensee provided the following additional information:

(1) Control of the SG feed flow for the symmetric cool down phase of the seismic and flooding scenarios is performed by operators either in the MCR or at the SSF control boards. The indications and controls required by the operators are readily available. Operation of the ADVs to maintain a constant pressurizer level is a local action that requires radio communication with operators in the MCR.
(2) The ADV modeling uses logic that intends to mimic operator action and a 30 minute delay

between the termination of SSF ASW flow to the SGs and alignment of the portable FLEX SG makeup pump is assumed in the analysis. Natural circulation flow is maintained during this time frame.

(3) Duke is using RELAP5 and RETRAN for the RCS response (as discussed further in Section 3.2.1.1 of this report) and FATHOMS and GOTHIC for the containment response, and the acceptance criteria employed for these analyses are to maintain the core covered and cooled by natural circulation, to maintain the core subcritical, and to maintain containment pressure below design pressure.

Based on (1) the licensee's statement that the reactor coolant system will be maintained in single-phase natural circulation and (2) the relative slowness of the plant cooldown for the ELAP scenario without advanced warning, the above response may be reasonable. However, as stated in Confirmatory Item 3.2.1.1.B, the licensee has not yet provided its analysis for the staff's audit review. Therefore, the staff will assess the modeling of the cooldown and the capability to restore natural circulation after a delay in SG makeup under that confirmatory item.

ONS's main steam system design does not include main steam line isolation valves. During the audit the license was asked to discuss consequences of this ONS design aspect with regard to an ELAP event and the mitigation actions required. Related questions and responses are presented below:

(1) The licensee was asked to clarify whether consequential damage to unprotected portions of the main steam system piping directly resulting from the ELAP initiating event (e.g., earthquake or tornado) could result in an uncontrolled cooldown to the RCS. In response to this question the licensee stated that such an event would result in an uncontrolled cooldown until SG inventory is depleted.

(2) The licensee was asked to clarify whether postulated main steam system damage would result in a cooldown of one or both SGs and to provide a technical basis supporting the answer. In response to this question the licensee stated that an analysis of main steam line breaks was performed in support of the measurement uncertainty recapture power uprate licensing application, and that the results indicate that natural circulation flow is lost immediately following the end of the uncontrolled cooldown, but is recovered during the subsequent heat up. The licensee stated that the scenario relies on SSF ASW for SG cooling and SSF RCMU pumps for RCP seal cooling and that the analysis demonstrates that the core remains covered, natural circulation is reestablished, and RCP seals remain intact. The licensee further stated that there should be no damage to SG feed lines or RCS makeup lines used for FLEX Phase 1 or Phase 2 primary or alternate strategies.

(3) The licensee was asked whether ELAP scenarios involving the uncontrolled cooldown of one or more SGs may be postulated, and was further asked to describe key operator actions that would be taken to mitigate such an event. In response to this question the licensee stated that no uncontrolled cooldowns are expected for ELAP events except for a complete failure of one or both steam lines and that in such a situation the uncontrolled part of the event ends when all feedwater finishes flashing into the SGs. The licensee stated that no operator actions will mitigate the SG blowdown phase of the event.

(4) If ELAP scenarios involving the uncontrolled cooldown of one or more SGs may be postulated, the licensee was asked to provide analysis demonstrating that the intended mitigation actions would lead to satisfaction of the requirements of Order EA-12-049 for such cases. In response to this question the licensee stated that for scenarios which

postulate damage to the steam lines, a wider variety of options for feeding the SGs is more readily available. The licensee stated that operator actions to locally operate the ADVs are no longer needed and the reduced SG pressure allows the use of pumps that are not capable of feeding at main steam safety relief valve pressures.

The licensee stated that the operator at the SSF will refer to the SSF EOP and perform the following actions:

- Establish flow to the RCP seals using the SSF RCMU pump
- Verify that SSF ASW is required, determining this before leaving the MCR
- Isolate normal letdown and seal return
- Align SSF valves to set up a flow path
- Throttle SSF ASW to maintain RCS pressure within a pressure band of 1950 to 2250 psig
  - The licensee stated that for once-through SGs, ONS will induce natural circulation flow by feeding high on the SG tubes because ONS feeds through the auxiliary feedwater nozzles directly onto the SG tubes. The licensee stated that this will raise the thermal center of the heat sink higher than the thermal center of the heat source and promote natural circulation.
  - The licensee stated that operators will not begin to feed the SGs until the overcooling is stopped and the corresponding RCS heatup has returned RCS pressure to the range of 1950 to 2250 psig and that this band will ensure that the SGs are neither under fed nor over fed.

The licensee stated that following an uncontrolled cooldown the operator would initially provide SG cooling to maintain an average RCS temperature of approximately 550 degrees Fahrenheit, meaning that the operator would allow the RCS to heat up. The licensee stated that during this time frame the RCMU pump would provide additional RCS inventory and that the analysis described in response to question (2), above, demonstrates that natural circulation is recovered.

(5) The licensee was asked whether operator actions to mitigate an ELAP event involving an uncontrolled cooldown result in an asymmetric cooldown of the RCS and, if so, to address the consequences of the asymmetric cooldown on the mixing of boric acid that is added to the RCS to ensure subcriticality. In response to this question the licensee stated that there are no operator actions for such an event, as described in response to question (3), above.

A related question was asked during the audit in that ONS's ELAP analysis assumes that the RCS cooldown can be controlled using the SG ADVs, but there are no main steam line isolation valves at ONS and there are long runs of main steam piping that potentially could be damaged by an event. The licensee was asked to explain why no damage to main steam piping is postulated during an ELAP event. In response to this question the licensee stated that the "T=0" event strategy does not postulate damage to the main steam piping and that assuming main steam piping failures is a credit when considering the initial RCS temperature response for RCP seal integrity. The licensee stated that main steam piping failure limits the options for establishing SG cooling and that reduced secondary pressure resulting from steam piping damage would eliminate the operator actions to locally operate the ADVs and would also allow immediate SG cooling from a variety of low head pumps. The licensee stated that the postulated piping failure would not significantly alter the overall mitigation strategy.

The licensee stated that if steam line piping damage were postulated, the current SSF procedures would maintain the RCS within a prescribed set of conditions: an average RCS temperature of approximately 550 degrees Fahrenheit, with a pressurizer level within limits (nominally 220 inches to 240 inches), and RCS pressure between 1950 psig and 2250 psig. The licensee stated that initially the operator would allow the RCS to heat back up to 550 degrees Fahrenheit, and natural circulation would be recovered in the process. The licensee stated that, following the declaration of an ELAP event, the SSF letdown line would be closed and ASW flow would be controlled to maintain a constant pressurizer level and that a slow RCS cool down would result to accommodate the in-leakage from the SSF RCMU pump.

Based on the information provided by the licensee during the audit regarding the potential for an uncontrolled cooldown resulting from consequential damage to the main steam system due to the severe natural hazard that initiates the ELAP event, the NRC staff made the following observations:

(1) The licensee had previously analyzed a double-steam-line rupture to support a measurement uncertainty power uprate application. However, this application had been suspended without the staff's review of the analysis having been completed. In particular, the licensee had not fully addressed requests for additional information regarding the analysis prior to suspension of the review.

(2) Review of the double-steam-line-rupture analysis in the present audit resulted in a number of questions that could not be resolved within the limited audit timeframe. For example, these questions included

    a. Consistency of analytical input assumptions, conditions, and methods with ELAP event guidance (e.g., availability of plant equipment such as pumps and pressurizer heaters, scope of feedwater and condensate system modeling, system nodalization).
    b. Interpretation of the calculated results (e.g., one reactor coolant system cold leg did not return to natural circulation following system repressurization, a significant asymmetry in steam generator inventory develops).
    c. Consistency of the actions assumed in the analysis with the actions specified in the existing integrated plans for Oconee. It is not clear to the staff that a double-steam-line rupture would not significantly affect the mitigation strategy and time constraints presented in the integrated plan.
    d. Termination of the double-steam-line-rupture analysis well before the typical ELAP computational envelope of 72 hours. The long-term strategy to mitigate this event, and the supporting analysis demonstrating its feasibility, is not clear.

(3) Completion of the staff's review of the double-steam-line-rupture analysis would be facilitated by making the full calculation available for audit review.

Addressing the issues identified above regarding the potential for an ELAP event involving an uncontrolled cooldown is designated as Open Item 3.2.1.6.D in Section 4.1 of this report.

During the audit it was noted that ONS's ADVs are not currently qualified to survive an ELAP event, yet operators are required to operate these valves as part of the core cooling strategy. The licensee was asked to further discuss its considerations related to this situation. In response, the licensee stated that ONS has an open item to address ADV survivability and operator accessibility, and that this is being tracked by ONS's open item 11 from the Integrated Plan. When evaluations are completed, ONS's open item evaluating the survivability of ADVs during an ELAP event should be reviewed to confirm that performance of the valves is adequate to support ONS's mitigation strategy. This is identified as Confirmatory Item 3.2.1.6.E in Section 4.2.

During the audit the licensee was asked whether personnel performing actions at the SSF prior to the onset of flooding would be required to evacuate the facility or would shelter in place during the persistence period of the flood-induced ELAP event. In response to this question the licensee stated that personnel performing actions at the SSF will shelter in place in the SSF HVAC (heating, ventilation and air conditioning) room which is located above the peak flood level on site.

During the audit the licensee was asked to explain which analyses performed in WCAP-17601-P are being applied to ONS and to justify the use of those analyses by identifying and evaluating the important parameters and assumptions and demonstrating that they are representative of ONS and appropriate for simulating the ELAP transient. Discussion with the licensee during the audit confirmed that the licensee is not relying upon generic ELAP analysis, such as those in WCAP-17601-P; rather, plant-specific ELAP analysis has been performed to model the mitigating strategies proposed for Oconee. Therefore, significant deviations between the inputs and assumptions for the ELAP analysis and Oconee's plant design and mitigating strategy are not expected.

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 ELAP sequence of events if these requirements are implemented as planned.

3.2.1.7 Cold Shutdown and Refueling

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

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

The generic concern related to shutdown and refueling requirements is applicable to Oconee. This generic concern has been resolved through the submittal of an NEI position paper entitled "Shutdown/Refueling Modes" (ADAMS Accession No. ML13273A514), which 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 licensees are capable of implementing mitigation strategies in all modes of operation. The NRC staff will evaluate the licensee's resulting program through the audit and inspection process.

During the audit Duke informed the NRC of its plan to abide by this generic resolution.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to the analysis of an ELAP during Cold Shutdown or 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.

As previously noted, ONS provided two SOE timelines, one based on a seismic-caused ELAP ("T=0" ELAP event), and the other based on a flood-caused ELAP. With the flood-caused ELAP, one of the critical operator actions performed during the approximate 3-hour time interval between upstream dam failure and ELAP initiation is that after tripping the units the operators borate the RCS at each unit to cold shutdown conditions. For the flood-caused ELAP, this action prevents return to criticality as the reactor units cool down; however, the licensee provided no detailed discussion or analysis related to this action.

For the seismic-caused ELAP, where there is no advanced warning that ELAP may occur, ONS's Integrated Plan does not document any considerations related to ensuring that a return to criticality does not occur as a long-term cooldown of the RCS is implemented.

During the audit the licensee was asked to discuss ONS's considerations and required actions related to preventing a return to criticality during long-term cooldown of the RCS, including an explanation of how boration to support cold shutdown conditions will be accomplished if there is no advanced warning.

In response to this question, the licensee stated that "T=0" events will initially have boron injection during Phase 1 using the SSF RCMU pump, which takes suction from the SFP. The licensee stated that this ensures the core will remain subcritical at 240 degrees Fahrenheit without xenon. As noted in Section 3.2.1.1 above, analysis demonstrating adequate shutdown margin for events with and without advanced warning were not made available for staff review during the audit. This issue is being tracked as part of Confirmatory Item 3.2.1.1.B in Section 4.2. The licensee stated that the transition to asymmetric cooling limits the cooldown rate in Phase 2. The licensee stated that shutdown analysis being performed will determine any additional boron requirements which will be added during Phase 2 using a portable high-head pump taking suction from the BWST, and that this is being tracked by open item 10 from ONS's Integrated Plan. Because the licensee is performing additional analysis to determine Phase 2 boron requirements, results of the analysis should be reviewed when ONS's open item 10 is closed to confirm that concerns related to achieving and maintaining core subcriticality are adequately addressed. The licensee's completion of analysis to determine Oconee's Phase 2 boration requirements is identified as Confirmatory Item 3.2.1.8.A in Section 4.2.

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 ONS.

The PWROG submitted a position paper, dated August 15, 2013 (withheld from public disclosure due to proprietary content), which provided test data regarding boric acid mixing under single-phase natural circulation conditions and outlined applicability conditions intended to ensure that boric acid addition and mixing 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 the licensee was asked to discuss ONS's boron mixing model used in the ELAP analysis to confirm core subcriticality and to address the adequacy of the boron mixing model for the intended purpose. The licensee also was asked to discuss how the boron concentration in the borated coolant added to the RCS is considered in the cooldown phase of the ELAP analysis. It was noted that the Integrated Plan calls, in part, for an asymmetric cooldown using portable FLEX equipment; and the licensee was asked to provide a basis that the proposed mitigation strategy will ensure adequate mixing of boric acid within the reactor coolant system. The licensee also was asked to clarify whether the required timing for providing borated makeup to the primary system considers bounding conditions (a) with no RCS leakage, and (b) with the maximum assumed RCS leakage rate.

The licensee responded to these questions with the following information:

(1) The licensee stated that the boron mixing model used assumes perfect mixing in the RCS and that this is appropriate because single phase fluid conditions are expected during the seismic and flooding scenarios.
(2) The licensee stated that ONS's mitigation strategy employs a symmetric cool down during Phase 1, that the majority of the cool down and boron addition occurs during Phase 1, and that the asymmetric cool down using portable FLEX equipment occurs during Phase 2. The licensee further stated that preliminary analysis indicates that the primary system will be adequately borated prior to aligning asymmetric feed.

(3) The licensee stated that the seismic scenario assumes that the SSF RCMU pump starts and provides borated RCP seal injection flow within 20 minutes and that this timing ensures seal integrity is maintained. The licensee stated that for the flooding scenario, forced RCS flow is maintained while the RCS is borated to remain shutdown at 70 degrees Fahrenheit.

Based upon a review of the information provided during the audit, the licensee has not fully justified its modeling of boric acid mixing under ELAP conditions. Industry activities to generically resolve the boric acid mixing issue were ongoing during the Oconee audit, and the staff's endorsement letter was issued during the preparation of the present report. As such, at the time the audit was conducted, the licensee had neither (1) committed to abide by the generic approach discussed above, including the additional conditions specified in the NRC's endorsement letter, nor (2) identified an acceptable alternate approach for justifying the boric acid mixing assumptions in the analyses supporting its mitigating strategy. Considering the industry position paper, as modified by the additional conditions in the NRC staff's endorsement letter, several key issues to be addressed for Oconee with respect to the modeling of boric acid mixing are as follows:

i. Although maintaining single-phase flow in the reactor coolant system loops facilitates mixing of boric acid, consideration of a delay period remains necessary to account for the physical duration over which boric acid mixes uniformly throughout the reactor coolant system.
ii. As previously noted, the licensee did not make its analyses of shutdown margin for ELAP scenarios with and without advanced warning available for staff audit review.
iii. The licensee is still analyzing whether injection of boric acid is required to ensure adequate shutdown margin in Phase 2 of the event, when an asymmetric cooldown is employed. A methodology for determining boric acid mixing during an asymmetric cooldown is beyond the scope of current generic industry efforts on boric acid mixing.
iv. The response did not address the adequacy of the ELAP boration strategies for Oconee in scenarios (1) with the highest applicable reactor coolant system leakage rate and (2) with no reactor coolant system leakage.
v. Specific discussion of issues associated with boric acid mixing for the scenario involving the double-steam-line rupture had not been fully addressed, such as the apparent stagnation in one reactor coolant system cold leg following the apparent restoration of natural circulation throughout the remainder of the reactor coolant system loops.

Based on the outstanding issues discussed above, the staff has designated Open Item 3.2.1.8.B in Section 4.1 of this report for the licensee to (1) confirm that Oconee's approach for modeling boric acid mixing is consistent with a generically acceptable methodology or (2) develop a plant-specific technical basis to support the modeling assumptions for boric acid mixing in the ELAP analysis for Oconee.

During the audit it was noted that on page 6 and other pages of the Integrated Plan, the licensee stated that one of ONS's strategies for establishing RCS makeup uses a portable, low-capacity, high-head pump taking suction from the missile-protected portion of the BWST. The licensee was asked to clarify the volume associated with the missile-protected portion of the BWST and how long this volume will be capable of providing sufficient makeup to the RCS and other destinations. The licensee was asked to clarify whether the FLEX pumps will have the capability of taking suction on the SFP after the missile-protected portion of the BWST is depleted and how borated makeup will be provided after the missile-protected portion of the BWST is depleted.

In response to these questions, the licensee stated that the entire BWST is missile protected and that, as a minimum, 350,000 gallons of inventory will be available for event mitigation. Because (1) the licensee's docketed submittal references "the missile protected portion of the BWST" in a number of places and (2) a brief survey of Oconee's UFSAR was unable to locate a reference regarding the missile protection capabilities for the BWST, the staff designated Confirmatory Item 3.2.1.8.C for the licensee to provide documentation for the BWST design features with respect to missile protection.

During the audit the licensee was asked to clarify how borated water will be prepared or supplied to the site in the long-term following the ELAP event. In response to this question, the licensee stated that ONS will rely on Phase 3 regional response for a boric acid mixing tank skid, and that this is being tracked by open item 9 from the integrated plan.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01 and 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 boron mixing, 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 cool down 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.

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 11 of the Integrated Plan, the licensee provided a discussion of ONS's Phase 2 strategy for maintaining core cooling and heat removal. This discussion was divided into two parts, with one part being the strategy for the seismic-caused ELAP (“T=0” event), and the other part being the strategy for the flooding caused ELAP, initiated by upstream dam failure.

For the seismic response (“T=0” ELAP event) the licensee stated that Phase 2 core cooling will be achieved with a high-capacity, low-head portable diesel-driven pump with the pump’s suction coming from the plant’s intake canal at a location separate from the intake pump structure. The licensee stated that the pump’s discharge will use one of two options:

(1) The primary SG feed option will be to feed through the station ASW feed lines through the existing tap upstream of the units’ manual throttle valves. The licensee stated that this single tap feeds a header that supplies all three units.
(2) The alternate SG feed option will be to feed through three individual unit connections to the SSF ASW, upstream of the SSF ASW control valves.

The licensee noted that when the new protected service water (PSW) modification is completed, the station ASW line (used in the primary strategy) will be replaced with a PSW line that will perform the same function as the ASW line.

For the flood response the licensee stated that Phase 2 core cooling will be achieved with a high-capacity, low-head portable diesel-driven pump with the pump’s suction coming from CTP-1. The licensee stated that the pump’s discharge will be into the same two SG feed options described for the “T=0” ELAP event. The licensee stated that administrative controls ensure there is always enough water in CTP-1 to supply cooling for 24 hours and that Phase 2 core cooling will be sustained beyond the initial capability of CTP-1, by using the water volume retained in the embedded CCW piping. The licensee stated that operator action to break siphon is required to maximize CCW water retention and that these actions must be taken during the 2.86 hours prior to site inundation. The licensee stated that modifications are required to enable the siphon break actions and that access to the CCW inventory is achieved by opening CCW manway 1A4 or 1B4, inserting a diesel-driven submersible pump, and discharging to CTP-1. The licensee stated that CCW inventory coupled with the water initially in CTP-1 provides cooling for approximately 6.75 days.

ONS’s Phase 2 strategies are essentially identical for the “T=0” ELAP event and for the flood-caused ELAP event, except that the portable pump’s suction source for the “T=0” ELAP event is from the plant’s intake canal while the portable pump’s suction source for the flood-caused ELAP event if from CTP-1.

On page 14 of the Integrated Plan, the licensee provided a discussion of ONS’s Phase 3 strategy for maintaining core cooling and heat removal. The licensee stated that at the end of Phase 2, based on preliminary analysis the RCS will between 240 and 250 degrees Fahrenheit. The licensee stated that it will continue to steam the SGs using the diesel-driven pump and ADVs while allowing RCS pressure to slowly decrease as RCS temperature decreases until a decay heat removal (DHR) capability is available. The licensee stated that in Phase 3 it will have the capability to sustain Phase 2 SG makeup by supplying spare pumps and redundant capability and by integrating filtration and demineralization into the makeup process. Additionally, the licensee stated that a Phase 3 strategy using offsite resources will have to be developed for the flood event to establish logistics for delivery and purification/filtration of raw water to the site to replenish CTP-1 at an estimated rate of approximately 700,000 gallons per day within approximately 6 days of event occurrence; the licensee linked this action with its open item 23.

On page 17 of the Integrated Plan, the licensee provided a discussion of ONS's Phase 2 strategy for maintaining RCS inventory control. This discussion was divided into two parts, with one part being the strategy for the seismic-caused ELAP ("T=0" event), and the other part being the strategy for the flooding-caused ELAP, initiated by upstream dam failure.

For the seismic response ("T=0" ELAP event), the licensee stated that Phase 2 RCS boration and makeup will be accomplished using either of two makeup strategies. The licensee identified that one of the key activities will be either venting or isolating the CFTs to prevent pressurized nitrogen gas contained in the CFTs from expanding into the RCS and potentially blocking natural circulation flow. In the Integrated Plan dated February 28, 2013, the licensee stated that the primary strategy will require repowering the SSF RCMU pumps with suction being from the SFP and discharge being to the RCP seal injection lines, and repowering CFT vent valves (CF-4 and CF-5) using portable equipment to allow venting nitrogen pressure off the tanks. The licensee stated that its alternate strategy requires establishing RCS injection flow using a portable or pre-staged high pressure, low flow (40 gpm) diesel injection pump taking suction from the missile-protected portion of the BWST and discharging into existing vent lines on the HPI injection header. The licensee's alternate strategy for CFT venting or isolation will be to repower CFT isolation valves (CF-1 and CF-2) using portable equipment to allow isolation of the CFTs and thereby prevent nitrogen injection into the RCS. In the first six-month update to the Integrated Plan, the licensee identified a new open item 33 to reevaluate the strategy of repowering the SSF RCMU pumps and to consider this strategy for elimination by implementing train-specific diesel-powered pump strategies.

For the flood response the licensee stated that RCS boration is accomplished during shutdown, meaning that the RCS is borated to cold shutdown conditions during the Phase 1 shutdown activity; so additional boration is not required in Phase 2 to achieve cold shutdown. The licensee further stated that RCS makeup will be accomplished using either of the previous makeup options. The licensee also stated that the CFT isolation valves, CF-1 and CF-2, are closed during Phase 1. The reviewer noted that although boration to cold shutdown conditions is accomplished during Phase 1, the Phase 2 RCS makeup strategy for ONS's flood response uses borated water sources, eliminating any potential concern of diluting the cold shutdown boration conditions established in Phase 1.

On page 20 of the Integrated Plan the licensee described its Phase 3 strategy by stating that at the end of Phase 2, based on preliminary analysis the RCS will be between 240 and 250 degrees Fahrenheit and the Phase 3 capability is to sustain the RCS Phase 2 makeup by supplying spare makeup pumps, generators, and redundant capability and supplying boration. The licensee's strategy for RCS makeup during Phase 3 is a continuation of its Phase 2 strategy.

During the audit the licensee was asked to provide additional discussion of operator actions and time required to align the portable pumps for Phase 2 and Phase 3 operation.

In response, the licensee stated that, upon declaration of an ELAP condition, Operations and SPOC (maintenance single point of contact) will begin FLEX deployment, with the first priority being to establish a makeup source to the SGs. The licensee stated that a version of this deployment system exists today and is directed by the External Flood Mitigation abnormal procedure. The licensee stated that the makeup source to the SGs can be aligned in approximately 2 hours after the event passes and debris is cleared, and that this has been demonstrated during validation and an emergency preparedness drill on December 31, 2010.

The licensee further stated that for the "T=0" events, ONS is planning around 24 hours to deploy Phase 2 equipment, and that this is being tracked by open item 4 from the Integrated Plan.

During the audit the licensee corrected a typographic error on page 36 of the Integrated Plan by stating that the SG makeup FLEX pump discharge pressure for planning purposes should have been listed as 150 psig, rather than 15 psig, and that the 150 psig value will be confirmed by hydraulic analysis. The licensee further stated that this activity is being tracked by open items 13 and 15 from the Integrated Plan. With regard to the SGs remaining depressurized, the licensee stated that for the "T=0" events ONS is using 24 hours for planning purposes to have the Phase 2 FLEX strategies available, but that as long as other sources of SG makeup are viable they will be preferentially used. The licensee stated that cooldown analysis will validate that adequate depressurization can be achieved, and that this is being tracked by open item 10 from the Integrated Plan.

The licensee was asked to clarify whether a single FLEX pump will be used to provide cooling flow to multiple destinations, to confirm that the FLEX pump can supply adequate flow for multiple destinations if applicable, and to clarify whether the pumped flow would be split and simultaneously supplied to all destinations or be alternated between the destinations. Further, if ONS proposes to use simultaneous flow, then the licensee was asked to clarify how the flow splits will be measured and controlled to ensure adequate flow reaches each destination.

In response to these questions the licensee stated that ONS intends to use a single FLEX pump to supply multiple destinations in the SG makeup and SFP makeup strategies to the extent that the hydraulic analysis supports this plan. The licensee stated that ONS's intention is that multiple flow paths can be established simultaneously and that at points where hoses split off to different destinations there will be provisions for branch isolation, throttling, and to the extent needed flow instruments will be specified. The licensee stated that this activity is being tracked by open items 13, 15, and 27 from the Integrated Plan.

Based on the information provided by the licensee in ONS's Integrated Plan and in response to audit questions, the licensee's strategy for use of portable pumps conforms to the guidance in NEI 12-06, Section 3.2.2, Guideline (13), and Section 11.2. The licensee currently is working on analysis to confirm portable pump capability requirements and fuel requirements to implement its Phase 2 and Phase 3 strategies, and results of these analyses should be made available for review when the analyses are completed. This is identified as Confirmatory Item 3.2.1.9.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 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 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 BDB event, the analysis used to provide the technical basis for time constraints for the mitigation strategies may use nominal initial values (without uncertainties) for plant parameters, and best-estimate physics data. All equipment used for consequence mitigation may be assumed to operate at nominal setpoints and capacities. NEI 12-06, Section 3.2.1.2, describes the initial plant conditions for the at-power mode of operation; Section 3.2.1.3 describes additional 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 25 of the Integrated Plan, the licensee described its Phase 1 strategy using installed equipment to maintain SFP cooling. There are two SFPs at ONS, one for Units 1 and 2, and the second for Unit 3. The licensee stated that upon a loss of power and loss of SFP cooling, abnormal procedures contain curves that predict SFP temperatures versus times and heat loads and that ONS's Engineering Manual, Engineering Emergency Response Plan, has guidance to establish vent paths. The licensee stated that in accordance with ONS Units 1 and 2, and Unit 3 Engineering Instructions, Loss of Spent Fuel Cooling Heat Up Times Due to Decay Heat, the time to boil is estimated to be 7 hours for the Units 1 and 2 pool, and 6.1 hours for the Unit 3 pool. The licensee stated that these values are based on the licensed abnormal heat load (full core offload) of 34 million BTU/hour for the Units 1 and 2 pool and 30.8 million BTU/hour for Unit 3 pool. The licensee stated that design analysis also supports that sufficient coping time exists to establish inventory makeup in Phase 2 prior to fuel damage. The licensee stated that SFP level indication will be available in accordance with NRC Order EA-12-051.

On page 26 of the Integrated Plan the licensee described ONS's Phase 2 strategy using portable equipment to maintain SFP cooling. The licensee stated that actions to be taken prior to the onset of SFP boiling include verifying operability of the SFP level instrumentation, installing the B.5.b SFP spray nozzle, and routing the flexible hose from the spray nozzle to the accessible staging location outside. The licensee stated that the capability to provide 200 gpm per unit, as specified in NEI 12-06, Table D-3, will be provided and that this capability bounds the maximum ONS SFP boil off rates. The licensee also stated that based on preliminary analysis, one pump can supply both the Units 1 and 2 SFP and the Unit 3 SFP.

The licensee stated that for the Units 1 and 2 SFP, the boil down time to reach a level approximately 10 feet above the fuel racks is 36 hours, and to reach a level 1 foot above the fuel racks is 72 hours. The licensee stated that the maximum rate of inventory loss is 114.9 gpm, based on considering 29 gpm RCMU feed to each of the two reactor units and 56.9 gpm boil off, and for Unit 3, the maximum rate of inventory loss is 62.3 gpm, based on considering 29 gpm RCMU feed to Unit 3 and 33.3 gpm boil off. The licensee further stated that boil down times are bounded by the Units 1 and 2 pool.

For the seismic response (T=0 ELAP event) the licensee stated that analysis will be performed to verify SFP cooling can be achieved using a portable diesel driven pump with the pump's suction coming from the plant's intake canal at a location separate from the intake pump structure and the discharge will be into one of two connection options. The primary discharge connection option will be through permanently installed SFP fill lines located in the Unit 1 and Unit 3 Cask Decontamination Rooms, and the licensee stated that analysis will be performed to verify seismic robustness of this piping. The alternate strategy will be to use flexible hose pulled from the spray nozzle at the pool deck to the staging location outside.

For the flood response the licensee stated that analysis will be performed to verify SFP cooling can be achieved using a portable diesel driven pump with the pump's suction coming from CTP-1. The same two discharge connection options described for the T=0 ELAP event will be used in the flood response for SFP cooling.

On page 29 of the Integrated Plan the licensee described its Phase 3 strategy using portable equipment to maintain SFP cooling. The licensee stated that Phase 2 will leave the SFPs with inventory makeup capability and the Phase 3 strategy is to sustain Phase 2 SFP makeup by (a) supplying spare makeup pumps and redundant capability; (b) integrating filtration and demineralization into the makeup water supply; and (c) providing the capability to add boron to the makeup water as needed.

During the audit the licensee was asked to explain additional details of its strategy for establishing and maintaining SFP cooling during an ELAP. In response, the licensee provided the following additional information:

(a) With regard to requirements for boration of the SFP makeup water, the licensee stated that the cool down analysis is being tracked by open item 10 from ONS's Integrated Plan to determine when boration of the SFP is required and whether boration will be required before Phase 3. The licensee stated that the following considerations will factor into this requirement:

    (1) The coping time for the SFP with respect to needing to add water is large, thus establishing makeup capability will be further into the event.
    (2) Preliminary indications show that sufficient RCS boration for cool down can be achieved prior to the need to start SFP makeup.
    (3) Deployment of the RCS makeup portable pumps taking suction off the BWST should be available prior to the need to establish SFP makeup.
    (4) With diminishing need for ongoing RCS makeup from the SFP, there is a diminishing effect of boron dilution in the SFPs.

(b) SFP makeup water is added at the surface of the pools. Stored fuel and RCMU pump suction are at the bottom of the pools. Vertical circulation and boiling due to decay heat from the stored fuel provide adequate mixing of the added boron with the SFP water.

(c) ONS initially intends to supply raw water to the SFP using filtration equipment to catch particulates; however, in Phase 3 additional purification and boration equipment will be added.

(d) The vent paths established for each SFP area include opening the fuel bay roll-up door as well as the doors between the SFP and the purge inlet room, and the door between the purge inlet room and the outside. These actions provide a steam exhaust pathway to prevent SFP steam and condensate from causing access and equipment problems in other parts of the plant.

During the audit the licensee was asked to explain why its proposed Phase 3 SFP cooling strategy is a continuation of the Phase 2 strategy of providing makeup water to the SFP, rather than an effort to re-establish SFP cooling using additional equipment obtained from off-site. In response to the question, the licensee stated that it considers re-establishment of SFP cooling to be a recovery action beyond the scope of NEI 12-06. The licensee's response is acceptable because NEI 12-06, Appendix A, defines "sustaining functions indefinitely" as "establishing strategies and resources to maintain a stable plant condition until recovery actions can be implemented; and NEI 12-06, Section 1.3, states that "recovery of the damaged plant is beyond the scope of FLEX capabilities."

Based on information provided by the licensee in ONS's Integrated Plan and in response to audit questions, the licensee's strategy for re-establishing and maintaining SFP cooling during an ELAP event conforms to the guidance in NEI 12-06 for SFP cooling strategies. The licensee currently is working on analyses and open items to confirm and finalize its proposed SFP cooling and boration strategies, and analysis and results of these activities should be made available for review when the activities are completed. This is identified as Confirmatory Item 3.2.2.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 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 21 of the Integrated Plan the licensee described its Phase 1 strategy for using installed equipment to maintain containment. At ONS, the containment is called the Reactor Building. The licensee stated that based on planned mitigation strategies and preliminary reviews of existing analysis, containment integrity is not expected to be challenged for 72 hours. The licensee further stated that additional analysis will be required beyond 72 hours and that no Phase 1 containment mitigation actions have been identified as required at this time. The licensee also stated that ONS does not have ice condenser containments. The licensee stated that an indication of containment pressure during Phase 1 coping is not required based on preliminary reviews of existing containment response analysis for a loss of ac power event and that re-powering of containment instrumentation will be addressed in Phase 2.

On page 22 of the Integrated Plan the licensee described Phase 2 mitigation strategy using portable equipment to monitor and maintain containment.

For the seismic response (T=0 ELAP event) the licensee stated that wide range Reactor Building pressure indication will be available. The licensee noted that this is not a priority item based on preliminary review of existing containment response analysis.

For the flood response the licensee stated that indication of wide range Reactor Building pressure will be available using portable instrumentation in the east penetration room.

On page 24 of the Integrated Plan, the licensee stated that its Phase 3 strategy and key instrumentation related to maintaining containment are the same as in Phase 2.

The licensee did not identify any modification required to implement its strategy to monitor and maintain containment during an ELAP event.

During the audit the licensee was asked to provide results of containment analysis beyond 72 hours when the results become available and to explain why different methods for monitoring Reactor Building pressure are used for the T=0 ELAP event versus the flood-caused ELAP event.

In response to these requests, the licensee stated that results of the containment analysis beyond 72 hours will be provided when completed and that ONS will consider the need for FLEX equipment to provide containment cooling if the analysis shows that cooling is required. The licensee stated that this is being tracked by open item 26 from the Integrated Plan. When ONS's open item 26 is completed, results of the licensee's containment analysis beyond 72 hours should be reviewed and confirmed to be acceptable. This is identified as Confirmatory Item 3.2.3.A in Section 4.2 of this evaluation.

With regard to the difference in containment monitoring between the T=0 and the flood-caused ELAP events, the licensee stated that a new open item was identified to evaluate the alternate repower FLEX strategy to include the same displays in the MCR, including the wide range Reactor Building pressure indication. The licensee noted that this action is being tracked by open item 34 in its first six-month update to the Integrated Plan. The licensee's response, as understood, means that the same MCR instrumentation would be available for the T=0 ELAP and for the flooding ELAP event.

Based on information provided by the licensee in ONS's Integrated Plan and in response to audit questions, the licensee's strategy for monitoring and maintaining containment during an ELAP event conforms to the guidance in NEI 12-06, Table 3-2 and Appendix D.

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 containment function strategies, if these requirements are implemented as described.

3.2.4 Support Functions

3.2.4.1 Equipment Cooling – Cooling Water

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

> *Plant procedures/guidance should specify actions necessary to assure that equipment functionality can be maintained (including support systems or alternate method) in an ELAP/LUHS or can perform without ac power or normal*

> *access to the UHS.*
>
> Cooling functions provided by such systems as auxiliary building cooling water, service water, or component cooling water may normally be used in order for equipment to perform their function. It may be necessary to provide an alternate means for support systems that require ac power or normal access to the UHS, or provide a technical justification for continued functionality without the support system.

During the audit the licensee was asked to discuss the guidance in NEI 12-06, Section 3.2.2, Guideline (3). In response, the licensee stated that all portable mitigation equipment will be either air-cooled or water-cooled, with a self-contained closed cooling system utilizing a radiator to transfer heat to the environment. The licensee stated that none of the portable mitigation equipment will require external cooling water sources.

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 cooling using 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 degrees Fahrenheit. 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 30 of the Integrated Plan the licensee described ONS's Phase 1 safety functions support using installed equipment. The licensee stated that upon loss of ac power, all Auxiliary Building power is lost, and no HVAC systems are available. The licensee stated that abnormal procedures for degraded control room area cooling include steps to open electrical cabinet doors and control room doors and that based on a preliminary review of existing analyses, no additional actions are expected to be required during Phase 1. The licensee will also perform additional HVAC analysis in accordance with ONS's open item 32 in the Integrated Plan.

On page 32 of the Integrated Plan the licensee described ONS's Phase 2 safety functions support using portable equipment. The licensee stated that based on results of further HVAC analysis to be performed in accordance with ONS's open item 32, potential mitigation strategies may include: opening electrical cabinet doors, opening control room doors, opening battery room doors, opening penetration room doors, opening electrical equipment room doors, installing fans, and installing spot coolers. The licensee stated that once the vital battery chargers are repowered by the portable power distribution equipment, hydrogen buildup within the battery rooms will begin to occur due to a lack of ventilation, but that based on a preliminary review of existing analysis, there will be adequate time to implement Phase 2 portable ventilation strategies prior to hydrogen concentrations becoming a concern. The licensee further stated that additional analysis of hydrogen buildup will be performed in accordance with ONS's open item 24 in the Integrated Plan. The licensee needs to confirm that as result of additional analysis of hydrogen buildup (open item 24), there will be no impact on the Phase 2 ventilation strategies. This is identified as Confirmatory Item 3.2.4.2.A in Section 4.2.

On page 33 of the Integrated Plan the licensee stated that ONS will develop a portable power distribution scheme to repower required equipment using portable diesel generators, transformers, power panels, and cables and that equipment to be re-powered includes portable HVAC equipment for the control rooms, penetration rooms, electrical equipment rooms, and vital battery rooms.

On page 35 of the Integrated Plan, the licensee describes its Phase 3 strategy for safety functions support as, "Sustain Phase 2 capabilities with redundant and replacement equipment from the Regional Support Centers," and "Establish offsite fuel oil delivery logistics."

During the audit the licensee was asked to provide additional discussion of its considerations related to procedural guidance, required actions, and action times to ensure that equipment failure or hydrogen buildup related to battery charging do not occur as a result of a loss of ventilation or HVAC. The licensee was also asked to describe provisions for monitoring air temperatures in critical building areas and to provide information of the adequacy of the ventilation provided in the battery room to protect the batteries from the effects of extreme high or low temperatures.

In response to these requests, the licensee provide the following information:

(a) GOTHIC compartment/area temperature modeling for an ELAP event will be developed and used to determine environmental conditions in various areas/compartments of the Auxiliary Buildings to assess personnel and equipment functional limitations predicated by the ONS FLEX strategies. The results of these analyses will be used to determine what FLEX mitigation strategies are required (i.e., opening doors, installing portable fans, installing spot coolers, etc.) to ensure temperature in these areas remain within acceptable limits. This is being tracked by open item 32 from the Integrated Plan. In addition to the ELAP heat up analyses, an analysis documenting expected hydrogen concentration levels in the station's Control Battery Rooms as a function of time will be completed, and the results will be used to determine needed actions to ensure hydrogen levels remain within acceptable limits. This is being tracked by open item 24 from the Integrated Plan.
(b) The need to monitor air temperature in critical areas will be determined based on the results of the analyses described in the response above.
(c) The adequacy of ventilation in the Control Battery Rooms will be evaluated based on the results of the analyses described in response (a), above.

When ONS's evaluation of building and area temperatures are completed (licensee-identified open item 32), results should be confirmed acceptable to support the licensee's proposed ELAP mitigation strategies. This is identified as Confirmatory Item 3.2.4.2.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 relating to Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to ventilation – equipment cooling, if these requirements are implemented as described.

3.2.4.3 Heat Tracing

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

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

During the audit the licensee was asked to address heat tracing or other normal sources of equipment heating that may be lost during an ELAP event. In response to this question the licensee stated that sources of borated makeup water are at a concentration that does not precipitate at temperatures above freezing and the RRC equipment specification for the boron addition skid includes a requirement for heating. The licensee also stated that ONS's mitigation strategies are not relying on any plant instrumentation exposed to the external environment.

The licensee stated that because ONS is located in a temperate climate region, it is unlikely that additional actions to provide freeze protection will be needed. However, the licensee stated that a new open item has been created to address the need to evaluate freeze protection requirements in those areas of the plant that contain equipment used in the FLEX strategies, and this will be tracked by open item 37, which will be added in the second six-month update to the Integrated Plan. Confirmation that the licensee has adequately addressed the need for freeze protection will be tracked as Confirmatory Item 3.2.4.3.A in Section 4.2 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, subject to successful closure of issues relating to Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to heat tracing, if these requirements are implemented as described.

3.2.4.4 Accessibility – Lighting and Communications

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

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

On page 6 of the Integrated Plan, the licensee stated that portable lighting will be installed during the 2 to 72 hour time interval after initiation of the seismic-caused or flood-caused ELAP events.

On page 31 of the Integrated Plan the licensee described ONS's Phase 1 safety functions support using installed equipment and provided discussions related to ONS's considerations of lighting and communications. With regard to lighting, the licensee stated that NFPA 805 lighting is available in many areas where manual actions (e.g., connecting hoses, power cables, or operating pumps or compressors) are necessary. The licensee stated that the NFPA 805 lights have self-contained batteries with an 8 hour life and that an evaluation will be performed to determine whether there are areas where manual actions are performed that do not have existing NFPA 805 lighting.

On page 32 of the Integrated Plan the licensee described ONS's Phase 2 safety functions support using portable equipment and provided discussions related to ONS's considerations of lighting and communications. With regard to lighting, the licensee stated that hard hat LED (light-emitting diode) lights will be procured to ensure operators can safely move through the plant during an ELAP. The licensee also stated that additional portable lighting will be procured to provide lighting in the yard, to replace some of the emergency lighting once it is depleted, and to enhance lighting in other areas of the plant as deemed necessary.

The licensee's Integrated Plan includes no additional discussion of lighting and communication related to its Phase 3 safety functions support.

During the audit the licensee was asked to provide additional discussion of ONS's conformance to NEI 12-06, Section 3.2.2, Guideline (8), including a discussion of ONS's strategy for loss of its in-plant communication system. In response, the licensee stated that specific areas at ONS that may benefit from additional lighting will be identified and that this activity is being tracked by ONS's open item 29 from the Integrated Plan. The licensee also stated that operational (onsite) communications will be done primarily with hand-held radios and portable repeaters and that offsite communications will be done with satellite telephones staged at the TSC and the OSC. The licensee needs to provide details of any additional lighting after analysis of lighting (ONS's open item 29) is completed by the licensee. This has been identified as Confirmatory Item 3.2.4.4.A in Section 4.2.

The licensee has also previously provided its communications assessment in letters dated October 31, 2012, and February 22, 2013 (ADAMS Accession Nos. ML12311A028 and ML13058A066) in response to the NRC March 12, 2012 50.54(f) request for information letter. As documented in the staff analysis provided in the letter dated May 13, 2013 (ADAMS Accession No. ML13108A168), the NRC staff 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. 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 was asked to discuss the means of communication between the MCR and local equipment operators responsible for controlling SG makeup and relief valve operation and to clarify whether environmental factors such as ambient noise of exiting steam have been considered in ONS's evaluation to confirm that the necessary coordination is feasible. The licensee stated that the ADVs are inside the Turbine Building and are operated by chain wheel from below, at floor elevation, but the ADVs discharge outside the Turbine Building. The licensee also stated that ONS's PIP (Problem Investigation Process) report 2007-1327 documents the successful use of ADVs for cool down from a dual unit trip in 2007. The licensee's reference to PIP 2007-1327 is understood to mean that the licensee has relatively recent, successful experience with manual operation of ADVs for cool down of two of its operating units, and that on the basis of this experience the licensee is confirming that noise caused by steam release through the ADVs does not interfere with the communications needed to direct the manual operation of the ADVs.

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 closure of issues related to Confirmatory Items, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to accessibility – lighting and communications, if these requirements are implemented as described.

3.2.4.5 Protected and Internal Locked Area Access

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

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

The licensee's Integrated Plan for ONS describes no considerations related to the effects of ac power loss on area access or the need to gain entry to the protected area and internal locked areas where remote equipment operation is necessary.

During the audit the licensee was asked to describe ONS's considerations with regard to NEI 12-06, Section 3.2.2, Guideline (9). In response, the licensee stated that ONS has involved its plant's Security organization in development of plans to deploy FLEX strategies during an ELAP event while there is no ac power. The licensee further stated that additional details may be subject to safeguards requirements.

Based on the relatively simple guidance in NEI 12-06, Section 3.2.2, Guideline (9), the licensee's statement that its Security organization has been involved in development of plans to deploy FLEX strategies provides reasonable assurance that ONS has adequately considered NEI 12-06, Section 3.2.2, Guideline (9). However, a confirmatory item has been created to confirm that the details of ONS's FLEX strategies with regard to protected and internal locked area access are acceptable. This is 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 protected and internal locked area access, 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.

During the audit the licensee was asked to provide a discussion of ONS's considerations and proposed actions related to the potential for elevated temperatures and humidity in building locations where local operator actions may be required to implement ELAP strategies.

In response, the licensee referred to its discussion of ONS's GOTHIC compartment/area temperature modeling, being tracked by open item 32 from the Integrated Plan; this licensee-identified open item assesses personnel and equipment functional limitations predicated by ONS's FLEX strategies. The licensee's full response is presented earlier in Section 3.2.4.2 of this report, and Confirmatory Item 3.2.4.2.B was identified to confirm that results of ONS's compartment and area temperature analyses are acceptable when open item 32 is completed. No additional concerns are identified related to specific consideration of personnel habitability.

Based on information provided by the licensee during the audit, the licensee's has provided reasonable assurance that its considerations related to personnel habitability during its ELAP mitigation strategies conform to the guidance in NEI 12-06, Section 3.2.2, Guideline (11).

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 – elevated temperature, 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 [net positive suction head] 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 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 discussions and evaluations of water sources in this report are divided into three parts:

(1) Water Sources for Maintaining Core Cooling and Heat Removal
(2) Water Sources for Maintaining RCS Inventory Control
(3) Water Sources for Maintaining SFP Cooling

Water Sources for Maintaining Core Cooling and Heat Removal

ONS's assumptions about ac power availability during Phase 1 of its ELAP mitigation strategies affect the considerations related to ensuring that makeup flow is promptly established to the SGs.

On page 9 of the Integrated Plan the licensee provided a discussion of ONS's Phase 1 strategy for maintaining core cooling and heat removal. The discussion was divided into two parts, with one part being the strategy for the seismic-caused ELAP (T=0 event), and the other part being the strategy for the flooding-caused ELAP, initiated by upstream dam failure. Details of the licensee's Phase 1 core cooling and heat removal strategy are provided in Section 3.2.1.3 of this evaluation.

For the seismic response (T=0 ELAP event) the Phase 1 source of makeup water to the SGs is water supplied by the SSF ASW pump with suction from the embedded Unit 2 CCW piping, as described in ONS's UFSAR Section 9.6.3.3.

For the flooding response event, during the Phase 1 cool down scenario, cooling and water inventory increase are accomplished using normally available plant systems and water sources because the loss of site ac power does not occur until at least 2.86 hours after the Condition A failure is declared for Jocassee Dam.

On page 11 of the Integrated Plan, the licensee described ONS's Phase 2 mitigation strategy for maintaining core cooling and heat removal using portable pumps. The Phase 2 strategy has been described earlier in Section 3.2.1.9 of this evaluation and is not repeated here. As noted in Section 3.2.1.9, the suction source for makeup water to the SGs is either the plant's intake canal (for the T=0, seismic-caused ELAP) or CTP-1 (for the flooding-caused ELAP).

On page 14 of the Integrated Plan, the licensee described ONS's Phase 3 mitigation strategy for maintaining core cooling and heat removal. The licensee stated that at the end of Phase 2, based on preliminary analysis, the RCS will be between 240 to 250 degrees Fahrenheit, and ONS will continue to steam the SGs using the diesel driven pump and ADVs, while allowing RCS pressure to slowly decrease as RCS temperature decreases until a decay heat removal capability is available. The licensee stated that the Phase 3 strategy is to sustain the Phase 2 SG makeup by (a) supplying spare makeup pumps and redundant capability and (b) integrating filtration and demineralization into the makeup water supply. The licensee stated that additionally, a Phase 3 strategy, using offsite resources, will have to be developed for the flood event to establish logistics for delivery and purification/filtration of raw water to the site to replenish the water inventory in CTP-1 at an estimated rate of 700,000 gallons per day within approximately 6 days; the licensee identified development of ONS's strategy for makeup water logistics as open item 23 in the Integrated Plan.

The licensee's description of water sources for core cooling and heat removal did not address a number of issues that might arise in a postulated, ELAP event:

(1) The licensee took credit for ac power availability at the beginning of the event, and on this basis the licensee claimed ability to align the SSF ASW within 14 minutes; however, the licensee did not address a contingency action or alternate mitigation strategy if the SSF ASW pump were not available when an ELAP occurs.

(2) As described in ONS's UFSAR Section 9.6.3.3, the normal suction supply for the SSF ASW pump is raw water (lake water), taken from the embedded Unit 2 CCW piping; however, the licensee did not discuss what alternate SSF ASW pump suction sources could be established if this source were not available.

(3) As described in ONS's UFSAR Section 10.4.7, the ONS plant design includes three TDEFW pumps, one for each unit, that are capable of operating without ac power. However, the licensee did not credit availability of the TDEFW pumps because they are expected to be unavailable following a seismic event that may result in flooding of the Turbine Building basement caused by rupture of CCW piping during a seismic event. The TDEFW pumps take suction from the upper surge tanks, which contain condensate-quality water that, if available, would be a preferred source for injection to the SGs; however, the licensee did not describe any contingency or provisions for using preferred condensate-quality water sources (e.g., the upper surge tanks or the condensate storage tanks) if they are available during an ELAP.

(4) The licensee's open item 23 relates to establishing logistics for replenishing the water inventory in CTP-1 at an estimated rate of 700,000 gallons per day within approximately 6 days following a flood-cause ELAP event. This open item is problematic because it is unclear whether ONS will propose that CTP-1 makeup water will be supplied by tanker truck, which would require travel of 70 large capacity (10,000 gallon) tanker trucks to the site each day, or whether ONS will propose re-establishing a source of makeup water from Lake Keowee. Either of these methods is judged to present challenges following an extreme external flooding event.

During the audit the licensee was asked to further describe its considerations related to water sources used in ONS's core cooling and heat removal mitigation strategy. In response, the licensee provided the following additional information:

(a) During an ELAP event, ONS will follow its normal symptom-based procedures until forced into the FSG responses. If a source of feedwater remains operable following an event, ONS will exhaust that source prior to feeding with lake water. ONS will respond to any event using any and all equipment that is available in a pre-established order of priority, including TDEFW pumps, if available. At ONS the TDEFW pumps, as well as the condensate storage and upper surge tanks are not robust and cannot be relied upon as a source of water during Phase 1. Furthermore, ONS is not planning to install taps or similar features in consideration of using installed tanks as a water source for the portable FLEX pumps. The only system that meets the requirements for Phase 1 coping is the SSF; and, therefore, the SSF, and not the normal condensate system, is credited for Phase 1 coping.

(b) ONS uses the intake canal for Phase 2, T=0 events, because it is a large water source that is robust for all of the T=0 events. For the flooding event, ONS uses CTP-1 as a 24 hour source of water because it is located above the worst case postulated flood height, but the intake canal could be vulnerable to the flooding event.

During the audit the licensee was asked to identify non-safety related, installed equipment credited for mitigating an ELAP event and to discuss its reliability and availability following an ELAP event. In conjunction with this question, the licensee was asked specifically about the SSF diesel's cooling water return piping and its safety significance. In response to this question the licensee stated that a new open item 38 has been created to establish a technical basis for use of non-safety related, installed equipment credited for mitigating an ELAP event and that ONS's open item 38 will be in the second six-month update to the Integrated Plan. Completion of this evaluation is designated as Open Item 3.2.4.7.A in Section 4.1.

With regard to the SSF diesel cooling water return piping, the licensee stated that ONS has verified that the diesel cooling water return piping is safety related and protected within the SSF. The licensee further stated that it should be noted that equipment that uniquely supports the Jocassee Dam failure event is not required to be robust for other extreme external events and therefore does not need to be vetted for safety significance. The licensee stated that, for example, CTP-1 is not a safety-related or seismically qualified pond; however, it does not support mitigation of a seismic event. The licensee stated that CTP-1 is above flood level and only supports the flood strategy.

The information provided by the licensee adequately addresses the issues described in (1), (2) and (3), above, because the licensee's responses clarify that by using by symptom-based procedures, ONS will exhaust preferred water sources and methods for delivering water for core cooling and heat removal to the SGs before implementing strategies that use less preferred sources and methods.

No additional information was requested or obtained addressing ONS's open item 23 related to logistics for long-term replenishing of water in CTP-1. Because ONS's proposed resolution for its open item 23 is currently unavailable, ONS's strategy for providing CTP-1 make up water at a rate of 700,000 gallons per day following a flooding event should be reviewed when that strategy is developed. This is identified as Open Item 3.2.4.7.B in Section 4.1.

Water Sources for Maintaining RCS Inventory Control

ONS's assumptions about ac power availability during Phase 1 of its ELAP mitigation strategies affect considerations related to ensuring that makeup flow to the RCS and seal cooling flow to the RCP seals are promptly established.

On page 15 of the Integrated Plan the licensee provided a discussion of ONS's Phase 1 strategy for maintaining RCS inventory control and establishing RCP seal cooling. The discussion was divided into two parts, with one part being the strategy for the "T=0" event, and the other part being the strategy for the flooding-caused ELAP.

ONS will use the SSF to implement its Phase 1 mitigation strategy for "T=0" ELAP events. The SSF is designed to operate for 72 hours, as described in ONS's FSAR Section 9.6.3.2. However, the licensee stated that Phase 1 reliance on the SSF will be only as long as needed to deploy the Phase 2 FLEX equipment. SSF RMCU pumps used in Phase 1 take suction from the SFP and discharge to the RCP seal injection lines to provide boration of the RCS along with RCS makeup and RCP seal cooling. This activity is described in more detail in Section 3.2.1.2 of this evaluation.

For the flooding-caused ELAP event, ONS will use the advanced warning time of approximately 3 hours to fully borate the RCS to shutdown conditions and increase the pressurizer level to accommodate normal, expected RCP seal leakage. ONS will also cool down the primary system as much as possible during the time available before the ELAP occurs. All of these Phase 1 flood mitigation actions will be done using normally available ac power, plant equipment, and water sources.

On page 17 of the Integrated Plan, the licensee described ONS's Phase 2 mitigation strategy for RCS inventory control using portable pumps. The Phase 2 strategy has been described earlier in Section 3.2.1.9 of this evaluation and is not repeated here. As noted in Section 3.2.1.9, the suction source for borated makeup water to the RCS is either from the SFP (if the SSF RCMU pumps are repowered), or from the missile protected portion of the BWST using portable or pre-staged high pressure, low flow (40 gpm) pumps that will discharge into existing vent lines on the HPI header. As noted in Section 3.2.1.9, in its first six-month update to the Integrated Plan, the licensee identified a new open item 33 to reevaluate the strategy of repowering the SSF RCMU pumps and to consider this strategy for elimination by implementing train-specific diesel driven pump strategies.

On page 20 of the Integrated Plan, the licensee described ONS's Phase 3 mitigation strategy for maintaining RCS inventory control by stating that the Phase 3 strategy will be a continuation of its Phase 2 actions.

The water sources identified by the applicant for maintaining RCS inventory control conform to the recommendations in NEI 12-06, Section 3.2.2, Guideline (5).

<u>Water Sources for Maintaining Spent Fuel Pool Cooling</u>

On page 25 of the Integrated Plan the licensee provided a discussion of ONS's Phase 1 strategy for maintaining adequate SFP cooling. The licensee stated that the time to boil for the Unit 3 pool is 6.1 hours and the time to boil for the Unit 1 and Unit 2 pool is 7 hours. The licensee further stated that design analysis supports that sufficient coping time exists to establish inventory makeup in Phase 2 prior to fuel damage and that SFP level indication will be available in accordance with NRC Order EA 12-051. The licensee's Phase 1 strategy for SFP cooling, based on existing analyses, does not require makeup to the SFP during Phase 1 of ONS's mitigation strategy.

On page 17 of the Integrated Plan, the licensee described ONS's Phase 2 mitigation strategy for maintaining adequate SFP cooling using portable pumps. ONS's Phase 2 strategy has been described earlier in Section 3.2.2 of this evaluation and is not repeated here. As noted in Section 3.2.2, the licensee stated that for the portable pumps used to provide makeup to the SFPs, the suction source will be from the plant intake canal at a location separate from the intake pump structure (for the T=0 ELAP event) or will be from CTP-1 (for the flood-caused

ELAP event). The licensee identified primary and alternate strategies accomplishing discharge of the SFP makeup water into the SFP; however, it did not identify any additional, alternative water sources for suction of the pumps.

On page 29 of the Integrated Plan, the licensee described ONS's Phase 3 mitigation strategy for maintaining SFP cooling. The licensee stated that ONS's Phase 3 strategy will sustain the Phase 2 SFP makeup by (a) supplying spare makeup pumps and redundant capability; (b) integrating filtration and demineralization into the water supply; and (c) providing capability to add boron as needed.

The licensee's description of water sources for maintaining SFP cooling does not address the potential for alternate sources of makeup water other than from the intake canal, for the T=0 ELAP, or from CTP-1, for the flood-initiated ELAP. The licensee also did not include any mention of potential need to borate the SFP makeup water until Phase 3.

As noted in Section 3.2.2 of this evaluation, the licensee currently is working on analyses and open items to confirm and finalize its proposed SFP cooling strategy, and results of these activities should be made available for review when the activities are completed. This is identified as Confirmatory Item 3.2.2.A in Section 4.2. No additional concerns are identified related to specific consideration of the water sources to be used for SFP makeup and cooling.

Based on the information and evaluations presented above, the licensee's considerations of water sources for maintaining core cooling and heat removal, RCS inventory control, and SFP cooling conform to the guidance in NEI 12-06, Section 3.2.2, Guideline (5).

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 Items, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to water sources to implement the licensee's mitigation strategy, 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 33 of the Integrated Plan the licensee discussed ONS's portable power distribution strategy. The licensee stated that a portable power distribution scheme will be developed to repower required equipment using portable DGs, transformers, power panels, and cables. The licensee stated that equipment required to be repowered includes vital battery chargers, CFT isolation valves (primary) and CFT vent valves (alternate), reactor high point vent valves and reactor head vent valves, RCS cold leg temperature indications, SSF RCMU pump (if this strategy is not eliminated by ONS's open item 33, as discussed in Section 3.2.1.6), portable lighting, and portable HVAC equipment for the MCR, penetration rooms, electrical equipment rooms, and vital battery rooms. The licensee stated that permanent connections will be installed or identified (such as MCC back feed receptacles or terminal blocks) to provide power to existing components from the portable power distribution equipment. The licensee also stated that connection points in electrical penetrations or electrical terminal blocks in the penetration rooms will be identified to support connection of portable instrumentation and repower capability for the reactor high point and head vent valves as an alternate approach. The licensee's Integrated Plan did not address additional considerations related to providing isolation between portable and permanent equipment and ensuring that inappropriate electrical interactions do not occur.

During the audit the licensee was asked to describe how electrical isolation will be maintained such that Class 1E equipment is protected from potential faults in portable/FLEX equipment and such that multiple sources do not attempt to power electrical buses simultaneously. In response to this question the licensee stated that electrical isolations during FLEX deployment will be administratively controlled and that this is being tracked by ONS's open item 4 from the Integrated Plan. It is noted that ONS's open item 4 is described as, "Implement programmatic controls per NEI 12-06," in Attachment 5, on page 57 of the Integrated Plan.

Because the licensee has provided limited information describing its considerations related to electrical power source isolation and interactions, ONS's processes and procedures to prevent inappropriate interactions of portable electrical power sources with permanent plant equipment should be reviewed when ONS's open item 4 is completed to confirm that ONS's strategy conforms to the guidance in NEI 12-06, Section 3.2.2, Guideline (13), or provides an acceptable alternative to that guidance. This is identified as Confirmatory Item 3.2.4.8.A in Section 4.2.

During the audit the licensee was asked to provide a summary of sizing calculations for the FLEX generators and details of loads connected to show that they can supply the loads assumed in Phase 2 and Phase 3. In response, the licensee stated that portable diesel generator sizing is being evaluated and will be completed in support of the engineering changes to design the portable power system. The licensee further stated that this is being tracked by ONS's open items 20 and 22 from the Integrated Plan and open item 34 from the first six-month update.

During the audit process, the licensee provided additional information regarding the SSF electrical independence. Based on the information provided, the NRC staff notes that: The SSF auxiliary system (SSF 4160V bus OTS1) is normally energized from the plant safety-related electrical switchgear (Unit #2, 4160V bus MFB#2) via a 4kV tie-line. This tie-line has two breakers – one at plant Unit #2, 4kV switchgear (B2T-4), and another at the SSF 4kV switchgear (OST1-1). If the SSF 4160V bus OTS1 loses power, the operator will manually start the SSF DG within 10 minutes, and power the SSF bus OTS1 by opening the tie-breaker OST1-1 (isolating from the plant safety bus MFB#2) and then closing the SSF DG output breaker OST1-4 to reenergize bus OTS1. The 4kV tie-breakers are provided with adequate protection so that a fault (in either switchgear) cannot disable both the plant 4kV switchgear and SSF switchgear. Therefore, the staff finds that adequate electrical isolation is provided between the two switchgears.

During the audit the licensee was asked to provide single line diagrams showing the proposed connections for Phase 2 and Phase 3 electrical equipment, including information such as breakers and relays, and rating of the equipment shown on the diagrams. In response, the licensee stated that the design of the primary and alternate portable power system is under development and that the requested single line diagrams are expected to be available by the second quarter of 2014 and will be provided when available. The licensee also stated that the Phase 3 coping strategy is to sustain the Phase 2 repower capability by replenishing Phase 2 portable equipment as necessary from the RCC and that 4160 VAC diesel generators will be available from the RRC for recovery actions beyond Phase 3. The licensee stated that this is being tracked by ONS's open items 20 and 22 from the Integrated Plan and open item 34 from the first six-month update. The licensee should provide FLEX generator sizing calculations/analysis and single line diagrams showing proposed connections of FLEX electrical equipment, when complete. This is identified as Confirmatory Item 3.2.4.8.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 electrical power sources/isolations and interactions, if these requirements are implemented as described.

3.2.4.9 Portable Equipment Fuel

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

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

NEI 12-06, Section 3.2.1.3, 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 33 of the Integrated Plan the licensee discussed ONS's considerations related to providing fuel oil for portable equipment. The licensee stated that fuel oil will initially be provided from the buried SSF diesel engine fuel oil storage tank, which maintains a minimum of 25,000 gallons, using portable fuel oil transfer pumps. The licensee stated that the fuel oil will be transferred to a refueling trailer for FLEX equipment refueling and that an analysis will need to be performed to determine daily fuel oil consumption rates and verify storage requirements. The licensee identified ONS's fuel oil consumption analysis as open item 14 in the Integrated Plan. On page 35 of the Integrated Plan the licensee identified a related item to establish off-site fuel oil delivery logistics. The licensee stated that this item is included in ONS's open item 9 which is described on page 57 of the integrated plan as, "Regional Response Center 'Playbook.'"

During the audit the licensee was asked to further describe ONS's considerations related to ensuring an adequate fuel supply for the portable FLEX equipment. In response, the licensee provided the following additional information:

(1) The licensee stated that for the T=0 strategy, the SSF fuel oil storage tank is maintained with enough fuel oil to provide a continuous supply of fuel to the SSF diesel day tank for a minimum of 72 hours of diesel engine operation at full load. The licensee stated that if the SSF continues to operate without interruption (i.e., no need for use of FLEX equipment) regional response will be on-site to supply additional fuel as needed within 72 hours and that if portable FLEX pumps are required during Phase 2 (i.e., the SSF is no longer operating), the remaining fuel oil, previously designated for SSF consumption, will be available for the portable FLEX equipment. The licensee stated that since overlap of SSF and the portable FLEX pumps is minimal, the initial on-site inventory of fuel oil is expected to be sufficient to supply needs until fuel oil delivery from the RRC is established.

The licensee stated that for the upstream dam failure event, the SSF fuel oil will not be considered available for FLEX and ONS's fuel oil consumption analysis will determine the volume of fuel oil to stage above the peak flood elevation to sustain Phase 2 strategies until the RRC can establish deliveries. The licensee stated that RRC fuel delivery would be in approximately 48 hours if it is classified as a top RRC priority item. The licensee stated that the open item associated with this will verify that there is sufficient fuel oil to operate through Phases 1 and 2 until offsite deliveries are established and that the consumption rate analysis will determine the priority and quantities needed for indefinite coping.

(2) The licensee stated that the SSF fuel oil tanks are robust with regard to T=0 hazards. The licensee further stated that there are two separate tanks used for the storage and supply of fuel to the SSF DG; these are the fuel oil storage tank and the day tank. The licensee stated that both tanks are classified as safety related and that the storage tank is underground, while the day tank is inside the robust SSF building. The licensee stated that the fuel oil storage tank contains enough fuel oil for continuous supply of fuel oil to the day tank for at least 72 hours of SSF diesel engine operation. The licensee stated that a small portion of day tank drain piping which will provide a FLEX tie-in point is Class G (non-safety related) and must be re-analyzed to ensure that it can be considered to be robust. The licensee stated that this re-analysis will be tracked by ONS's open item 38 from the second six-month update to the Integrated Plan.

(3) The licensee stated that the required amount of fuel oil will be available and ability to transfer it will not be impeded by the ELAP hazard. The licensee stated that for the T=0 strategy fuel oil from the embedded SSF diesel storage tank gravity drains to the day tank located in the SSF diesel engine room and that for Phase 2 of the T=0 event ONS will have portable engine-driven transfer pumps and hoses for refilling the FLEX refueling tank from a connection at the SSF day tank. The licensee stated that the FLEX refueling trailer is subject to the same deployment "challenges" as the other FLEX equipment. The statement by the licensee related to deployment challenges is understood to mean that the FLEX refueling trailer is subject to the same considerations and requirements for equipment protection, storage, and deployment as other FLEX portable equipment.

The licensee stated that for the upstream dam failure event the SSF fuel oil will not be considered available for FLEX and the fuel oil consumption analysis will determine the volume of fuel oil to stage above the peak flood elevation to sustain Phase 2 strategies until the RRC can establish deliveries, which is estimated to take between approximately 24 and 48 hours.

(4) The licensee stated that SSF fuel oil quality is a technical specification requirement and portable equipment preventive maintenance (PM) instructions will be established to include fuel oil quality. The licensee stated that ONS's current design basis requires diesel fuel oil from the SSF's day tank and storage tank to be sampled and analyzed quarterly (in accordance with Technical Specification Surveillance Requirement 3.10.1.8) and that ONS intends to establish fuel oil monitoring and replacement PMs for FLEX equipment with fuel oil tanks. The licensee stated that the activity to establish additional PMs is being tracked by open item 14 from the Integrated Plan. On page 57 of the Integrated Plan, the licensee identifies ONS's open item 14 as the fuel oil consumption analysis.

The licensee needs to provide a summary of fuel oil consumption analysis (licensee's open item 14), when complete. This has been identified as Confirmatory Item 3.2.4.9.A in Section 4.2.

With regard to response (1) provided above, the licensee should provide explanation of ONS's considerations related to use of the SSF during a "T=0" event, explaining what criteria will be used to determine when to switch from use of the SSF to use of portable equipment and to explain whether use of the SSF beyond its currently approved mission time of 72 hours would be allowed. This is identified as Confirmatory Item 3.2.4.9.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 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 41 of the Integrated Plan the licensee identified actions 3a and 5a on ONS's SOE time line for T=0 (seismic response) actions:

Action 3a, with an elapsed time of 20 minute to 1 hour, states that the operations crew will follow guidance in the EOP Blackout Tab to stabilize the plant. This includes actions to load-shed the inverters, align the ADVs, purge hydrogen from the generators, and start the station backup diesel instrument air system compressors.

Action 5a, with an elapsed time of 2 to 3 hours, identifies an action to perform vital battery deep load shedding and states that the extension in battery life is to be determined based upon load shed analysis. This action is associated with ONS's open item 12, which is described on page 57 of the Integrated Plan as, "Vital battery deep load shed analysis to provide margin for deployment of FLEX equipment for Phase 2.

On page 10 of the Integrated Plan, the licensee stated that the vital MCR instrumentation powered from 120 VAC battery backed vital panel boards remains available to support core cooling and heat removal and that a load shedding analysis will be performed to determine the length of time this instrumentation will be available.

The licensee made a similar statement on page 16 of the Integrated Plan discussion of Main Control Room instrumentation to support RCS inventory control.

On page 30 of the Integrated Plan the licensee provided a discussion of essential instrumentation and vital instrumentation and controls. The licensee stated that a vital battery load reduction analysis will be completed to determine expected battery life with manual stripping of all loads except those components and instrumentation that are essential to supporting the FLEX strategy and that extension of battery life is to provide margin for deployment of FLEX equipment for Phase 2. The licensee further stated that the remaining instrumentation is consistent with the instrumentation outlined in PWROG generic FSGs and Interfaces and in NEI 12-06. The licensee stated that the load reduction scheme will require removal of non-essential loads beginning at T+2hrs, the estimated time to identify an event as an ELAP condition, with completion of load shedding within 3 hours.

The licensee did not list any currently available load shedding analyses in its references. The effect of the vital battery deep load shedding performed at 2 to 3 hours was not available for review; and a determination could not be made with regard to whether the load shedding is expected to result in a battery duty cycle in excess of 8 hours.

During the audit the licensee was asked to provide additional information related to ONS's strategy for dc load shedding, including providing the dc load profile with the required loads for ONS's mitigation strategies; providing a discussion of the loads to be shed from dc buses, the locations where operator actions are required to be taken, and the required operator actions and the time required to perform the actions; and providing the basis for the minimum dc bus voltage needed to ensure proper operation of required electrical equipment.

In response, the licensee provided the following information and stated that activities are being tracked by ONS's open item 12 from the Integrated Plan.

The licensee stated that in accordance with current design, ONS performs a time-critical load shed within 30 minutes in accordance with the "Restoration of Power" enclosure in the EOP. The licensee stated that this load shed is limited to the non-safety related integrated control system, the operator aid computer, and auxiliary loads fed from non-essential inverters KI, KU and KX, and that this load shed is performed to ensure a 4 hour SBO coping time as required in ONS's UFSAR, Section 8.3.2.2.4. The licensee stated that this load shed does not interfere with any valve positioning or operator actions required for ELAP response including actions related to isolation of RCS leakage paths, including the RCS seal return. The licensee stated that for FLEX strategy planning purposes such as resource allocation, debris removal, or Phase 2 deployment, for T=0 events, the SSF will be relied on for approximately 24 hours for Phase 1, or one-third of the 72 hour SSF design mission time. The licensee stated that all instrument readings required to support the ELAP cool down are available in the SSF during this Phase 1 period and that this will allow time to deploy the primary re-power strategy, which is to re-power the vital battery chargers and associated buses without performing additional load shedding. The licensee stated that this approach eliminates resources required to perform additional load shedding activities on all three ONS units in the T+2 to T+3 hour time frame during which many critical activities are underway and it also eliminates potential unanticipated interactions created by load shed activities. The licensee also stated that based on the considerations described above, the station vital batteries will be available for approximately 4 hours after loss of power.

The licensee stated that for the postulated Jocassee Dam break, the 125 VDC and vital 120 VAC instrumentation systems will be inundated with flood waters and therefore not available for coping. The licensee stated that for this worst case flooding event, the alternate re-power strategy will be deployed. The licensee stated that the alternate re-power strategy uses small 120 VAC diesel generators (approximately 6 kilowatts) deployed on the Turbine Building deck to directly re-power electronics to provide the key instrumentation parameters through connections in the MCR and cable spreading rooms. The licensee stated that generators and connection points will be located above the maximum flood level and the generators and associated cabling will either be deployed from the FLEX storage building prior to site inundation or from pre-staged robust locations in the Auxiliary Building. The licensee further stated that the reference source for operators to obtain necessary instrument readings to support ELAP coping by measuring key instrument readings at containment penetrations using a portable device will also be available.

The licensee needs to provide details of load shed analysis (licensee's open item 12), and summaries of battery sizing calculations for both seismic and flooding scenarios of ELAP. This is identified as Confirmatory Item 3.2.4.10.A in Section 4.2.

The NRC staff reviewed the licensee's Integrated Plan and determined that the Generic Concern related to battery duty cycles beyond 8 hours may be applicable to the plant. This Generic Concern has been resolved generically through the NRC endorsement of NEI's position paper entitled "Battery Life Issue" (ADAMS Accession No. ML13241A186 (position paper) and ML13241A188 (NRC endorsement letter)).

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

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

The NRC staff will evaluate a licensee's application of the guidance (calculations and supporting data) in its development of the final Safety Evaluation documenting review of the licensee's Integrated Plan.

The 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 battery 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 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.

   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.

On pages 7 and 8 of the Integrated Plan the licensee described how ONS's mitigation strategies will conform to the recommendations for programmatic controls in NEI 12-06, Section 11. The licensee stated that equipment associated with ONS's strategies will be procured as commercial equipment with design, storage, maintenance, testing, and configuration control in accordance with NEI 12-06, Section 11.1. The licensee also stated that installed structures, systems and components pursuant to 10 CFR 50.63(a) will continue to meet augmented guidelines of NRC Regulatory Guide 1.155, "Station Blackout." The licensee further stated that the availability of equipment and applicable connections that directly performs a FLEX mitigation strategy will be managed using plant equipment control guidelines developed in accordance with NEI 12-06, Section 11.5.

On pages 36 through 38 of the Integrated Plan, the licensee provided a list of currently identified portable equipment to be used in its Phase 2 mitigation strategies. A note associated with the table states that the equipment and performance criteria provided in the list are best estimates based on information available at the time the list was developed and may change as designs are finalized and implementation proceeds. The licensee further stated that the list is not considered to be final nor regulatory commitments. In its tabulation of Phase 2 portable equipment, the licensee described applicable maintenance by stating that maintenance will be performed in accordance with NEI 12-06, Section 11.5.

The information provided by the licensee in the Integrated Plan describes an intention to follow the guidance in NEI 12-06, Section 11.5, with regard to maintenance and testing of its portable mitigation equipment.

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's 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 staff's endorsement letter is dated October 7, 2013 (ADAMS Accession No. ML13276A224).

This Generic Concern involves clarification of how licensees will maintain FLEX equipment such that it will 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 licensee's implementation of the maintenance and testing guidance in its development of the final Safety Evaluation documenting review of the licensee's Integrated Plan. This is identified as Confirmatory Item 3.3.1.A in Section 4.1 of this evaluation.

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

3.3.2 Configuration Control

NEI 12-06, Section 11.8 states:

> 1. The FLEX strategies and basis will be maintained in an overall program document. This program document will also contain a historical record of previous strategies and the basis for changes. The document will also contain the basis for the ongoing maintenance and testing programs chosen for the FLEX equipment.
> 2. Existing plant configuration control procedures will be modified to ensure that changes to the plant design, physical plant layout, roads, buildings, and miscellaneous structures will not adversely impact the approved FLEX strategies.
> 3. Changes to FLEX strategies may be made without prior NRC approval provided:
>   a) The revised FLEX strategy meets the requirements of this guideline.

b) An engineering basis is documented that ensures that the change in FLEX strategy continues to ensure the key safety functions (core and SFP cooling, containment integrity) are met.

On page 8 of the Integrated Plan the licensee described ONS's implementation of programmatic controls. The licensee stated that the FLEX strategies and basis will be maintained in overall FLEX basis documents and that the existing plant configuration control procedures will be modified to ensure that changes to the plant design, physical plant layout, roads, buildings, and miscellaneous structures will not adversely impact the approved FLEX strategies in accordance with NEI 12-06, Section 11.8.

The licensee did not specifically address provision 3, related to changes in its FLEX strategies that may be made without prior NRC approval. However, provision 3 is a permissive allowed, rather than a limitation imposed, for the licensee's configuration control process. The licensee's statements provide reasonable assurance that the licensee's programmatic controls for ONS's mitigation strategies conform to the recommendations in NEI 12-06, Section 11.8.

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

3.3.3 Training

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

1. Programs and controls should be established to assure personnel proficiency in the mitigation of beyond-design-basis events is developed and maintained. These programs and controls should be implemented in accordance with an accepted training process.

2. Periodic training should be provided to site emergency response leaders on beyond- design-basis emergency response strategies and implementing guidelines. Operator training for beyond-design-basis event accident mitigation should not be given undue weight in comparison with other training requirements. The testing/evaluation of Operator knowledge and skills in this area should be similarly weighted.

3. Personnel assigned to direct the execution of mitigation strategies for beyond-design basis events will receive necessary training to ensure familiarity with the associated tasks, considering available job aids, instructions, and mitigating strategy time constraints.

4. "ANSI/ANS 3.5, Nuclear Power Plant Simulators for use in Operator Training" certification of simulator fidelity (if used) is considered to be sufficient for the initial stages of the beyond-design-basis external event scenario until the current capability of the simulator model is exceeded. Full scope simulator models will not be upgraded to accommodate FLEX training or drills.

5. Where appropriate, the integrated FLEX drills should be organized on a team or crew basis and conducted periodically; with all time-sensitive actions to be

evaluated over a period of not more than eight years. It is not the intent to connect to or operate permanently installed equipment during these drills and demonstrations.

On page 8 of the Integrated Plan, the licensee described ONS's training plan related to its FLEX mitigation strategies. The licensee stated that training will be initiated through the Systematic Approach to Training (SAT) process and that training will be developed and provided to all involved plant personnel based on any procedural changes or new procedures developed to address and identify FLEX activities. The licensee also stated that applicable training will be completed prior to the implementation of FLEX. ONS's open item 6 in the Integrated Plan is tracking this activity.

The licensee's description of its proposed plan for training on FLEX strategies conforms to the recommendations in NEI 12-06, Section 11.6.

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

3.4 OFFSITE RESOURCES

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

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

On page 8 of the Integrated Plan the licensee described its plans for obtaining off-site resources from the RRC. The licensee stated that the industry will establish two RRCs to support utilities during a BDBEE. The licensee stated that each RRC will hold five sets of equipment, four of which will be able to be fully deployed when requested, while the fifth set will have equipment in a maintenance cycle. Equipment will be moved from an RRC to a local assembly area, established by the SAFER team and the utility. The licensee stated that communication will be established between the affected nuclear site and the SAFER team and required equipment will be moved to the site as needed. The licensee stated that first arriving equipment, as established during development of the nuclear site's playbook, will be delivered to the site within 24 hours from the initial request. The licensee also stated that a contract has been signed between the site and the Pooled Equipment Inventory Company to provide Phase 3 services and equipment.

On pages 39 and 40 in the Integrated Plan, the licensee provided a list of equipment and commodities that it expects to obtain from the RRC for use in Phase 3 of its mitigation strategy. However, the licensee also stated, “The equipment and performance criteria provided in this list are best estimates based on information available at the time the list was developed and may change as designs are finalized and implementation proceeds. Therefore, the list is not considered to be final nor regulatory commitments.”

On page 57 of the Integrated Plan, in the list of open items, the licensee described its open item 9 as, “RRC. Regional Response Center ‘Playbook.’”

During the audit the licensee was asked to provide additional discussion of how its mitigation strategy will conform to the recommendations in NEI 12-06, Section 12.2, focusing on items 2) through 10) in the list above. In response, the licensee stated that the SAFER playbook will contain the requested information when it is finalized and this item is being tracked by open item 9 from the Integrated Plan. Because of the limited information provided in this response, it is recommended that the ONS’s playbook for obtaining offsite resources should be reviewed when it is developed to confirm that recommendations in NEI 12-06, Section 12.2, are adequately implemented or acceptable alternatives to the recommendations are provided. This is 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
3.2.1.1.A	Provide a description and justification for the specific evaluation model(s) used in the ELAP analyses for Oconee.	
3.2.1.6.A	The licensee should either (1) develop a successful mitigating strategy that does not rely on repowering the SSF RCMU pumps following recession of floodwaters or (2) provide adequate justification that the SSF RCMU pumps can reliably be repowered following recession of floodwaters.	
3.2.1.6.B	Provide adequate basis that nitrogen from the core flood tanks will not be injected into the reactor coolant system.	
3.2.1.6.C	When further analyses are completed, the licensee should provide additional information that either supports a conclusion that pressurizer relief or safety valves do not lift during the ELAP event or that lifting of the valve(s), if it occurs, is acceptable.	
3.2.1.6.D	Provide additional information demonstrating successful mitigation of an ELAP event involving an uncontrolled cooldown resulting from consequential damage to the main steam system due to the severe natural hazard that initiates the ELAP event.	
3.2.1.8.B	Confirm that Oconee's approach for modeling boric acid mixing is consistent with a generically acceptable methodology or develop a plant-specific technical basis to support the modeling assumptions for boric acid mixing in the ELAP analysis for Oconee.	
3.2.4.7.A	Confirm that the use of non-safety related installed equipment (licensee's open item 38) is acceptable.	
3.2.4.7.B	Confirm that the licensee's strategy for providing CTP-1 make up water at a rate of 700,000 gallons per day following a flooding event is acceptable. This is ONS's open item 23 in the Integrated Plan.	

4.2 CONFIRMATORY ITEMS

Item Number	Description	Notes
3.1.1.2.A	ONS's proposed FLEX equipment deployment routes should be reviewed when they are finalized to ensure that they include adequate consideration of potential soil liquefaction or other conditions that could impede movement following a severe seismic or other BDB event.	

Item Number	Description	Notes
3.1.1.3.A	Confirm that the licensee's reference source providing guidance for operators to obtain instrument readings under ELAP conditions adequately addresses the considerations in NEI 12-06, Section 5.3.3, consideration (1).	
3.1.1.4.A	Confirm that the details for delivery and staging of off-site resources in the licensee's RRC playbook developed by the SAFER team and the utility are acceptable for all BDBEEs.	
3.1.2.2.A	To show conformity with NEI 12-06, Section 6.2.3.2, consideration 2, the licensee should provide additional technical basis to support its claim that persistent, prohibitive flooding levels will not occur at the ONS site.	
3.2.1.1.B	Provide the ELAP analyses for core cooling, reactor coolant system inventory, shutdown margin, and containment integrity for NRC staff audit review.	
3.2.1.1.C	Reliance on the RELAP5/MOD2-B&W and RETRAN-3D codes in the ELAP analysis for B&W plants should be limited at the present time to the flow conditions prior to boiler-condenser cooling initiation.	
3.2.1.2.A	Clarify the means of isolating RCP seal return and RCS letdown in accordance with the Jocassee dam break procedure and the associated timeframe.	
3.2.1.2.B	Provide additional information necessary to justify that RCP seal temperature would be maintained at an acceptably low value by establishing injection flow to the RCP seals via the SSF RCMU pump within 20 minutes of event initiation	
3.2.1.2.C	Provide a justification for the assumed seal leakage rates for the Bingham RCPs with Sulzer seal assemblies.	
3.2.1.2.D	Provide a justification for the assumed seal leakage rates for the Westinghouse 93-A RCPs with Flowserve N-9000 seals with the Abeyance feature.	
3.2.1.5.A	Clarify that steam generator pressure indication will be available to support the cooldown directed by the ELAP mitigating strategy, or provide adequate basis that such indication is unnecessary even at average reactor coolant temperatures below 525 degrees Fahrenheit.	
3.2.1.5.B	Confirm that the final containment analysis (open item 26) demonstrates that there will be no impact on the credited instrumentation.	
3.2.1.6.E	When evaluations are completed, ONS's open item evaluating the survivability of ADVs during an ELAP event should be reviewed to confirm that performance of the valves is adequate to support ONS's mitigation strategy.	
3.2.1.8.A	Confirm that the analysis to determine Oconee's boration requirements in Phase 2 of the mitigating strategy provides acceptable results.	
3.2.1.8.C	Confirm that the BWST design provides tornado missile protection to ensure a source of borated water.	
3.2.1.9.A	Confirm the portable pump capability requirements and fuel	

Item Number	Description	Notes
	requirements to implement Phase 2 and Phase 3 strategies. Results of these analyses should be made available for review when the analyses are completed.	
3.2.2.A	Confirm acceptability of the final SFP cooling strategy. Results of these activities should be made available for review when the activities are completed.	
3.2.3.A	Confirm that the results of the licensee's containment analysis beyond 72 hours are acceptable (ONS open item 26).	
3.2.4.2.A	Confirm using the analysis of hydrogen buildup (open item 24), that there will be no impact on the Phase 2 ventilation strategies.	
3.2.4.2.B	Confirm that the results of ONS's evaluation of building and area temperatures (licensee-identified open item 32), are acceptable to support the licensee's proposed ELAP mitigation strategies.	
3.2.4.3.A	Confirm that the licensee's evaluation of freeze protection (ONS open item 37) is acceptable.	
3.2.4.4.A	Confirm that the licensee's analysis of lighting (open item 29) is acceptable.	
3.2.4.4.B	Confirm that upgrades to the site's communications systems have been completed.	
3.2.4.5.A	Confirm that ONS's FLEX strategies with regard to protected and internal locked area access are acceptable.	
3.2.4.8.A	Confirm that ONS's processes and procedures to prevent inappropriate interactions of portable electrical power sources with permanent plant equipment (ONS's open item 4) conforms to the guidance in NEI 12-06, Section 3.2.2, Guideline (13), or provides an acceptable alternative to that guidance.	
3.2.4.8.B	Confirm that the licensee's FLEX generator sizing calculations/analysis and single line diagrams showing proposed connections of FLEX electrical equipment are acceptable.	
3.2.4.9.A	Confirm that the licensee's fuel oil consumption analysis (licensee's open item 14) is acceptable.	
3.2.4.9.B	The licensee should provide additional explanation of ONS's considerations related to use of the SSF during a "T=0" event, explaining what criteria will be used to determine when to switch from use of the SSF to use of portable equipment and to explain whether use of the SSF beyond its currently approved mission time of 72 hours would be allowed.	
3.2.4.10.A	Confirm that the licensee's analyses on load shedding (licensee's open item 12), and summaries of battery sizing calculations for both seismic and flooding scenarios of ELAP are acceptable.	

Item Number	Description	Notes
3.3.1.A	Confirm that the licensee's implementation of maintenance and testing guidance for FLEX equipment is acceptable.	
3.4.A	Offsite Resources - Confirm NEI 12-06 Section 12.2, Guidelines 2 through 10, are addressed with SAFER.	