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 0

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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

- Spent Fuel Pool 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. ML13071A614), and as supplemented by the first six-month status report in letter dated August 28, 2013 (ADAMS Accession No. ML13252A180), Energy Northwest (hereinafter referred to as the licensee) provided Columbia Generating Station's (Columbia's) Integrated Plan for Compliance with Order EA-12-049. The Integrated Plan describes the strategies and guidance under development for implementation by Energy Northwest 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 staff notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049. That letter described the process used by the NRC staff in its review, leading to the issuance of an interim staff evaluation and audit report. The purpose of the staff's audit is to determine the extent to which the licensees are proceeding on a path towards successful

implementation of the actions needed to achieve full compliance with the Order.

3.1 EVALUATION OF EXTERNAL HAZARDS

Sections 4 through 9 of NEI 12-06 provide the NRC-endorsed methodology for the determination of applicable extreme external hazards in order to identify potential complicating factors for the protection and deployment of equipment needed for mitigation of BDBEEs leading to an extended loss of all 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.

Beginning on page 3 of its Integrated Plan, the licensee addressed six applicable extreme external hazard classes. Five of these are the hazard classes listed in Section 4.1 of NEI 12-06. In addition, the licensee addressed volcanic ashfall as an extreme external event applicable at Columbia's site; this site-specific hazard is discussed in Section 3.1.6 of this evaluation.

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.

In its discussion of seismic events, the licensee referred to information contained in three documents: (1) Columbia Technical Memorandum TM-2143, "Geology, Seismology, and Geotechnical Engineering Report"; (2) Columbia's Final Safety Analysis Report (FSAR), Chapters 2 and 3; and (3) NRC staff Safety Evaluation Report for WPPSS Nuclear Project No. 2 [Columbia], Supplement 1, August 1982.

On page 3 of its Integrated Plan, the licensee stated that the safe shutdown earthquake (SSE) at Columbia is based on a response spectrum anchored at 0.25g (where g is the acceleration of gravity) and that the operating basis earthquake (OBE) is assumed to be half of the SSE, or 0.125g. Additional details in the Columbia FSAR, Section 3.7.1.1, state that the maximum horizontal ground acceleration for the SSE was selected to equal 0.25g, and the peak ground acceleration in the vertical direction is taken as two-thirds of the horizontal value. The Columbia FSAR further states that systems, structures and components (SSCs) that perform safety related functions are designed to remain functional based on maximum vibratory ground motion occurring during the SSE.

The licensee's screening has appropriately determined that the seismic event hazard is applicable at Columbia. However, on page 8 of its Integrated Plan, the licensee stated that it has not completed the seismic re-evaluation required by the 10 CFR 50.54(f) letter of March 12, 2012. The licensee stated that as re-evaluations are completed, appropriate issues will be entered into its corrective action system and addressed on a schedule commensurate with other licensing basis changes.

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

3.1.1.1 Protection of FLEX Equipment – Seismic Hazard

NEI 12-06, Section 5.3.1 states:

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

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

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

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

2. Large portable FLEX equipment such as pumps and power supplies should be secured as appropriate to protect them during a seismic event (i.e., Safe Shutdown Earthquake (SSE) level).

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

On pages 4 and 25 of its Integrated Plan, the licensee discussed considerations related to storage and protection of its FLEX equipment with respect to a seismic hazard. The licensee stated that storage of FLEX equipment will be either in structures meeting the plant's seismic design basis or in structures evaluated equivalent to ASCE 7-10, and that for the latter, the buildings will be equipped with a means to provide backup power. The licensee stated that equipment stored outside will be evaluated for seismic interactions to ensure that equipment is not damaged by non-seismically robust components or structures and that equipment stored inside structures will be evaluated and protected from seismic interactions between components. The licensee stated that at least two FLEX buildings (equipment storage facilities) will be used to provide diverse storage locations, that the design and location of the storage facilities is still in progress, and that the complete list of portable equipment required will not be finalized until procedures are in place and training has been conducted. In its update report dated August 28, 2013, the licensee identified the target start and finish dates to complete the

modification and install the FLEX buildings as October 2013 and June 2014, respectively.

The reviewer compared the licensee's description of storage considerations against the recommendations in NEI 12-06, Section 5.3.1, and noted that, in general, the licensee's considerations of seismic hazards for storage of portable equipment conform to guidelines provided in NEI 12-06.

During the audit, the licensee was asked to provide a more detailed discussion of the proposed design for its FLEX equipment storage buildings. In response, the licensee stated that portable FLEX equipment will be primarily stored in designated FLEX buildings B-82 and B-600. The licensee stated that building B-82 is a new FLEX structure that will be built as the primary FLEX storage location within the protected area and that all construction will be accordance with the 2009 edition of the International Building Code, International Mechanical Code, International Fire Code, International Fuel Gas Code, and Uniform Plumbing Code, including all state and local amendments. The licensee stated that Building B-82 will meet the NEI 12-06 recommendation that buildings be designed or evaluated equivalent to ASCE 7-10. The licensee stated that the building design is complete and the building contract is currently in the bid process. The licensee stated that building B-600 is an existing structure designated for FLEX storage outside the protected area and that it will be modified to meet the same standards as building B-82, except that it will not meet the wind loading criteria and the site-specific requirement to operate during an ashfall event. The licensee stated that since building B-82 will meet the wind loading and ashfall criteria, the NEI 12-06, Section 11.3, paragraph (3), guidance that no one external event can reasonably fail the site's FLEX capability (N) will be met. The licensee stated that building B-600 modifications are currently in the design phase.

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 portable 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 for the FLEX equipment will only require access through seismically robust structures. This includes both the connection point and any areas that plant operators will have to access to deploy or control the capability.
> 3. If the plant FLEX strategy relies on a water source that is not seismically robust, e.g., a downstream dam, the deployment of FLEX coping capabilities

should address how water will be accessed. Most sites with this configuration have an underwater berm that retains a needed volume of water. However, accessing this water may require new or different equipment.

4. If power is required to move or deploy the equipment (e.g., to open the door from a storage location), then power supplies should be provided as part of the FLEX deployment.
5. A means to move FLEX equipment should be provided that is also reasonably protected from the event.

Beginning on page 3 of its Integrated Plan, the licensee stated that soil liquefaction is not postulated at Columbia because of the soil type and unsaturated conditions. The Integrated Plan refers to Columbia Technical Memorandum TM-2143, “Geology, Seismology, and Geotechnical Engineering Report,” which is incorporated by reference into the Columbia FSAR. Technical Memorandum TM-2143 states that based on the existing groundwater conditions at the site, no possibility of liquefaction of the soils underlying the site could result from motions associated with the SSE. However, the licensee stated that although liquefaction is not a concern at Columbia, the effects of a potential failure of a circulating water (CW) pipe, coincident with the ELAP, will be considered to ensure that the FLEX storage areas are located such that deployment of at least one set of portable equipment can be accomplished.

On page 4 of its Integrated Plan, the licensee described additional considerations related to deployment of FLEX equipment with respect to seismic hazard. The licensee stated that at least one connection point for the FLEX equipment will require access only through seismically robust structures including both the connection point and any areas that plant personnel will have to access, that the means to move FLEX equipment will be reasonably protected, and that the effects of a potential failure of a CW pipe, coincident with an ELAP, will be considered to ensure that the FLEX storage areas are located such that deployment of at least one set of portable equipment can be accomplished.

The licensee referred to Columbia’s FSAR Section 2.4.11 and stated that water levels at the Columbia intake structure are not influenced by backwater from the downstream McNary Dam. The licensee stated that the intake provides makeup water to the ultimate heat sink (UHS) spray ponds and that these concrete ponds provide suction and discharge points for the redundant pumping and spray facilities of the standby service water (SW) system. The licensee stated that FSAR Section 9.2.5.2 documents that the combined water volume of the UHS spray ponds is adequate to provide cooling water for 30 days without makeup.

On page 13 of its Integrated Plan, the licensee stated that analysis of transport routes of the equipment to the point of deployment will be conducted.

On page 23 of its Integrated Plan, the licensee stated that vehicles to refuel and deploy the FLEX equipment will be available on site.

The licensee’s Integrated Plan does not explicitly address NEI 12-06, Section 5.3.2, consideration (4), related to whether electrical power is required to move or deploy FLEX equipment. During the audit, the licensee was asked to discuss the design and purpose of the FLEX building generator-backed power sources, and whether electrical power is required to move or deploy portable equipment, as described in NEI 12-06, Section 5.3.2, consideration (4). In response, the licensee stated that each of the two FLEX storage buildings includes a permanently installed diesel-powered generator for the primary purpose of carrying building house loads, such as lighting, building air intake, battery chargers, and general emergency and

supporting repair activities during an ELAP event. The licensee stated that other than general FLEX building house loads, the FLEX building generators are not used to support other mitigation actions. The licensee stated that power is not required to deploy the FLEX mitigation equipment because doors can be operated manually and equipment not requiring power (e.g., connectors, tools, etc.) may be stored in existing safety-related structures. The additional information provided by the licensee adequately addresses NEI 12-06, Section 5.3.2, consideration (4).

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

On pages 4 and 7 of its Integrated Plan, the licensee stated that the procedural interfaces related to alternate instrument readouts will be addressed after the critical monitoring parameters are identified. The licensee identified an open item to track completion of this consideration. In Columbia's update report dated August 28, 2013, the licensee identified this as open item as OI-FLEX-05 and gave the status as "not started." Additional discussion of NEI

12-06, Section 5.3.3, consideration 1 is included in Section 3.2.1.5 of this evaluation.

On page 4 of the Integrated Plan, the licensee stated that Columbia will not be impacted by the failure of a downstream dam.

The licensee's Integrated Plan does not include a discussion of potential impacts from large internal flooding sources that are not seismically robust and do not require ac power (NEI 12-06, Section 5.3.3, consideration 2), or a discussion of whether Columbia uses ac power to mitigate ground water in critical locations or whether a strategy to remove this water will be required (NEI 12-06, Section 5.3.3, consideration 3).

During the audit, the licensee was asked to provide additional discussion of NEI 12-06, considerations 1, 2, and 3. In response the licensee stated that, with regard to consideration 1, currently the critical parameters to be monitored have been defined and a procedure for obtaining the readouts has been drafted and in under review. The licensee stated that consideration 2 (impacts from large internal flooding sources) will be addressed in future six-month updates of the Integrated Plan. This has been identified as Confirmatory Item 3.1.1.3.A in Section 4.2.

The licensee stated that consideration 3 (use of ac power to mitigate ground water) does not apply to Columbia because the ground water elevation is approximately 60 feet below grade level, the lowest building foundation level extends to approximately 40 feet below grade level, and there is ample margin between the lowest building foundation and the ground water elevation.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01 and, subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to procedural interfaces related to a seismic event 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 4 of the Integrated Plan, the licensee provided a general discussion of transportation considerations at Columbia by saying that the primary means of transporting off-site resources to Columbia will be by highway and that within the Columbia owner controlled area there are two paved access roadways (i.e., one normal, one secured alternate access), one railroad line (secured), and one paved roadway to the Columbia River that can be used. The licensee stated

that there are no bridges in the site area that could compromise site access following an earthquake.

On pages 15 and 16 of its Integrated Plan, the licensee provided a discussion related to obtaining resources from the Regional Response Center (RRC). The licensee stated that the industry is establishing two RRCs to support utilities during BDB events and 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 Energy Northwest. The licensee stated that first arriving equipment will be delivered to the site within 24 hours from the initial request and that details will be as established during development of the site's playbook. The licensee stated that Columbia has executed a contract to ensure support is available from the off-site RRC, that Columbia is currently identifying the equipment that will be requested to be delivered, and that the location for the delivery of the RRC-supplied equipment will be at a radius of approximately 25 miles from the site.

On page 16 of its Integrated Plan, the licensee identified an open item to establish a “playbook” with the RRC that will define and coordinate RRC and plant actions in response to events. In Columbia’s update report dated August 28, 2013, the licensee identified this as open item as OI-FLEX-24 and gave the status as “not started.”

The licensee’s approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to use of offsite 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 5 of the Integrated Plan, the licensee referred to Columbia’s FSAR, Section 2.4.10, and stated that Columbia is built above the design basis flood level. The licensee stated that the approximate finished grade of all Seismic Category I structures, except the spray ponds, is at elevation 440 feet mean sea level (msl) and that the finished grade of the spray ponds is 434 feet msl. The licensee stated that the probable maximum flood (PMF) of the Columbia River at the site is 390 feet msl. The licensee stated that FSAR Section 2.4.3.6 documents that

the flood elevation as a result of the probable maximum precipitation (PMP) (including surge and wave run-up) is 433.3 feet msl. The licensee stated that because Columbia is built above the design basis flood level it is not required to evaluate flood-induced challenges for the protection and deployment of FLEX equipment. The licensee stated that FLEX equipment storage will be at or above elevation 433.3 feet msl.

On page 8 of its Integrated Plan, the licensee stated that it has not completed the flooding re-evaluation required by the 10 CFR 50.54(f) letter of March 12, 2012, and that results of flooding re-evaluation are not assumed in the submittal. The licensee stated that as re-evaluations are completed, appropriate issues will be entered into its corrective action system and addressed on a schedule commensurate with other licensing basis changes.

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/guidelines address the needed actions to relocate the equipment. Based on the timing of the limiting flood scenario(s), the FLEX equipment can be relocated [footnote 2 omitted] to a position that is protected from the flood, either by barriers or by elevation, prior to the arrival of the potentially damaging flood levels. This should also consider the conditions on-site during the increasing flood levels and whether movement of the Flex equipment will be possible before potential inundation occurs, not just the ultimate flood height.
>
> 2. Storage areas that are potentially impacted by a rapid rise of water should be avoided.

On pages 25, 36, 43, and 50 of its Integrated Plan, the licensee stated that NEI 12-06 Section 6.2.3.1 is not applicable because Columbia is a dry site as described in NEI 12-06, Section 6.2.1, and equipment will be stored above the maximum flood level for the site.

Although Columbia is a “dry site,” during periods of intense precipitation there may be some likelihood that equipment stored in a low elevation building with inadequate drainage or directly on the ground could be exposed to, and adversely affected by short-duration precipitation runoff. The licensee did not provide sufficient information in its Integrated Plan to determine whether evaluations of potential adverse effects of short-term precipitation runoff will be included in design of Columbia’s FLEX equipment storage building or in evaluation of mitigation equipment that is stored outside.

During the audit the licensee was asked to provide additional information describing how equipment stored in FLEX equipment storage buildings or outside will be protected from the effects of intense local precipitation. In response, the licensee stated that the flooding hazards analysis will provide information about site water level associated with a PMP event and a local intense precipitation (LIP) event and that water levels from these events will be compared to elevations for the FLEX buildings as well as the deployment routes for the equipment. The licensee stated that a Lidar survey, which measures distance or elevation by laser reflection, was performed for the site and a topographic plan of the site has been generated to assist the flooding evaluation. The licensee stated that additional information will be provided in the February 2014 update to the Integrated Plan. This is identified as Confirmatory Item 3.1.2.1.A in Section 4.2.

The licensee’s approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01 and, subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to protection of FLEX equipment for 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 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.
>
> 2. The ability to move equipment and restock supplies may be hampered during a flood, especially a flood with long persistence. Accommodations along these lines may be necessary to support successful long-term FLEX deployment.
>
> 3. Depending on plant layout, the UHS may be one of the first functions affected by a flooding condition. Consequently, the deployment of the equipment

should address the effects of LUHS [loss of normal access to the ultimate heat sink], as well as 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.

As discussed in Section 3.1.2 of this evaluation, Columbia screened as a dry site in accordance with NEI 12-06, Section 6.2.1, and the licensee did not provide any additional detailed discussion related to deployment of portable equipment with consideration of a flooding hazard.

Although many of the considerations listed above have limited applicability at a dry site, some may be applicable at Columbia. Examples of considerations that may be applicable are the ability to move equipment, effects on connection points for portable equipment, or potential effects on the ultimate heat sink.

During the audit, the licensee was asked to review the deployment considerations listed in NEI 12-06, Section 6.2.3.2 and address considerations that may be relevant to deployment of equipment during an intense precipitation or similar flooding-related event. In response to this request the licensee stated that the next update of its Integrated Plan, scheduled for February, 2014, will address the applicability to Columbia of each of the nine considerations for FLEX equipment deployment listed in NEI 12-06, Section 6.2.3.2. This is included with Confirmatory Item 3.1.2.1.A in Section 4.2 below.

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

during or following a flooding hazard if these requirements are implemented as described.

3.1.2.3 Procedural Interfaces – Flooding Hazard

NEI 12-06, Section 6.2.3.3 states:

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

As discussed in Section 3.1.2 of this evaluation, Columbia screened as a dry site in accordance with NEI 12-06, Section 6.2.1; and the licensee did not provide any additional, detailed discussion related to procedural interfaces with consideration of a flooding hazard.

During the audit, the licensee was requested to clarify whether it has external flooding procedures that would be affected by considerations related to deployment of FLEX mitigation equipment during an external flooding event. In response, the licensee stated that the flooding analysis is currently in progress and will be used to determine whether any of the Columbia external flooding procedures should be changed. This is included with Confirmatory Item 3.1.2.1.A in Section 4.2 below

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

3.1.2.4 Considerations in Using Offsite Resources – Flooding Hazard

NEI 12-06, Section 6.2.3.4 states:

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

As discussed in Section 3.1.2 of this evaluation, Columbia screened as a dry site in accordance with NEI 12-06, Section 6.2.1; and the licensee did not provide additional, detailed discussion

related to using offsite resources with consideration of a flooding hazard.

However, on page 16 of its Integrated Plan, the licensee identified an open item to establish a "playbook" with the RRC to define and coordinate RRC and plant actions in response to events.

The site's playbook should be reviewed when completed and confirmed to adequately address potential regional impacts that might affect transportation of off-site equipment during an extreme, regional flooding event. This is identified as Confirmatory Item 3.1.2.4.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 use of offsite 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 recurrence of hurricanes with wind speeds in excess of 130 mph exceeds 10^{-6} per year, the site should address hazards due to extreme high winds associated with hurricanes.

The screening for high wind hazards 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 5 of the Integrated Plan, the licensee referred to Columbia's FSAR Section 2.1.1.1 and stated that the reactor is located at 46° 28′ 18" north latitude and 119° 19′ 58" west longitude. The licensee stated that using NEI 12-06 Figures 7-1 and 7-2, Columbia screens out for both hurricanes and tornados for the protection and deployment of FLEX equipment. The licensee stated that storage of FLEX equipment will be either in structures meeting the Columbia design basis for wind or in structures designed or evaluated equivalent to ASCE 7-10.

On page 11 of its Integrated Plan, the licensee identified an open item stating that the design of the SSCs used to mitigate the ELAP and LUHS will be verified to be robust with respect to seismic events, floods, and high winds.

On pages 25, 36, 43, and 50 of the Integrated Plan the licensee stated that these NEI 12-06 recommendations are not applicable and that beyond-design-basis high wind conditions do not have to be addressed for the Columbia site per NEI 12-06, Section 7.2.

In Columbia's FSAR Section 9.2.5.3, the licensee's safety evaluation of the Columbia UHS, the reviewer noted that the possibility of a tornado passing over the spray ponds and removing a significant amount of water is considered a credible event and that, for this reason, the makeup water pump house is designed to be tornado proof, with all piping and electrical power supply between the plant and the pump house running underground with adequate soil cover to provide protection from tornado generated missiles. The reviewer noted that during an ELAP event, power to the makeup water pumps would not be available from off-site or installed on-site ac sources. The licensee's Integrated Plan does not provide sufficient information to determine whether Columbia's mitigation strategy will address a contingency to potentially make up UHS inventory on a relatively short time scale following a tornado event.

During the audit, the licensee was asked to provide additional information addressing the potential need to make up UHS inventory following a tornado event. In response, the licensee stated that Columbia is located in a region having an extremely low probability of tornados and that using the criteria in NEI 12-06, Section 7.2, the maximum predicted tornado speed of 127 miles per hour is expected to occur at a rate of 1 in 1 million per year. The licensee stated that assuming such a tornado did occur and pass directly over the UHS spray ponds, some water might be lost. However, the licensee stated that it is not feasible to accurately quantify the amount of water that could be lost, but that Energy Northwest believes that the large volume maintained in the spray ponds will assure that a sufficient volume of water would remain to support make-up requirements during the first 72 hours of an ELAP event. The licensee stated that it will perform an evaluation to compare (1) the quantity of water required to dissipate, for 72 hours, the decay heat of the reactor core and spent fuel pool during Phases 1 and 2, with (2) the volume of water normally in the spray ponds. The licensee stated that results of that evaluation will be reported in the February 2014 update to Columbia's Integrated Plan. This is identified as Confirmatory Item 3.1.3.A in Section 4.2 below.

The licensee stated that in addition to the spray ponds, other large and diverse sources of water are available. The licensee stated that the circulating water basin could be used to provide water using one of the diesel driven fire pumps and the underground fire main, or through hoses connected to the pump truck or high-head diesel powered pump. In addition, the licensee stated that fire pump FP-P-110 could be used to provide water from its dedicated water supply (approximately 285,000 gallons) via the underground fire main.

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

As discussed in Section 3.1.3 of this evaluation, Columbia screened out for special concerns related to the impact of severe storms with high winds in accordance with NEI 12-06, Section 7.2. Therefore, the considerations of NEI 12-06, Section 7.3.1 are not applicable and beyond-design-basis high wind conditions do not have to be addressed for Columbia per NEI 12-06, Section 7.2.

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 storage and protection of FLEX equipment from a high wind hazard 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 discussed in Section 3.1.3 of this evaluation, Columbia screened out for special concerns related to the impact of severe storms with high winds in accordance with NEI 12-06, Section 7.2. Therefore, the considerations of NEI 12-06, Section 7.3.2 are not applicable and beyond-design-basis high wind conditions do not have to be addressed for Columbia per NEI 12-06, Section 7.2.

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 deployment of FLEX equipment during or following a high wind hazard if these requirements are implemented as described.

3.1.3.3 Procedural Interfaces – High Wind Hazard

NEI 12-06, Section 7.3.3, states:

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

As discussed in Section 3.1.3 of this evaluation, Columbia screened out for special concerns related to the impact of severe storms with high winds in accordance with NEI 12-06, Section 7.2. Therefore, the considerations of NEI 12-06, Section 7.3.3 are not applicable and beyond-design-basis high wind conditions do not have to be addressed for Columbia per NEI 12-06, Section 7.2.

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 procedural interfaces related to a high wind hazard 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.

As discussed in Section 3.1.3 of this evaluation, Columbia screened out for special concerns related to the impact of severe storms with high winds in accordance with NEI 12-06, Section 7.2.
Therefore, the considerations of NEI 12-06, Section 7.3.4 are not applicable and beyond-design-basis high wind conditions do not have to be addressed for Columbia per NEI 12-06, Section 7.2.

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 considerations in using offsite resources during or following a high wind hazard if these requirements are implemented as described.

3.1.4 Snow, Ice and Extreme Cold

As discussed in NEI 12-06, Section 8.2.1:

All sites should consider the temperature ranges and weather conditions for their site in storing and deploying their FLEX equipment consistent with normal design practices. All sites outside of Southern California, Arizona, the Gulf Coast and Florida are expected to address deployment for conditions of snow, ice, and extreme cold. All sites located north of the 35th Parallel should provide the capability to address extreme snowfall with snow removal equipment. Finally, all sites except for those within Level 1 and 2 of the maximum ice storm severity map contained in Figure 8-2 of NEI 12-06 should address the impact of ice storms.

On page 5 of the Integrated Plan, the licensee referred to Columbia's FSAR, Section 9.4, and stated that the winter outdoor design temperature is 0 degrees Fahrenheit (F) with an extreme outdoor winter condition of minus 27 degrees F. The licensee referred to FSAR, Section 2.3.1.2.2, and stated that a value of 20 lb/ft^2 was used as the design snow and ice loading for Columbia structures. The licensee stated that Columbia is located above the 35th parallel and that snow removal equipment is required in accordance with NEI 12-06, Section 8.2.1. The licensee stated that FSAR, Section 2.3.1.2.1.1, documents the record snowfalls for the site as (1) the greatest 24-hour snowfall being 10.2 inches, and (2) the highest number of days with greater than 12 inches of snow on the ground being 9 days. The licensee stated that in accordance with NEI 12-06, Figure 8-2, Columbia is located in the yellow region (Level 3) and must consider ice storm impacts causing low to medium damage to power lines and/or existence of considerable amount of ice.

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 pages 5 and 6 of the Integrated Plan, the licensee stated that the following consideration will be applied to storage of FLEX equipment with respect to cold temperatures, snow and ice: (1) storage of FLEX equipment will be either in structures meeting Columbia's design basis for snow, ice, and cold conditions or in structures designed or evaluated equivalent to ASCE 7-10; (2) equipment will be procured to function in the cold weather conditions applicable to Columbia and will be maintained within a temperature range to ensure it will function when called upon; (3) snow removal equipment is available onsite; and (4) under extreme cold conditions coincident with the ELAP, the surface of the SW spray ponds and CW basin could freeze, and actions will be developed to ensure the continued availability of the water inventory from these sources and to thaw any frozen SW piping that will be required in Phase 3.

On page 7 of its Integrated Plan, the licensee identified an open item stating equipment stored outside will be evaluated for seismic interactions, cold weather operation, and ash fall.

On page 26 of its Integrated Plan, the licensee discussed storage and protection of mitigation equipment during snow, ice, and extreme cold conditions. The licensee stated that the FLEX buildings will have an environmentally-controlled area equipped with a heating, ventilation, and air conditioning (HVAC) system to maintain the proper environment to ensure that the portable equipment stored therein will function when required. The licensee stated that building power will be generator-backed thereby allowing the HVAC system to remain functional during the ELAP and that building design will be finalized when storage requirements have been completed. The licensee stated that it does not plan to store large, diesel-powered equipment in the environmentally-controlled area but that this equipment will include block heaters for cold starts.

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 the UHS on the deployment of FLEX equipment. For example, if UHS water is to be used as a makeup source, some additional measures may need to be taken to assure that the FLEX equipment can utilize the water.

On page 6 of its Integrated Plan, the licensee stated that: (1) equipment will be procured to function in the cold weather conditions applicable to Columbia and will be maintained within a temperature range to ensure it will function when called upon; (2) snow removal equipment is available onsite; and (3) under extreme cold conditions coincident with the ELAP, the surface of the standby service water spray ponds and circulating water basin could freeze and actions will be developed to ensure continued availability of the water inventory from these sources and to thaw any frozen service water piping required in Phase 3 of Columbia's mitigation strategy.

On page 7 of its Integrated Plan, the licensee identified an open item stating that actions will be developed to ensure the continued availability of water inventory from the service water ponds and circulating water basin in cold weather and to thaw any frozen service water piping required in Phase 3, with plans to remove ice and snow from equipment haul paths being evaluated and to be developed as needed.

During the audit, the licensee was asked to provide additional information describing the actions necessary to ensure the availability of water inventory from the service water ponds and the circulating water basin which could be affected by conditions of extreme cold. In response, the licensee stated that the plant procedure for breaking the frozen surface of the service water ponds is contained in procedure SOP-COLDWEATHER-OPS and that a procedure will either be modified or created to address freezing in the circulating water system. The licensee stated that during Phase 2 the water hoses supplying makeup water for the spent fuel pool, the reactor pressure vessel (RPV) or the suppression pool, and the CST will be flowing continuously to prevent frozen lines and that, if makeup water is not needed for a period of time, the flow will be reduced and diverted into floor drains or into the ground outside such that flooding or frozen surfaces will not interfere with mitigation activities. The licensee stated that mitigation strategies for Phase 3 are under development and that additional details will be provided in the February 2014 update of its Integrated Plan.

Information provided by the licensee did not address considerations made for manual operations required by plant personnel during cold weather conditions. Also, comparison of statements in the licensee's Integrated Plan against guidance in NEI 12-06, Section 8.3.2, consideration (2), noted the licensee's statement that snow removal equipment is available onsite; however, the licensee identified in its open item that a plan to remove ice and snow from equipment haul paths is under evaluation and key actions will be developed as needed. The licensee's considerations related to manual operations during cold weather conditions and its development of plans for ice and snow removal and appropriate haul paths should be confirmed when developed. This is identified as Confirmatory Item 3.1.4.2.A in Section 4.2.

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

guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01 and, subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to deployment of FLEX equipment during a snow, ice, and extreme cold event if these requirements are implemented as described.

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

NEI 12-06, Section 8.3.4, states:

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

On page 7 of the Integrated Plan, the licensee stated that the plan to remove ice and snow from equipment haul paths is under evaluation and actions will be developed as needed. When fully developed the licensee's procedural enhancements addressing effects of snow and ice on transport of the FLEX equipment should be reviewed and confirmed to be adequate. This is included with Confirmatory Item 3.1.4.2.A in Section 4.2.

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

On page 29 of the Integrated Plan, the licensee stated that procedures will be developed to obtain, install and utilize the 4160 VAC FLEX diesel generator (DG) and large FLEX pump obtained from the RRC and that Columbia will use the industry-developed guidance from the boiling-water reactor owners group (BWROG), EPRI, and NEI to develop site specific procedures or guidelines to address the criteria in NEI 12-06.

The licensee's statement is directed toward installation and use of the offsite resources, rather than the logistics of delivering and staging them. In the Integrated Plan, the licensee did not provide specific information related to how site access and staging areas for the receipt of offsite materials and equipment might be affected by snow, ice, and extreme cold. However, the licensee did state that a "playbook" describing Columbia's coordination with the RRC is currently being developed.

When the licensee's playbook for coordination with the RRC is developed, it should be reviewed to confirm that issues related to delivery of off-site equipment during conditions of snow and ice and extreme cold are adequately addressed. This has been combined with Confirmatory

Item 3.1.2.4.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 consideration of 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 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 6 of the Integrated Plan, the licensee referred to Columbia's FSAR, Chapter 9.4, and stated that the summer outdoor design temperature for Columbia is 105 degrees F (dry-bulb) with an extreme outdoor summer condition of 115 degrees F (dry-bulb).

On page 6 of the Integrated Plan, the licensee stated that equipment will be procured to function in the hot weather conditions applicable to Columbia and will be maintained within a temperature range to ensure the equipment is likely to function when called upon.

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.

On page 26 of their Integrated Plan, the licensee stated that Columbia's FLEX buildings will have an environmentally-controlled area equipped with a heating, ventilation, and air conditioning (HVAC) system to maintain the proper environment to ensure that the portable equipment stored in the buildings will function when required. The licensee stated that only equipment needing a controlled environment will be stored in this area of the buildings.

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 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 discussed in Sections 3.1.5 and 3.1.5.1 of this evaluation, the licensee's Integrated Plan states that portable mitigation equipment will be procured to function in the hot weather conditions applicable to Columbia and will be maintained within a temperature range to ensure it is likely to function when called upon. The licensee's Integrated Plan does not include explicit considerations of manual operations required by plant personnel in conditions of high ambient temperatures or extreme heat. However, with a summer outdoor design temperature of 105 degrees F (dry-bulb) and an extreme outdoor summer condition of 115 degrees F (dry-bulb), it is judged that normal industrial safety practices related to occupational heat exposure are adequate to address this issue at Columbia's site.

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

In the Integrated Plan the licensee did not provide specific information describing potential procedural enhancements related to the effects of high temperatures on the FLEX equipment. However, on page 6 of the Integrated Plan the licensee stated that equipment will be procured to function in the hot weather conditions applicable to Columbia and will be maintained within a temperature range to ensure equipment is likely to function when called upon.

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 for an event involving high temperature hazards if these requirements are implemented as described.

3.1.6 Volcanic Hazards (Site-Specific)

NEI 12-06, Appendix B, Section B.3 states:

Some hazards could contribute to the potential for a simultaneous ELAP and LUHS, but do not significantly challenge the structures and internal plant equipment. These hazards are therefore considered to be enveloped by baseline ELAP in Step 1:

- forest fire
- grass fire
- lightning
- sandstorm
- volcanic activity

On pages 6 and 7 of the Integrated Plan, the licensee stated that there are several major volcanoes in the Cascade Range west of Columbia. The licensee stated that the closest volcano is Mount Adams, which is approximately 165 km distant and the most active volcano is Mount St. Helens, which is approximately 220 km west-southwest of the site. The licensee stated that most volcanic activity, including mud flows, avalanches, lava flows, and shock waves, is confined to the immediate area of the volcano and does not pose a hazard to Columbia. The licensee stated that the only volcano-related potential hazard to the site is ashfall resulting from a major eruption of one of these volcanoes. The licensee stated that travel time of the ash to the site will vary with wind speed but a few hours of warning time will be available for site preparations and that additional warning time (days to months) may be available based on U.S. Geological Survey monitoring of the Cascade volcanoes.

The licensee stated that it included considerations of the potential effects of ashfall on the FLEX equipment. The licensee stated that the FLEX equipment will be evaluated to operate in the Columbia design basis ashfall conditions and stored or located within structures designed for ashfall conditions to ensure it is likely to function when called upon. The licensee stated that deployment of FLEX equipment will be evaluated to ensure manual actions required by plant personnel can be accomplished under ashfall conditions.

On page 7 of the Integrated Plan, the licensee identified two open items related to volcanic ashfall, stating (1) that equipment stored outside will be evaluated for seismic interactions, cold weather operation, and ashfall; and (2) that evaluation of FLEX equipment will be completed to ensure proper functioning under the design basis temperatures and ashfall conditions, including manual actions to transport and set up the equipment.

On page 26 of the Integrated Plan, the licensee stated that portable mitigation equipment and deployment vehicles potentially used during a volcanic ashfall event will be equipped, or capable of being equipped with combustion air filtering to ensure continued operations in ashfall conditions and that FLEX equipment storage buildings and structures will consider ashfall in their design. The licensee stated that a diesel generator will be located in a FLEX Building protected from ashfall and the diesel generator will be capable of running from this location, with the ability to be moved, if necessary, to allow for an alternate hook-up point.

NEI 12-06 provides no specific guidance with regard to assessing the potential challenges presented by a volcanic ashfall event. However, the licensee has identified volcanic ashfall as a potential hazard applicable to Columbia. The licensee addressed potential challenges related to volcanic ashfall with consideration of equipment design, storage, protection, and deployment issues that might be affected by volcanic ashfall. The licensee's proposals for addressing a

postulated volcanic ashfall hazard are consistent with its current design basis, and are, therefore, considered 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 and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to consideration of a site-specific volcanic ashfall hazard if these requirements are implemented as described.

3.2 PHASED APPROACH

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

To meet these EA-12-049 requirements, licensees will establish a baseline coping capability to prevent fuel damage in the reactor core or SFP and to maintain containment capabilities in the context of a BDBEE that results in the loss of all ac power, with the exception of buses supplied by safety-related batteries through inverters, and loss of normal access to the UHS. As described in NEI 12-06, Section 1.3, "[p]lant-specific analyses will determine the duration of each phase." This baseline coping capability is supplemented by the ability to use portable pumps to provide RPV makeup in order to restore core or SFP cooling capabilities as described in NEI 12-06, Section 3.2.2, Guideline (13). This approach, described in NEI 12-06, Section 3, is endorsed by JLD-ISG-2012-01.

3.2.1 Reactor Core Cooling, Heat Removal, and Inventory Control Strategies

NEI 12-06, Table 3-1 and Appendix C summarize one acceptable approach for the reactor core cooling strategies. This approach uses the installed reactor core isolation cooling (RCIC) system, or the high pressure coolant injection (HPCI) system to provide core cooling with installed equipment for the initial phase. This approach relies on depressurization of the RPV for injection with a portable injection source with diverse injection points established to inject through separate divisions/trains for the transition and final phases. This approach also provides for manual initiation of RCIC or HPCI as a contingency for further degradation of installed SSCs as a result of the beyond-design-basis initiating event.

Columbia is a BWR/5, and its design incorporates an ac-powered high pressure core spray (HPCS) system rather than a turbine driven HPCI system; therefore, the recommendations related to HPCI in NEI 12-06 are not applicable for Columbia.

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

describes boundary conditions for the reactor transient.

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

As described in NEI 12-06, Section 1.3, plant-specific analyses determine the duration of the phases for the mitigation strategies. In support of its mitigation strategies, the licensee should perform a thermal-hydraulic analysis for an event with a simultaneous loss of all alternating current (ac) power and loss of normal access to the ultimate heat sink for an extended period (the ELAP event).

3.2.1.1 Computer Code Used for ELAP Analysis

NEI 12-06, Section 1.3 states in part:

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

In pages 54 through 58 of its Integrated Plan, the licensee provided a sequence of events (SOE) timeline identifying elapsed time from time zero for each plant response action following the start of the simultaneous ELAP and LUHS event. It is noted that for many actions in the licensee's SOE timeline, the elapsed time and the determination of an ELAP time constraint are stated as "TBD" (to be determined), indicating that at the time when its Integrated Plan was submitted the licensee had not completed analyses to determine the timeline values. The SOE is based on an analysis using the industry-developed Modular Accident Analysis Program (MAAP) Version 4 computer code. MAAP4 was written to simulate the response of both current and advanced light water reactors to loss of coolant accident (LOCA) and non-LOCA transients for probabilistic risk analyses as well as severe accident sequences. The code has been used to evaluate a wide range of severe accident phenomena, such as hydrogen generation and combustion, steam formation, and containment heating and pressurization.

In numerous instances describing establishment of its SOE timeline (see, e.g., pages 10-12, 18-20, 30, 33, and 55-58 of its Integrated Plan), the licensee referred to use of the MAAP computer code.

On page 11 of its Integrated Plan, the licensee listed an open item to track development and completion of its SOE timeline, stating that MAAP analysis and the resulting time line will establish the necessary actions that will be taken to protect both the core and the containment. In its six-month update report dated August 28, 2013, the licensee listed the status of this open item as "started."

The licensee has decided to use the MAAP4 computer code for simulating the ELAP event. While the NRC staff does acknowledge that MAAP4 has been used many times over the years

and in a variety of forums for severe and beyond design basis analysis, MAAP4 is not an NRC-approved code, and the NRC staff has not examined its technical adequacy for performing thermal-hydraulic analyses. Therefore, during the review of licensees' Integrated Plans, the issue of using MAAP4 was raised as a Generic Concern and was addressed by NEI in a position paper dated June 2013, entitled "Use of Modular Accident Analysis Program (MAAP4) in Support of Post-Fukushima Applications" (ADAMS Accession No. ML13190A201). After review of this position paper, the NRC staff endorsed a resolution through letter dated October 3, 2013 (ADAMS Accession No. ML13275A318). This endorsement contained five limitations on the MAAP4 computer code's use for simulating the ELAP event for Boiling Water Reactors (BWRs). Those limitations and their corresponding confirmatory item numbers for this TER are provided as follows:

(1) From the June 2013 position paper, benchmarks must be identified and discussed which demonstrate that MAAP4 is an appropriate code for the simulation of an ELAP event at the licensee's facility. This is Confirmatory Item 3.2.1.1.A, in Section 4.2.

(2) The collapsed RPV level must remain above Top of Active Fuel (TAF) and the cool down rate must be within technical specification limits. This is Confirmatory Item 3.2.1.1.B, in Section 4.2.

(3) MAAP4 must be used in accordance with Sections 4.1, 4.2, 4.3, 4.4, and 4.5 of the June 2013 position paper. This is Confirmatory Item 3.2.1.1.C, in Section 4.2.

(4) In using MAAP4, the licensee must identify and justify the subset of key modeling parameters cited from Tables 4-1 through 4-6 of the "MAAP4 Application Guidance, Desktop Reference for Using MAAP4 Software, Revision 2" (Electric Power Research Institute Report 1020236). This should include response at a plant-specific level regarding specific modeling options and parameter choices for key models that would be expected to substantially affect the ELAP analysis performed for that licensee's plant. Although some suggested key phenomena are identified below, other parameters considered important in the simulation of the ELAP event by the vendor / licensee should also be included.

    a. Nodalization
    b. General two-phase flow modeling
    c. Modeling of heat transfer and losses
    d. Choked flow
    e. Vent line pressure losses
    f. Decay heat (fission products / actinides / etc.)

    This is Confirmatory Item 3.2.1.1.D, in Section 4.2.

(5) The specific MAAP4 analysis case that was used to validate the timing of mitigation strategies in the Integrated Plan must be identified and should be available on the ePortal for NRC staff to view. Alternately, a comparable level of information may be included in the supplemental response. In either case, the analysis should include a plot of the collapsed vessel level to confirm that TAF is not reached (the elevation of the TAF should be provided) and a plot of the temperature cool down to confirm that the cool down is within technical specifications limits. This is Confirmatory Item 3.2.1.1.E, in Section 4.2.

During the audit the licensee's use of the MAAP computer code was discussed. The licensee acknowledged the NRC-endorsed resolution of Generic Concerns regarding use of the MAAP code in mitigation strategies. The licensee stated that Energy Northwest will assess the applicability of the generic resolutions to Columbia and that this assessment will be reported in the August 2014 update of its Integrated Plan.

In response to a question related to quality assurance for the licensee's MAAP analysis, the licensee stated that the MAAP calculations evaluate BDB events and are classified as non-safety related and that these calculations are performed under the Energy Northwest Quality Assurance (QA) program as non-safety related calculations in accordance with existing procedures. The licensee stated that engineers preparing and verifying the MAAP calculations are specifically qualified to perform engineering calculations and that the engineers verifying the applicable MAAP calculations have attended MAAP training programs endorsed by EPRI. The licensee also stated that trained engineers serve as qualified MAAP mentors for those preparing the calculations and that, where appropriate, third party MAAP expert reviewers have been employed to review the MAAP models and results. The licensee stated that all MAAP calculations are reviewed in accordance with applicable Columbia QA requirements and the records of the calculations are retained.

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 the computer code used for ELAP analysis if these requirements are implemented as described.

3.2.1.2 Recirculation Pump Seal Leakage Models

The guidance of NEI 12-06, Section 3.2.1.5, paragraph (4) includes consideration of BWR recirculation pump seal leakage. When determining time constraints and the ability to maintain core cooling, it is important to consider losses to the RCS inventory as this can have a significant impact on the SOE. Special attention is paid to the recirculation pump seals because these can fail in a SBO event and contribute to beyond normal system leakage.

On page 9 of its Integrated Plan, the licensee stated that the sequence of events developed to address the ELAP and LUHS will take into account sources of expected reactor coolant inventory loss when determining the timeframe that makeup is required. This statement broadly conforms to NEI 12-06, Section 3.2.1.5; however, the licensee did not provide detailed information in its Integrated Plan related to primary system leakage.

The licensee did not identify or provide justification for the assumptions made regarding primary system leakage from the recirculation pump seals and other sources that addresses the following items:

a. The assumed leakage rate and its predicted pressure dependence relative to test data.
b. Clarification of whether the leakage was determined or assumed to be single-phase liquid, two-phase mixture, or steam at the donor cell.
c. Comparison of design-specific seal leakage testing conditions to code-predicted thermal hydraulic conditions (temperature, void fraction) during an ELAP and justification if predicted conditions are not bounded by testing.
d. Discussion of how mixing of the leakage flow with the drywell atmosphere is modeled.

During the audit the licensee was asked to provide additional information addressing the items of concern listed above. In response to this request, the licensee stated that a MAAP analysis was performed to determine response of the containment during a beyond design basis external event. The licensee stated that primary system leakage such as recirculation pump seal leakage was not included in the current calculations. The licensee stated that further MAAP analyses will address leakage from the reactor recirculation pumps, including the magnitude and nature of the leakage as a function of time and that based on the current project schedule, this updated information will be included in the August 2014 Integrated Plan update. The licensee stated that this issue is enveloped by an existing open item, OI-FLEX-08, which states that the sequence of events developed to address the ELAP and LUHS will take into account sources of expected reactor coolant inventory loss.

When the licensee's evaluations related to its open item OI-FLEX-08 are completed, the evaluations should be reviewed to confirm that issues related to primary system leakage from the recirculation pump seals have been adequately addressed. This is identified as Confirmatory Item 3.2.1.2.A in Section 4.2.

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

3.2.1.3 Sequence of Events

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

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

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

In order to support the objective of an indefinite coping capability, each plant will be expected to establish capabilities consistent with Table 3-1 (BWRs). Additional explanation of these functions and capabilities are provided in NEI 12-06 Appendix C, "Approach to BWR Functions."

On pages 54 through 58 in Appendix 1 of its Integrated Plan, the licensee provided a sequence of events (SOE) timeline table. The SOE timeline table lists 18 actions and provides a

description of each action, including information about elapsed time when each action is completed, an indication of whether the action involves an ELAP time constraint, and related remarks. For many of the actions, the elapsed time and the ELAP time constraint are provided as “TBD” (to be determined).

The first 14 actions in the licensee’s SOE timeline table rely on installed plant equipment and are described under Phase 1 Actions, below. Actions 15 and 16 in the licensee’s SOE timeline table rely on portable FLEX equipment; these actions are described under Phase 2 Actions, below. Actions 17 and 18 in the licensee’s SOE time line table rely on large equipment from the RRC and are described under Phase 3 Actions, below.

Phase 1 Actions:

Columbia’s reactor is a single-unit BWR/5 which uses a turbine-driven RCIC system but does not have a HPCI system. On pages 17 through 19 of its Integrated Plan, the licensee provided a description of events and actions associated with Phase 1 of its mitigation strategy for ELAP/LUHS events occurring during power operation. The reviewer confirmed that RCIC and related system operations, as described in the licensee’s Integrated Plan and discussed below, are typical for BWR/5 reactors.

The licensee will initially use the RCIC system to remove decay heat during an ELAP event. The RCIC system consists of a steam-driven turbine and pump unit and associated valves and piping capable of delivering makeup water to the reactor vessel. The steam supply to the turbine comes from the reactor vessel and is generated by decay heat in the reactor fuel. The steam exhaust from the turbine discharges to the suppression pool. The RCIC pump can take suction from the condensate storage tank (CST) or from the suppression pool. Following any reactor shutdown, steam generation continues due to heat produced by the radioactive decay of fission products. The steam normally flows to the main condenser through the turbine bypass valves or, if the condenser is isolated, through the relief valves to the suppression pool. The RCIC system’s turbine and pump unit either starts automatically upon a receipt of a reactor vessel low-low water level signal or is started by the operator from the main control room by remote manual controls. The RCIC system delivers its design flow within 30 seconds after actuation. To limit the amount of fluid leaving the reactor vessel, the reactor vessel low-low water level signal also actuates the closure of the main steam isolation valves. The RCIC system has a makeup capacity sufficient to prevent the reactor vessel water level from decreasing to the level where the core is uncovered without the use of core standby cooling systems.

During an ELAP event the control room operators initially take actions in accordance with station blackout (SBO) procedures. An operator sequentially opens safety relief valves (SRVs) to control reactor pressure and provides make-up to the RPV using RCIC to maintain RPV level. At Columbia the operator manually starts and controls the RCIC barometric condenser’s condensate pump to maintain level in the RCIC barometric condenser vacuum tank and prevent flooding of the RCIC room through the barometric condenser’s relief valve. In accordance with Columbia’s SBO procedures, operators initiate compensatory measures to limit main control room temperature and promote cooling; take measures to bypass the RCIC trips on high area temperature, high area differential temperature and high exhaust pressure to ensure continued RCIC operation; take measures to promote RCIC room cooling; shed unnecessary loads on station batteries; and close tower makeup inlet and outlet valves to prevent siphoning water in the CW basin back to the river.

Normal operation of RCIC requires availability of only dc power, and the licensee stated that

procedures and supplies currently exist and are staged to allow RCIC to be started locally if neither ac nor dc power were available.

An operator will manually initiate RPV depressurization to 100-200 psig using SRVs, but minimizing SRV operations, at a rate not to exceed 100 degrees F per hour. If emergency depressurization is required in accordance with Columbia's Emergency Operating Procedures and RCIC is the only injection source to the RPV, the operator will emergency depressurize but stop the depressurization at approximately 100 psig to maintain a steam supply to the RCIC turbine.

The licensee stated that procedures and supplies currently exist and are staged to allow SRVs to be operated in the event there is no ac or dc power available using portable battery packs.

The licensee stated that within approximately 45 minutes following the loss of ac power, the operator will make a determination as to whether or not restoration of ac power is likely to occur within the 4 hour licensing basis for the SBO event; and if timely ac power restoration is not expected, the operators will transition to ELAP procedures and perform additional actions, including shedding additional dc loads to prolong battery life to 10 hours, bypass additional RCIC trips to ensure continued RCIC operation, vent the containment by opening the vent valves for the containment hardened vent system, continue to maintain RPV pressure in the range of 100-200 psig, and initiate additional compensatory measures to promote cooling in required areas of the reactor building, main control room and other vital areas.

DC control power and pneumatic pressure are required to open SRVs. The licensee stated that its additional dc load shedding will ensure required dc power from batteries is available for 10 hours with no charging available. The operator uses the seven SRVs assigned to the automatic depressurization system (ADS) to depressurize the RPV. Each of the ADS-SRVs is equipped with a pneumatic accumulator and check valve arrangement designed to Seismic Category I requirements. The ADS accumulators and check valves ensure that the ADS valves can be held open if the normal pneumatic supply to the accumulators should fail following a seismic event. The licensee stated that additionally the pneumatic supply piping to the ADS accumulators will automatically isolate from the normal nitrogen supply and nitrogen will be supplied from banks of high pressure compressed nitrogen cylinders. The licensee stated that the nitrogen cylinders are normally controlled by individual solenoid valves at each bottle and operated so that only one bottle is depleted at a time, but that on loss of inverter power to the solenoids, the nitrogen cylinder valves open, providing a bulk source of nitrogen for operation of the ADS valves. The licensee stated that the supply of nitrogen is sufficient to support required ADS-SRV operation during the ELAP event because the supply of nitrogen is adequate to provide 424 single valve actuations and analysis has shown 72 SRV actuations are needed during the first 72 hours of the ELAP event.

The suction of the RCIC pump is normally aligned to the CST. If the CST water inventory becomes depleted, RCIC suction automatically transfers (or can be manually transferred by remote operation from the control room) to the suppression pool. The licensee stated that analyses are in progress to model the response of the suppression pool (temperature, pressure, level) and RCIC pump net positive suction head (NPSH) available if RCIC pump suction is from the suppression pool. The licensee stated that results of this analysis will determine the time required to establish makeup water to the CST or to the suppression pool, and the required makeup rate. The licensee also stated that this analysis will confirm that adequate NPSH is maintained throughout the event. Although additional analyses are being performed, the licensee stated that on the basis of currently completed analyses, with RCIC suction initially

from the suppression pool, adequate NPSH is predicted to be available until approximately 50 hours after event initiation and that actions will be taken in Phase 2 of its mitigation strategy to add water to the RPV or to the suppression pool prior to loss of adequate NPSH for the RCIC pump.

Phase 2 Actions:

On pages 22 through 24 of its Integrated Plan, the licensee provided a description of events and actions associated with Phase 2 of its mitigation strategy. For Phase 2 the licensee provided a primary and an alternate strategy.

In the licensee's primary Phase 2 strategy, RCIC continues to operate and provide RPV injection as in Phase 1. When water level in the CST drops below a predefined minimum level, RCIC suction will be swapped to the suppression pool, and portable FLEX equipment will be used to replenish the water inventory in the CST. The licensee identified several diverse potential sources of CST makeup water, including the service water spray ponds, the circulating water basin, and the fire protection bladder tank, and stated that diverse pumping methods are also available, including two installed diesel driven fire protection pumps, and a high-head diesel driven pump. The licensee stated that diverse means to route the water to the two CSTs are available, including use of the installed fire protection ring header and portable hoses. The licensee stated that the strategy of using the circulating water basin, service water spray ponds, or the fire protection bladder tank limits the amount of debris, such as river grasses, that could be transferred into the RPV.

In Phase 2 the licensee includes provisions for recharging the 125 volt and the 250 volt batteries, which it states are available for 10 hours and 17 hours, respectively, without charging. The licensee credits its currently available, trailer-mounted 480 volt, 400 kW diesel generator (DG4) with being used to provide power to the battery chargers. DG4 is used in the licensee's current SBO procedures, and the licensee estimated that DG4 hook-up and required switching within the electrical distribution system can be accomplished within 4 hours. On its SOE timeline the licensee shows actions to connect DG4 and initiate recharging of the 125 volt and 250 volt batteries to be completed within 1-10 hours of event initiation. The licensee stated that it will procure a second portable, trailer mounted diesel generator (similar to DG4) to provide the N+1 capability of FLEX equipment recommended by NEI 12-06, Section 3.2.2.

The licensee's alternate Phase 2 strategy is used in the event that RCIC is (or becomes) unavailable. In its alternate strategy the licensee uses portable FLEX equipment to meet the N+1 recommendation for providing RPV injection. In its alternate strategy the licensee will use the same pumps and water sources as described in its primary strategy to make up water to the CST; however, the water would be injected directly into the RPV through connections with the residual heat removal (RHR) system. The licensee stated that makeup to the RPV through the RHR system involves connecting hoses to a yard fire hydrant (which would be pressurized from a diesel-driven fire pump) and routing the hoses to the pumper truck inlet. Hoses and a flow meter are connected to the outlet of the pumper truck. The hoses can then be run to the reactor building and either run up stairways or connected to the fire protection riser piping in the stairwells. The hose from the pumper truck is then connected to the condensate transfer blind flange in any one of the three RHR lines. The licensee stated that valves will be manually aligned as necessary to provide an injection path to the RPV. The licensee stated that analyses show that water can be supplied to the RPV at a rate of approximately 300 gallons per minute (gpm) while another hydrant is being used for other purposes such as firefighting under a B.5.b scenario. The licensee stated that alternatively, hoses can be run directly from either the

service water pond or the circulating water basin to either the pumper truck or the high head pump and from the pump to one of the three RHR lines described above. The licensee further stated that for these scenarios, the RPV must be depressurized.

Phase 3 Actions:

On page 29 of its Integrated Plan, the licensee provided a description of its Phase 3 primary and alternate mitigation strategies. The licensee stated that for Phase 3, core cooling will be accomplished by placing one loop of RHR into the shutdown cooling mode and that this will be done by providing power from a 4160 VAC FLEX portable DG obtained from the RRC and supplying the RHR heat exchangers with service water pumped by a large portable FLEX pump obtained from the RRC using connections to either division of the service water piping. The licensee stated that the 4160 VAC FLEX DG will be sized sufficient to carry the loads necessary to support the Phase 3 FLEX strategies including an RHR pump and its support equipment (e.g., motor-operated valves, keep-fill pumps, room coolers). The licensee stated that the large-capacity FLEX pump will be sized to provide sufficient service water flow to the RHR heat exchanger to support the shutdown cooling or suppression pool cooling modes of RHR and that the strategy for shutdown cooling can be accomplished using a single large FLEX pump or multiple FLEX pumps, depending on pump sizes available from the RRC. The licensee further stated that in order to prevent pipe damage caused by water hammer, a keep-fill pump will be repowered to allow proper fill and vent of the systems prior to RHR shutdown cooling operation. The licensee stated that its alternate strategy will provide an alternative means for core cooling by connecting to and using the opposite division of RHR and service water from that used for the primary strategy and that alternate connection points for the 4160 VAC FLEX DG will be identified and installed.

The licensee's mitigation strategy conforms to the guidance in NEI 12-06, Section 3.2.2, because (1) in Phase 1 Columbia's initial coping relies solely on currently installed equipment that requires only dc power to operate; (2) in Phase 2 there is a transition from initial coping to use of an on-site, portable FLEX DG to provide recharging of batteries plus use of on-site diesel-driven portable pumps to provide makeup water to the CST or to the RPV; and (3) in Phase 3 there is transition to a viable, long-term shutdown cooling operation using ac power provided by a large diesel generator and support equipment obtained from the off-site RRC, and Phase 3 operation can be sustained for an indefinite time until more permanent repairs or restorations can be implemented.

On page 12 of its Integrated Plan, the licensee referred to Appendix 1 of the Integrated Plan and listed six open items related to the sequence of events: (1) actions to validate that direct current (dc) load shed actions specified in current SBO procedures can be completed within 45 minutes, with the validated time constraint incorporated into existing SBO procedures; (2) evaluation of RCIC room flooding to confirm assumptions associated with operation of the RCIC barometric condenser condensate pump; (3) validation that a time of 15 minutes to complete additional dc load shedding, not currently specified in SBO procedures, is adequate; (4) validation of connections of FLEX generators to power Division 1 batteries to ensure actions can be completed within 4 hours; (5) completion of MAAP analyses to establish the SOE time line; and (6) completion of GOTHIC calculations to evaluate the effects of a loss of HVAC on area heat-up in the plant.

In its updated report dated August 28, 2013, the licensee stated that the evaluation of RCIC room flooding, and the MAAP and GOTHIC calculations have all been started and gave the status of other open items listed above as "not started."

On page 20 and 21 of its Integrated Plan the licensee listed several potential modifications and related open items to support its Phase 2 strategy. These include (1) installation of a reliable containment hardened vent (CHV) system; (2) analyses of RCIC operation at elevated temperatures, assessment of RCIC system piping, hangers and supports and identification of changes needed to support reliable RCIC operation at such conditions; (3) evaluation of the feasibility of redesigning or repowering the RCIC barometric condenser's level switch to determine whether it can remain functional during an ELAP to provide automatic level control; and (4) additional analyses to model various cases of RCIC operation taking suction from the CST or from the suppression pool and various timings for RCIC suction swap between CST and suppression pool.

In its updated report dated August 28, 2013, the licensee stated that open items related to Phase 1 of its core cooling strategy have all been started, except for those related to the CHV system.

On page 30 and 31 of its Integrated Plan the licensee listed several potential modifications and related open items to support its Phase 3 strategy. These include (1) developing primary and alternate connection points for the 4160 VAC FLEX DG, including ability to provide power to either Division 1 or Division 2 for shutdown cooling operation; (2) developing primary and alternate connection points for the large diesel-driven FLEX pump used for RHR heat exchanger cooling in Phase 3; and (3) developing appropriate procedures for implementation of these actions.

In its update report dated August 28, 2013, the licensee stated that it has started evaluation of modifications to establish connection points for the 4160 VAC FLEX DG and evaluation of service water piping modifications needed to support connection of the large diesel-driven FLEX pump; and the licensee gave the status of related procedure development as "not started."

On page 19 of its Integrated Plan the licensee stated that actions will be taken in Phase 2 of its mitigation strategy to add water to suppression pool prior to loss of adequate NPSH for the RCIC pump, if RCIC pump suction is aligned to the suppression pool; and on pages 23 and 24 of its Integrated Plan, the licensee described actions taken to add water to the RPV using its alternate core cooling strategy if the RCIC system is not available.

During the audit, the licensee was asked to describe how makeup water will be provided to the suppression pool if the CSTs were not available, and the suppression pool was being used to provide suction to the RCIC pump. In response, the licensee stated that procedure preparation for providing makeup to the suppression pool has not been completed; however, the flow path for providing suppression pool makeup will be through the same flanged connections in the RHR system that are used for RPV makeup, as described above. The licensee stated that although procedure preparation is not complete, the actions required to establish a flow path will likely be to (1) select the water source and deploy the desired pump, (2) route hoses to the selected blind flange connection point, (3) verify the applicable RHR isolation valve is closed, (4) remove the blind flange and connect the hose, (5) align the applicable RHR system valves open or closed as appropriate, and (6) slowly pressurize the system and adjust flow as necessary. The licensee stated that additional details, including the sequence and overlapping of the actions will be specified in the applicable procedures.

During the audit the licensee was asked to provide additional information related to its SOE time line. Audit information requests and the licensee's responses are discussed in the following

paragraphs.

NEDO-33771/NEDC-33771P, Revision 1, "GEH Evaluation of the FLEX Implementation Guidelines," ADAMS Accession No. ML130370742, (hereinafter NEDC-33771P) is a report prepared by the BWROG to supplement the guidance in NEI 12-06 by providing additional BWR-specific information regarding individual plant response to ELAP/LUHS events. The report includes identification of generic event scenarios and expected plant responses, the associated analytical bases, and recommended actions for performance of a site-specific gap analysis. During the audit the licensee was asked to provide Columbia's plant-specific ELAP analysis information commensurate with the level of detail contained in NEDC-33771P, including analysis assumptions and results in their tabulated and plotted forms. In response to this request the licensee stated that plant-specific ELAP analysis results will be provided in the format and detail equivalent to NEDC-33771P and that Energy Northwest expects to provide the information in the August 2014 updated of its Integrated Plan.

The licensee was asked to clarify the initial plant conditions used to develop its mitigation strategies for an ELAP event that occurs during power operation. The licensee responded that the initial plant conditions are consistent with those described in NEI 12-06, Section 3.2.1.2, paragraph (1); the reactor is assumed to have been operating at its full rated thermal power (3486 MWt) for greater than 100 days. The licensee's response is acceptable because it conforms to the guidance in NEI 12-06.

The licensee was asked to provide the seismic classification of the fire protection ring header and to describe how it will be verified to be robust with respect to seismic events or high winds with associated missiles. The licensee responded that a review of the current fire protection ring header shows that it was designed to Seismic Category II standards outside Seismic Category I structures and that except for minor portions, it is buried in engineered fill and is largely protected from the effects of high winds. The licensee also stated that while use of the fire protection ring header is an operational convenience, its availability is not credited; the licensee further stated that the February 2014 update of its Integrated Plan will clarify the wording to reflect the information provided above. The licensee's response is acceptable because it clarifies that use of the fire protection ring header is treated as an operational convenience but that, as a Seismic Category II feature, the ring header is not credited as part of the licensee's ELAP mitigation strategy; and this treatment conforms to the guidance in NEI 12-06.

The licensee was asked to provide additional discussion, describing Columbia's current and planned use of its 480 VAC diesel generator, DG4, and to provide justification that use of this currently-existing diesel generator is consistent with guidance in NEI 12-06. In response to this request, the licensee stated that DG4 is a 480 volt diesel generator that can be connected to the plant's Class 1E buses and associated division battery charges. The licensee stated that DG4 is currently used as part of the risk management actions for providing alternate ac sources to Division 1 or Division 2 to permit extending the 72 hour Technical Specification Completion Time for restoring an inoperable Emergency Diesel Generator (EDG) to 14 days. The licensee stated that DG4 provides supplemental ac power to the Division 1, 250 volt and 125 volt battery chargers and the Division 2, 125 volt battery charger. The licensee stated that although DG4 could be used to extend battery life during a station blackout, this is a risk management action and DG4 is not credited as additional SBO coping equipment in the SBO analysis. The licensee further stated that the high-pressure core spray diesel generator is credited as the SBO power source.

The licensee stated that DG4 typically is used if necessary to support the Technical Specification 14 day completion time utilized for online EDG maintenance outages and that these EDG outages normally occur a maximum of once per year for each of the two EDGs. The licensee further stated that DG4 could potentially be used to also support unplanned EDG outages that may exceed 72 hours, but that such unplanned EDG outages are infrequent.

The licensee stated that to support crediting DG4 as FLEX equipment, DG4 will be permanently mounted in one of the two currently planned FLEX buildings and that permanent cables from DG4 will be run underground to a hardened enclosure. The licensee stated that the hardened enclosure will contain connection points for cables that can be run above ground to connection points on the existing Division 1 and Division 2 ac distribution system and that the cables that can be run above ground will normally be stored in the FLEX building. The licensee stated that operation of DG4 in this manner will expedite the transition to Phase 2 of the mitigation strategy and that DG4 plus the planned DG5 480 volt portable diesel generator will satisfy the N+1 condition recommended in NEI 12-06. The licensee further stated that DG5 will be capable of being moved to a location near the connection points. The licensee's description and justification for use of DG4 are acceptable because the licensee's plans conform to the guidance provided in NEI 12-06, Section 3.2.1.3, condition (8).

The licensee was asked to provide for NRC staff review the calculations that demonstrate adequate core cooling is maintained throughout the ELAP event. In response to this request the licensee identified and provided access to several of its currently completed calculations. The licensee further stated that additional calculations are in progress and will be made available for NRC review when completed and that the results will be included in the August 2014 update of the Columbia's Integrated Plan.

During the audit, the licensee was asked to provide a description of how it will implement the bypass of RCIC trip function as described in it Integrated Plan. In response, the licensee stated that an evaluation of RCIC protective features during prolonged SBO events was performed by General Electric/Hitachi (GEH) and documented in Project Task Report 0000-0143-0382-R0, "RCIC System Operation in Prolonged Station Blackout – Feasibility Study," for the BWROG. The licensee stated that the study provided recommendations for addressing each RCIC trip or isolation and that the study recommendations included defeating selected trip and isolation signals. The licensee stated that several of these recommendations to defeat trip and isolation signals have already been incorporated into existing site SBO procedures. The licensee stated that these bypasses are accomplished through a combination of installed test switches, jumpers, and lifted leads in the main control room, and field valve manipulations in the RCIC room. The licensee stated that Energy Northwest intends to evaluate and incorporate additional recommendations of the GEH feasibility into SBO procedures as part of Columbia's integrated response to a prolonged SBO condition. The licensee stated that it will evaluate the ability to successfully accomplish each bypass under the expected conditions of a prolonged station blackout as a part of the procedure approval process and that based on incorporation of the GEH recommended trip bypasses, the potential for equipment protection features to interfere with operation of RCIC during an ELAP event will be minimized.

During the audit, the licensee was asked to provide additional information describing the potential for flooding of the RCIC room from the barometric condenser. In response, the licensee stated that the water level in the RCIC system barometric condenser is controlled by an ac-driven level switch that would lose functionality during an ELAP event. The licensee stated that its SBO procedure currently requires operators to manually start and stop the RCIC barometric condenser pump to prevent flooding of the RCIC room due to loss of the normal

barometric condenser level control switch. The licensee stated that a design change is currently being processed to change the power supply for the RCIC barometric condenser level control switch from 120 volt ac power to 125 volt dc power and to reconfigure the control circuits appropriately. The licensee stated that the dc power supply for the reconfigured circuit will be the Division 1, 125 volt dc battery which would remain functional during an ELAP event. The licensee stated that this change will assure that the capability of the RCIC barometric condenser level control switch to control the barometric condenser's condensate pump is not lost during an ELAP and will eliminate the need for periodic operator action to prevent flooding of the RCIC room from the barometric condenser.

Based on information provided in the licensee's Integrated Plan and additional information provided in the licensee's responses to audit questions as discussed above, the licensee's sequence of events for its core cooling strategy conforms to the guidance in NEI 12-06.

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

3.2.1.4 Systems and Components for Consequence Mitigation

NEI 12-06, Section 11 provides details on the equipment quality attributes and design for the implementation of FLEX strategies. It states:

> Equipment associated with these strategies will be procured as commercial equipment with design, storage, maintenance, testing, and configuration control as outlined in this section [Section 11]. If the equipment is credited for other functions (e.g., fire protection), then the quality attributes of the other functions apply.

And,

> 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.

NEI 12-06, Section 3.2.1.12 states:

> Equipment relied upon to support FLEX implementation does not need to be qualified to all extreme environments that may be posed, but some basis should be provided for the capability of the equipment to continue to function.

On page 13 of its Integrated Plan, the licensee stated that equipment for its FLEX mitigation strategies will be procured to commercial grade standards and that if the equipment is used to support other functions, such as fire protection, the quality requirements applicable to the other functions will be followed.

On page 53 of its Integrated Plan, the licensee provided a tabulation of key portable FLEX

equipment credited in Phase 2 of its mitigation strategy and listed the performance criteria and maintenance requirements for that equipment. Currently existing equipment includes a pumper truck, which is also used for fire protection, and DG4, currently used to support maintenance activities on emergency DGs. The licensee stated that maintenance for these pieces of equipment will be in accordance with its established preventive maintenance and testing tasks. In addition, the licensee listed one high-head and one low-head diesel powered pump, and additional 480 VAC generator, two diesel-driven air compressors, gasoline-powered fuel transfer pumps and two transportation/towing vehicles. The licensee stated that it will follow EPRI's template requirements for maintenance of these pieces of equipment, which will be procured specifically to support FLEX mitigation strategies.

On page 6 of its Integrated Plan, the licensee stated that its FLEX equipment will be procured to function in the cold weather and in the hot weather conditions applicable to Columbia's site.

During the audit, the licensee was asked to provide a summary of non-safety related installed equipment that is used in the mitigation strategies and to include a discussion of whether the equipment is qualified to survive all ELAP events. In response, the licensee stated that non-safety related installed equipment identified for potential use in the mitigation strategies includes the CST tanks and piping, a portion of RCIC piping, fire protection tanks, hydrants, and ring header, the circulating water basin, the auxiliary boiler diesel oil tank, facility gasoline refueling station tank, reactor building exhaust fan ductwork, containment exhaust purge piping beyond the isolation valve, and various electrical components such as batteries and buses. The licensee stated that mitigation strategies are still under development and that additional non-safety related equipment may be identified. The licensee stated that the design of installed SSCs used to mitigate the ELAP and LUHS will be verified to be robust with respect to seismic events, floods, and high winds and that further details will be provided in the February 2014 update to its Integrated Plan.

The licensee's descriptions of procurement requirements, environmental qualification, and maintenance requirements applicable for its portable FLEX equipment conform to the recommendations in NEI 12-06. However, the licensee has not completed all supporting design requirements and calculations needed to demonstrate that its proposed FLEX equipment has the capability to perform as intended. When supporting design requirements and calculations are completed, subsequent review will be needed to confirm that equipment credited by the licensee is adequate to perform its credited mitigation function(s). This is listed as Confirmatory Item 3.2.1.4.A in Section 4.2.

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

3.2.1.5 Monitoring Instrumentation and Controls

NEI 12-06, Section 3.2.1.10 states in part:

> The parameters selected must be able to demonstrate the success of the strategies at maintaining the key safety functions as well as indicate imminent or actual core damage to facilitate a decision to manage the response to the event within the Emergency Operating Procedures and FLEX Support Guidelines or

within the SAMGs. Typically these parameters would include the following:

- RPV Level
- RPV Pressure
- Containment Pressure
- Suppression Pool Level
- Suppression Pool Temperature
- 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 20 of its Integrated Plan, the licensee listed reactor vessel essential instrumentation credited in its coping evaluation. This includes RPV level wide range and fuel zone instruments and RPV pressure instruments. On pages 20 and 21 of its Integrated Plan, the licensee stated that the following additional instruments will remain powered throughout the event to assist with the mitigation of loss of core cooling: (a) RCIC flow and control; (b) RCIC turbine speed; (c) RCIC pump room water level; (d) RPV metal temperature; (e) Containment radiation monitor; (f) CST level indication; and (g) Portable tachometer for RCIC black start.

On pages 23 and 25 of its Integrated Plan, the licensee described a proposed modification related to instrumentation power by saying that a cross-connect will be provided between the Division 1 and 2 480 VAC buses to allow repowering key instrumentation on Division 2.

On page 34 of its Integrated Plan, the licensee listed containment essential instrumentation credited in its coping evaluation. This includes drywell pressure, suppression pool pressure, suppression pool level, drywell temperature, and suppression pool temperature. The licensee also stated that drywell level indication and containment oxygen and hydrogen monitors will remain powered throughout the event. The licensee further stated that additional instrumentation associated with its hardened primary containment vent system will also be available.

On page 40 of its Integrated Plan, the licensee stated that instrumentation for monitoring spent fuel pool (SFP) level will be installed in accordance with NRC Order EA 12-051.

The licensee's list of essential instrumentation and controls conforms to NEI 12-06, Section 3.2.1.10, because the set of instruments listed by the licensee includes all of the instruments listed in NEI 12-06 as typically used by BWRs.

During the audit the licensee was asked to provide additional discussion of how it is implementing the guidance in NEI 12-06, Section 5.3.3, consideration 1 which recommends that to support mitigation of a beyond-design-basis seismic event each plant should compile a reference source document for plant operators that provides approaches to obtain necessary instrument readings and provide guidance on how and where to measure key instrument readings at containment penetrations using portable instruments, where applicable.

In response to this request, the licensee stated that the essential instrumentation list in the Integrated Plan is considered to be the instrumentation required to monitor the minimum set of parameters necessary for implementation of Emergency Operating Procedures, Severe Accident Guidelines, and Flex Support Guidelines (EOP/SAG/FSGs) and that the essential

instrumentation listed requires only dc power to be functional. The licensee stated that to address an event in which dc power is not available, critical parameters to be monitored have been defined and a procedure for obtaining the readouts has been drafted and is under review. The licensee stated that the procedure uses battery powered digital multi-meters and loop-powered calibrators to obtain mille-ampere signals which are then converted to instrument readings. The licensee stated that readings can be obtained from control room terminal panels, remote shutdown room panels, or reactor building instrument racks and that critical parameters which can be monitored during loss of dc power include reactor water level, reactor pressure, RCIC flow, RCIC turbine speed, containment air temperature, containment pressure, suppression pool temperature, and spent fuel pool temperature and level. The licensee stated that this item is addressed by an open item, OI-FLEX-05, which states, “The procedural interface in NEI 12-06, Section 5.3.3.1 (alternate instrument readouts) will be developed once the critical monitoring parameters are identified.” This is identified as Confirmatory Item 3.2.1.5.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 monitoring instrumentation and controls if these requirements are implemented as described.

3.2.1.6 Motive Power, Valve Controls and Motive Air Systems

NEI 12-06, Section 12.1 provides guidance regarding the scope of equipment that will be needed from off-site resources to support coping strategies. NEI 12-06, Section 12.1 states in part that:

> Arrangements will need to be established by each site addressing the scope of equipment that will be required for the off-site phase, as well as the maintenance and delivery provisions for such equipment.

And,

> Table 12-1 provides a sample list of the equipment expected to be provided to each site from off- site within 24 hours. The actual list will be specified by each site as part of the site-specific analysis.

Table 12-1 includes “Portable air compressor or nitrogen bottles & regulators (if required by plant strategy).”

The primary method for RPV pressure control during an ELAP event is the SRVs. On page 18 of its Integrated Plan, the licensee described operator actions and constraints, and supporting systems needed to implement RPV pressure control. SRVs are cycled manually by the operator to reduce RPV pressure and control it in the range of 100-200 psig. DC control power and pneumatic pressure are required to open the SRVs. On page 55 of its Integrated Plan in describing SOE Action 11, the licensee stated that under ELAP conditions the RPV should be depressurized to the range of 100 to 200 psig to facilitate long-term RCIC operation and that this action will begin approximately 30 minutes into the ELAP event and take approximately 3 hours to complete. The licensee also stated that the primary factor for determining whether this is a time constraint will be the time to reach the Heat Capacity Temperature Limit for the primary containment’s wet well (suppression pool). The licensee stated that completion of

MAAP analyses will determine the timing of when this action must be completed.

Additional detail of operator actions and support system requirements have been described earlier in Section 3.2.1.3 of this evaluation under Phase 1 Actions.

During the audit the licensee was asked to provide additional information clarifying what installed batteries are needed to support the SRV actions, how long the installed batteries will support the SRV actuations plus other required loads, whether portable battery packs are required to be used in support of SRV actuations and any challenges related to their use. The licensee also was asked to address the seismic qualification and robustness of the pneumatic gas supply and expected availability of the pneumatic gas for a beyond-design-basis seismic event.

In response to these requests, the licensee stated that the 125 volt station batteries supply power to the solenoid valves that actuate the SRVs and that the 125 volt station batteries can support SRV actuations and other required loads for 10 hours without recharging. The licensee further stated that battery calculations conservatively assume that an SRV is actuated continuously in determining how long the batteries can perform their function without charging. The licensee stated that recharging of the 125 volt batteries can be accomplished within 10 hours of ELAP event initiation and that portable battery packs, while available, are not expected to be needed or used.

The licensee stated that compressed nitrogen is supplied to the Containment Instrument Air (CIA) system using high pressure nitrogen bottles in the Reactor Building and that the CIA system is safety related and designed to Seismic Category I criteria. The licensee further stated that the CIA system for one division of the ADS valves has capacity to provide over 400 single SRV actuations in 3 days and that based on MAAP analyses fewer than 200 SRV actuations would be required during the 3 day period.

On pages 23 and 24 of its Integrated Plan, the licensee described an alternate strategy for RPV injection and core cooling if the RCIC system becomes unavailable during Phase 2 of its mitigation strategy. The alternate Phase 2 core cooling strategy uses portable, diesel-driven pumping equipment to inject water to the RPV through any one of the three RHR lines. This strategy has been described earlier in Section 3.2.1.2 of this evaluation under Phase 2 Actions. In this alternate strategy, manipulation of RHR system valves will be required. On page 24 of its Integrated Plan the licensee stated that the required valves can be manually aligned as necessary to provide an injection path to the vessel; based on this statement, no additional electrical power would be required for valve manipulation in Phase 2 of the licensee's mitigation strategy for core cooling. Drawings of the RHR system in the FSAR were reviewed and normally closed valves in the RHR system, which would require to be opened manually, were confirmed to be located inside the reactor building, but outside the primary containment boundary; so, the valves would be accessible for manual operation during an ELAP event.

On page 29 of its Integrated Plan, the licensee stated that it will establish core cooling by placing one loop of RHR into the shutdown cooling mode using electrical power provided by a 4160 VAC FLEX diesel generator from the RRC; the licensee further stated that the diesel generator will be sized sufficient to carry the loads necessary to support the Phase 3 mitigation strategy, including an RHR pump and its support equipment, including motor-operated valves, keep-fill pumps, and room coolers.

On page 35 of its Integrated Plan, the licensee addressed motive power requirements for its

CHV system by stating that power for the CHV system valve solenoids and instrumentation will be provided from a permanently installed, dedicated battery charger and dc battery source. The licensee stated that the normal power to the battery charger is from a plant ac bus and that the battery will be designed to support at least 24 hours of operation without any outside power source and that beyond 24 hours power will be supplied from a portable ac generator that will have connection to the CHV system battery charger. The licensee further stated that motive air/gas supply for CHV system operation will be adequate for at least the first 24 hours during operation under ELAP conditions and that motive air/gas for CHV system operation can be supplied from replacement bottles or a portable air compressor. On page 53 of its Integrated Plan the licensee identified 2 diesel-driven air compressors as part of the BWR portable equipment that will be available for use in Phase 2 of its containment mitigation strategy.

As described above, the licensee has discussed motive air and power requirements needed to implement its ELAP mitigation strategies; and the licensee's discussions have adequately addressed availability of electrical and pneumatic power and manual valve operation to support implementation of its proposed mitigation strategies.

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 motive power, valve controls and motive air systems if these requirements are implemented as described.

3.2.1.7 Cold Shutdown and Refueling

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

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

On pages 19 and 23 of its Integrated Plan, the licensee stated that strategies for mitigating an ELAP/LUHS event during Mode 4 (cold shutdown) and Mode 5 (refueling) will be developed; and on page 28 of its Integrated Plan, the licensee identified a related open item and stated that strategies for mitigation of an ELAP and LUHS event during cold shutdown and refueling will be developed.

The NRC staff reviewed the licensee's Integrated Plan and determined that the Generic Concern related to shutdown and refueling requirements is applicable to the plant. This Generic Concern has been resolved generically through the NRC endorsement of NEI position paper entitled "Shutdown/Refueling Modes" (ADAMS Accession No. ML13273A514); and has been endorsed by the NRC in a letter dated September 30, 2013 (ADAMS Accession No. ML13267A382).

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

During the audit, the licensee informed the NRC of Energy Northwest's plans to abide by this generic resolution.

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

3.2.1.8 Use of Portable Pumps

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

> Regardless of installed coping capability, all plants will include the ability to use portable pumps to provide RPV/RCS/SG makeup as a means to provide diverse capability beyond installed equipment. The use of portable pumps to provide RPV/RCS/SG makeup requires a transition and interaction with installed systems. For example, transitioning from RCIC to a portable FLEX pump as the source for RPV makeup requires appropriate controls on the depressurization of the RPV and injection rates to avoid extended core uncovery. Similarly, transition to a portable pump for SG makeup may require cooldown and depressurization of the SGs in advance of using the portable pump connections. Guidance should address both the proactive transition from installed equipment to portable and reactive transitions in the event installed equipment degrades or fails. Preparations for reactive use of portable equipment should not distract site resources from establishing the primary coping strategy. In some cases, in order to meet the time-sensitive required actions of the site-specific strategies, the FLEX equipment may need to be stored in its deployed position.
>
> The fuel necessary to operate the FLEX equipment needs to be assessed in the plant specific analysis to ensure sufficient quantities are available as well as to address delivery capabilities.

NEI 12-06 Section 11.2 states in part:

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

Phase 2 of the licensee's mitigation strategy includes use of on-site portable FLEX pumps to support and maintain RPV makeup and core cooling. On pages 22 through 24 of the Integrated Plan, the licensee described Columbia's primary and alternate Phase 2 core cooling strategies. In the primary strategy the licensee will continue to inject makeup water to the RPV using the RCIC system, swapping suction from the CST to the suppression pool when CST level drops below a predefined minimum level. Portable pumps will be used to replenish water inventory in the CST. The licensee stated that diverse sources of makeup water are available including, but not limited to, the service water spray ponds, the circulating water basin, and the fire protection bladder tank and that diverse pumps capable of taking suction from these sources include two installed diesel powered fire protection pumps, a pumper truck, a portable low-head diesel powered pump, and a portable high-head diesel powered pump. The licensee stated that diverse means to route water to the two CSTs include use of the installed fire protection ring

header and portable hoses. In the alternate strategy for Phase 2 core cooling, the RCIC system is not available for RPV makeup, and the licensee will use portable pumps to meet the N+1 requirement for providing RPV injection. In the alternate strategy the licensee will provide makeup water directly to the RPV through any one of the three RHR lines. Sources of makeup water will be the same as in the primary strategy with portable, diesel power pumps provided either by the pump truck or by the portable high head pump. The licensee stated that for using either RHR A or B, a blind flange is removed and a flange connector is installed to allow hoses to be connected to the RHR piping; and for using RHR C, a hanger and piping elbow are removed, and the elbow is rotated 45 degrees and reattached with a flange connector installed to allow hoses to be connected to the RHR piping. The licensee stated that the RPV must be depressurized to support the alternate RPV injection strategy.

During the audit the licensee was asked to provide additional discussion of the activities and considerations related to removing the blind flange and establishing the RPV injection path for Columbia's alternate Phase 2 core cooling strategy. In response, the licensee stated that existing procedure ABN-TSG-005, "Reactor Pressure Vessel Makeup via Pumper Truck," provides directions for supplying makeup water to the RPV using a pumper truck and hoses. The licensee stated that there are flanged connection points for the hoses on each of the three RHR loops and that any of these connections can provide a flow path to the RPV. The licensee stated that each of the three connection points has an isolation valve close to the blind flange that will be removed. The licensee stated that the isolation valves are normally locked closed and procedure requires that these valves are verified to be closed prior to removing the blind flange. The licensee stated that there is less than 18 inches of 3 inch pipe between the closed isolation valve and the blind flange and that even if there had been previous leakage past the isolation valve, any pressure in the small section of pipe would rapidly dissipate as the flange bolts are loosened, and any spillage will be minimal. The licensee stated that procedure AGN-TSG-005 provides a caution statement to personnel that such leakage may be present. The licensee stated that prior to opening the RHR isolation valves, procedure AGN-TSG-005 directs operators to slowly pressurize the hose and piping between the pumper truck and the valve to be opened and that after the RHR isolation valve is opened the flow is adjusted up to 300 gpm. The licensee stated that these actions are expected to preclude water hammer concerns.

On page 53 of the Integrated Plan in a list of portable equipment to be used during implementation of its Phase 2 mitigation strategy, the licensee listed performance criteria for the portable pumps. The licensee's listing showed that the portable pumps will be used both in the Columbia core cooling strategy and in the SFP cooling strategy. The licensee stated that the pump truck has pumping capability of 500 gpm flow at 270 psig pressure, that the high-head diesel powered pump has a capability of providing 500 gpm flow at 630 feet of water pressure; and the low-head pump has a capability of providing 1500 gpm flow at 150 feet of water pressure. The licensee did not include a technical basis or reference supporting calculations demonstrating that these pump capabilities are adequate to support its alternate core cooling strategy together with its SFP cooling strategy, considering the pressure within the RPV and the pressure losses that would occur from the pumping stations to the point of RPV injection or the pressure losses from the pumping stations to the point of SFP injection. The licensee did not describe its considerations related to the possibility of needing simultaneous implementation of its alternate core cooling strategy and SFP injection. Results of supporting analyses, when completed, should be reviewed to confirm that performance criteria specified for the licensee's portable, diesel driven pumps (pumper truck, high-head pump and low-head pump) are adequate to support their intended uses in all Phase 2 mitigation strategy scenarios. This is identified as Confirmatory Item 3.2.1.8.A in Section 4.2 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 use of portable pumps if these requirements are implemented as described.

3.2.2 Spent Fuel Pool Cooling Strategies

NEI 12-06, Table 3-1 and Appendix C summarize one acceptable approach for the SFP cooling strategies for BWRs. 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 reasonably be 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 3.2.1.6 describes SFP 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.

NEI 12-06, Section 3.2.1.6 provides the initial boundary conditions for SFP cooling.

1. All boundaries of the SFP are intact, including the liner, gates, transfer canals, etc.
2. Although sloshing may occur during a seismic event, the initial loss of SFP inventory does not preclude access to the refueling deck around the pool.
3. SFP cooling system is intact, including attached piping.
4. SFP heat load assumes the maximum design basis heat load for the site.

On page 41 of the Integrated Plan, the licensee stated that the SFP initial temperature is 125 degrees F and that the assumed heat load is 8.2E+06 Btu/hour, which is the value stated in Columbia's FSAR Table 9.2-5 and used for analysis of ultimate heat sink performance during the design basis loss of coolant accident. The licensee stated that this is the SFP heat load for a "normal refueling," and that a normal refueling does not involve a full core offload. The licensee stated that for this SFP heat load the time required from SFP water temperature to increase from 125 degrees F to 200 degrees F is greater than 24 hours and that no mitigation actions to maintain SFP cooling would be required during Phase 1 of an ELAP/LUHS event.

On page 41 of the Integrated Plan, the licensee stated that during a full core offload the heat in the SFP will be "on the order of" three times greater than that of a normal refueling and that time for SFP temperature to increase from 125 degrees F to 200 degrees F is "on the order of" 8 hours. The licensee stated that in this scenario the reliable SFP level instrumentation required by NRC Order EA 12-051 will provide an indication of level in the SFP.

On pages 41 through 46 of the Integrated Plan, the licensee stated that makeup water to the SFP can be supplied by connecting hoses to a fire protection (FP) standpipe located in either the northeast or the southwest corner of the reactor building stairwell at the 606′ elevation level, with alternate connection points available on the 572′ elevation level, and water to these standpipes would be supplied from the installed diesel-driven fire pumps. The licensee stated that, using two connections, analysis shows that water can be supplied to the SFP at a rate of approximately 500 gpm while another fire hydrant is being used for other purposes (e.g., firefighting under a B.5.b scenario). The licensee stated that an alternate method to make up water to the SFP is to use the fire protection pumper truck or high head pump, connected with hoses to the standby service water spray ponds or the circulation water basin, to pump water directly to the SFP. The licensee stated that hoses would be routed directly from the pumper truck to the reactor building northeast or southwest stairwell and up the stairs to the refuel floor and directly into the SFP. The licensee stated that with either of the methods described above, a monitor nozzle can be used to direct nozzle spray to the SFP, and that this configuration has been analyzed to be capable of providing approximately 200 gpm of makeup water to the SFP.

The licensee stated that procedures will be developed or revised to address the use of additional portable equipment such as high head and low head portable pumps and portable generators and that procedure revisions will be required to address the various combinations of water supplies and pumping capabilities. The licensee stated that procedures will be developed to address fueling the portable equipment and that any changes to EOPs will be developed in alignment with the BWROG. The licensee stated that it will use the industry developed guidance from the BWROG, EPRI, and NEI to develop site specific procedures or guidelines to address the criteria in NEI-12-06 and that these procedures and/or guidelines will support the existing symptom based command and control strategies in its current EOPs.

On pages 42 and 43 of the Integrated Plan, the licensee listed two modifications associated with its Phase 2 mitigation strategy for maintaining SFP cooling. The licensee stated that (1) SFP level monitoring instrumentation will be installed in accordance with NRC Order EA 12-051, and (2) sections of underground piping may need to be installed to facilitate the installation of hoses around obstacles such as fences.

On page 44 of the Integrated Plan, the licensee stated that water can be supplied from multiple sources at multiple connection points such as any fire hydrant, the service water spray ponds, the circulating water basin, or the fire protection bladder tank. The licensee stated that primary and alternate connection points and hose routes internal to the reactor building allow water to be supplied to the SFP.

On page 45 of the Integrated Plan, the licensee stated that the Phase 2 strategies for adding inventory to the SFP will continue to be used in Phase 3. However, the licensee stated that an evaluation of the ability of the 4160 VAC FLEX DG (from the RRC) to repower a fuel pool cooling (FPC) pump will be completed and an evaluation of the ability of the large-capacity FLEX pump (from the RRC) to provide cooling to the FPC heat exchanger will be completed.

On page 46 of the Integrated Plan, the licensee identified two open items associated with Phase 3 of its SFP mitigation strategy. The licensee stated that (1) procedural guidance will be developed to support implementation of Phase 3 SFP cooling strategies, as described above, and (2) evaluations will be completed to support implementation of Phase 3 SFP cooling strategies as described above.

The licensee's closure of the above-listed open items has potential to affect Columbia's Phase 1 and Phase 3 SFP cooling strategies. Closure of open items related to Columbia's SFP cooling strategies will need to be reviewed and evaluated to confirm that the strategies are consistent with guidance in NEI 12-06 or that the strategies are based on an acceptable alternative to the NEI 12-06 guidance. This is identified as Confirmatory Item 3.2.2.A in Section 4.2.

NEI 12-06, Appendix C, Table C-3, states that BWRs should include a plant-specific strategy to provide a vent pathway for steam and condensate from the SFP. The purpose of this vent pathway is to prevent or mitigate steam and associated condensate from a boiling SFP from causing access and equipment problems in other parts of the plant. The licensee's Integrated Plan did not document any consideration of this NEI 12-06 guidance.

During the audit, the licensee was asked to describe whether Columbia's strategy includes a vent path from the SFP, or any other mitigation strategy, to prevent steam and condensate from the SFP from entering other parts of the plant. In response, the licensee stated that GOTHIC analyses of the Reactor building are in progress to determine environmental conditions that are likely to exist during an ELAP event and that those analyses will include evaluation of the refueling floor temperature and humidity conditions as a function of time. The licensee stated that heat up and boiling of the SFP will be specifically considered, and mitigation actions will be developed to assure required access and equipment operability. The licensee stated that results of its GOTHIC analyses will be reported in the August 2014 update of its Integrated Plan. When the GOTHIC analyses are completed and actions based on the results are fully developed, additional review will be needed to confirm that the licensee's strategy for venting of the refueling floor is consistent with guidance in NEI 12-06 or provides an acceptable alternative to that guidance. This is identified as Confirmatory Item 3.2.2.B in Section 4.2.

NEI 12-06, Section 3.2.1.6, item 4, states that the SFP heat load is assumed to be the maximum design basis heat load for the site. The licensee stated that using the "normal refueling" SFP heat load value of 8.2E+06 Btu/hour from Columbia's FSAR Table 9.2-5 provides greater than 24 hours for SFP pool temperature to increase from 125 degrees F to 200 degrees F, if the ELAP is assumed to occur at 0 hours. The licensee stated that during a full core offload the heat from the SFP will be "on the order of" three times greater than that of a normal refueling and that time for SFP temperature to increase from 125 degrees F to 200 degrees F is "on the order of" 8 hours. The licensee did not clearly state which, if either, of these SFP heat loads is the maximum design basis heat load as described in NEI 12-06, Section 3.2.1.6, item 4. In addition, the licensee's discussion of the heat load associated with full-core off-load implies that SFP time-to-boil calculations have not been completed for the full-core off-load case.

During the audit, the licensee was requested to provide additional information to clarify these uncertainties. In response, the licensee stated that FSAR Table 9.1-5 specifies the design basis heat load for the fuel pool cooling system of 8.0 MBtu/hr and that a conservatively high heat load of 8.2 MBtu/hr was used in the Ultimate Heat Sink analyses, as documented in FSAR Table 9.2-5, and will be used in calculations supporting Columbia's Integrated Plan. The licensee stated that for a full core off-load, FSAR Table 9.1-5 shows a maximum heat load of 44.3 MBtu/hr with both the recently off-loaded and previously discharged fuel assemblies in the

SFP. The licensee stated that the SFP section of its Integrated Plan will be updated to reflect actions taken in the event of full core offload to the SFP and that GOTHIC analyses are being performed to determine the ambient conditions in the refueling floor area, that those analyses will include the heatup rate of SFP, and results of the GOTHIC analyses will be reported in the August 2014 update of its Integrated Plan. Actions to be taken by the licensee in the event of an ELAP occurring when a full core offload is in the SFP should be reviewed when they are documented in the Integrated Plan update to confirm that the proposed actions are adequate to maintain satisfactory SFP cooling. This is identified as Confirmatory Item 3.2.2.C in Section 4.2.

During the audit, the licensee was asked to discuss the flow rate capacities of water supplies to the SFP for makeup and to provide justification for the stated flow rates, considering heat-up and boil-off rates of the SFP at different conditions. In response, the licensee stated that for a full-core offload, FSAR Table 9.1-5 shows that the maximum heat load would be 44.3 MBtu/hr with both the recently off-loaded and previously discharged fuel assemblies in the SFP. The licensee stated that with makeup water at 90 degrees F and boiling at 14.7 psia, the required makeup flow rate is 81 gpm for the full core off-load case. The licensee stated that for the case without a full core off-load, the required makeup water flow rate is 15 gpm and that a make-up rate of approximately 200 gpm can be provided, as stated on page 41 of the Integrated Plan.

NEI 12-06, Table 3-1, includes an SFP makeup strategy using portable injection sources through connection to SFP makeup piping or other suitable means, and Table C-3 expands on this recommendation by stating that the purpose or this strategy is to provide a means to supply SFP makeup without accessing the refueling floor. The licensee's description of Columbia's SFP makeup strategies appear to require directing flow from a hose to the pool by accessing the refueling floor. The licensee should provide clarification of whether Columbia's SFP makeup strategy includes provisions for providing SFP makeup without accessing the refueling floor, as recommended in NEI 12-06, Table 3-1 and Table C-3. This is identified as Confirmatory Item 3.2.2.D in Section 4.2.

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

3.2.3 Containment Functions Strategies

NEI 12-06, Table 3-1 and Appendix C, provide a description of the safety functions and performance attributes for BWR containments which are to be maintained during an ELAP as defined by Order EA-12-049. The safety function applicable to Columbia (a BWR with a Mark II containment) listed in Table 3-1 is Containment Pressure Control/Heat Removal, and the method cited for accomplishing this safety function is Containment Venting or Alternative Containment Heat Removal. Furthermore, the performance attributes listed in Table C-2 denote the containment's function is to provide a reliable means to assure containment heat removal. JLD-ISG-2012-01, Section 5.1 is aligned with this position stating, in part, that the goal of this strategy is to relieve pressure from the containment.

On pages 32 through 38 of the Integrated Plan, the licensee described Columbia's Phase 1, 2 and 3 mitigation strategies for maintaining containment during an ELAP/LUHS event. Columbia's strategy is based on venting the primary containment through a reliable hardened vent that implements the changes described in NRC Order EA 13-109. This order requires

BWR Mark I and Mark II containments to have a reliable hardened vent to remove decay heat and maintain control of containment pressure within acceptable limits following events that result in the loss of active containment heat removal capability or prolonged Station Blackout (SBO).

The licensee described Columbia's containment mitigation strategy on pages 32 through 38 of its Integrated Plan. The licensee stated that containment Pressure Suppression Pressure (PSP) and Heat Capacity Temperature Limit (HCTL) limits in the EOPs require emergency depressurization of the RPV when limits are exceeded, and that emergency depressurization will terminate RCIC operation. The licensee stated that if emergency depressurization is required and RCIC is the only available RPV injection source, then the operator will emergency depressurize but stop the depressurization at approximately 100 psig to maintain a steam supply to the RCIC turbine. The licensee stated that within approximately 45 minutes following event initiation, the Operator will make a determination as to whether or not restoration of ac power is likely to occur and will transition from SBO procedures to ELAP procedures to perform additional actions including venting the containment by opening the vent valves for the containment hardened vent system. The licensee stated that venting in accordance with the override allowed by Revision 3 of the BWROG Emergency Procedure Guidelines/Severe Accident Guidelines (EPG/SAG) using the containment hardened vent will relieve primary containment pressure, control suppression pool water temperature, and enable continued cooling of the reactor using the RCIC system.

However, in the audit process, the licensee proposed a new strategy for removing heat from containment following an ELAP event. Energy Northwest stated that Columbia intends to use existing ductwork to provide a vent path from the wetwell to remove heat. The licensee's evaluation of this new strategy is still in progress. The licensee stated that a calculation has been prepared which shows that the vent of the containment exhaust purge (CEP) system can be used to remove heat from the wetwell and the reactor building exhaust air ductwork integrity will be maintained. The licensee further stated that venting needs to commence not later than 6 hours following the ELAP event. The licensee stated that it will need to confirm that the CEP piping line-up can be achieved by the staff available during the first 6 hours because implementation of this strategy requires the manual manipulation of 5 air-operated valves and one damper.

Tables 3-1 and C-2 of NEI 12-06 both specify that, for BWRs with Mark I and Mark II containments, the reliable, hardened vent of Order EA-12-050 is the Baseline Capability standard and that the venting capability for these containments must credit, at a minimum, the changes associated with Order EA-12-050. Although Order EA-12-050 has been rescinded and replaced by Order EA-13-109, the technical requirements of the reliable, hardened vent have been upgraded to support severe accident conditions, not relaxed to allow the use of ductwork.

Order EA-12-050 required licensees to design the Hardened Containment Vent System (HCVS) to minimize the reliance on operator actions, to be accessible to plant operators, to be capable of remote operation and control, or manual operation, during sustained operations, and to withstand pressures that were consistent with the maximum containment design pressure as well as dynamic loading resulting from system actuation. Furthermore, the Interim Staff Guidance document, Compliance with Order EA-12-050, Reliable Hardened Containment Vents, JLD-ISG-2012-02, specifically stated that the HCVS was to be designed leak-tight. Requirement 1.1.3, Staff Position paragraph 2 states, in part, "As such, ventilation duct work (i.e., sheet metal) shall not be utilized in the design of the HCVS." Order EA-12-050 also required several upgrades to instrumentation, radiation monitoring requirements, and quality

standards for the newly installed equipment.

The licensee's proposed strategy appears to be in contrast to the requirements and intent of the original Order EA-12-050 HCVS which was incorporated into the NEI 12-06 guidance strategies for Mark I and Mark II containments. Several of the technical and operational considerations of Order EA-12-050 are not addressed by the information provided thus far by the licensee.

The following issues related to Columbia's strategy for maintaining containment during an ELAP/LUHS are noted:

1. The licensee is proposing venting in accordance with the override allowed by Revision 3 of the BWROG EPG/SAGs as part of its mitigation strategy.

   The NRC staff considers the adoption of Revision 3 to the BWROG Emergency Procedure Guidelines (EPG)/Severe Accident Guidelines (SAG) by licensees to be a Generic Concern (and thus an open item for the licensee) because the BWROG has not addressed the potential for the revised venting strategy to increase (relative to currently accepted venting strategies) the likelihood of detrimental effects on containment response for events in which the venting strategy is invoked. In particular it has not been shown that the potential for negative pressure transients, hydrogen combustion, or loss of containment overpressure (as needed for pump NPSH) is not significantly different when implementing Revision 3 of the EPG/SAG vs. Revision 2 of the EPG/SAG. Revision 3 provides for earlier venting than previous revisions. The BWR procedures are structured such that the new venting strategy is not limited to use during the BDBEEs that are the subject of EA-12-049, but could also be implemented during a broad range of events. Acceptance of EPG/SAG Revision 3, including any associated plant-specific evaluations, has been identified as Open Item 3.2.3.A in Section 4.1.

2. The licensee's proposed strategy for maintaining containment appears to be in contrast to the requirements and intent of the original Order EA-12-050 HCVS which was incorporated into the NEI 12-06 guidance strategies for Mark I and Mark II containments. Several of the technical and operational considerations of Order EA-12-050 are not addressed by the information provided by the licensee, and the proposed strategy, as a whole, may not be acceptable to the NRC staff. This is identified as Open Item 3.2.3.B in Section 4.1.

The licensee's approach described above, as currently understood, has raised concerns which must be addressed before confirmation can be provided that the approach is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, such that there would be reasonable assurance that requirements of Order EA-12-049 will be met with respect to containment functions strategies. These concerns are identified as Open Items 3.2.3.A and 3.2.3.B in Section 4.1.

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.

The licensee did not provide a discussion of equipment cooling in the Integrated Plan. The licensee did identify the potential need for compensatory measures to promote room cooling. The licensee's information regarding compensatory measures to promote room cooling is included in Section 3.2.4.2, later in this evaluation.

On page 53 of the Integrated Plan, the licensee provided a list of portable equipment that it expects to use in Phase 2 of its mitigation strategies. This list includes a pumper truck, a high head diesel powered pump, a low head diesel powered pump, two 480 VAC diesel generators, two diesel driven air compressors, gasoline powered fuel transfer pumps, and two vehicles. In addition, the licensee stated that it expects to obtain a 4160 VAC diesel generator and large-capacity pump(s) from the regional response center to support its Phase 3 mitigation strategies. Most of this equipment would require some form of cooling. However, except for the large equipment obtained from the RRC, the listed equipment is typical of commercially available units and would not be expected to require an external cooling system, nor would it require ac power or normal access to the UHS. For the larger equipment from the RRC a need for external cooling, if required, is expected to be identified as Columbia's mitigation strategies are further developed.

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

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 [auxiliary feedwater] AFW pump room, HPCI and RCIC pump rooms, 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 HPCI, RCIC, and 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.
>
> Temperatures in the HPCI pump room and/or steam tunnel for a BWR may reach levels which isolate HPCI or RCIC steam lines. Supplemental air flow or the capability to override the isolation feature may be necessary at some plants. The procedures/guidance should identify the corrective action required, if necessary.
>
> Actuation setpoints for fire protection systems are typically at 165-180°F. It is expected that temperature rises due to loss of ventilation/cooling during an ELAP/LUHS will not be sufficiently high to initiate actuation of fire protection systems. If lower fire protection system setpoints are used or temperatures are expected to exceed these temperatures during an ELAP/LUHS, procedures/guidance should identify actions to avoid such inadvertent actuations or the plant should ensure that actuation does not impact long term operation of the equipment.

The licensee provided considerations related to ventilation or room cooling at several locations in its Integrated Plan.

On page 17 of the Integrated Plan, the licensee stated that the operator will initiate compensatory measures to limit control room temperatures and promote cooling, that compensatory measures will be taken to maximize RCIC room cooling, and that RCIC trips on high area temperature, high area differential temperature, and high exhaust pressure will be bypassed to ensure continued RCIC operation. The sequence events timeline on page 54 of the Integrated Plan shows that the action to promote main control room cooling will be initiated between 5 and 30 minutes after start of the ELAP. On page 55 of its Integrated Plan the licensee stated that the timeline for bypassing RCIC trips is "TBD" (to be determined) and that selected RCIC trips are bypassed per the existing SBO procedures and that generally this action is completed within 30 minutes of start of the event. The licensee further stated that additional RCIC trips will be bypassed consistent with BWR Owners Group recommendations and that completion of MAAP and GOTHIC analyses will determine the timing of when this action must be completed. On page 56 of its Integrated Plan, the licensee stated that the timing to perform actions to promote RCIC room cooling is to be determined. The licensee further stated that actions to open doors to the RCIC pump room, building stairwells, and other areas in

the reactor building are expected to be necessary to provide added ventilation for the RCIC pump room and that GOTHIC analyses are in progress to confirm effectiveness and timing.

On page 19 of its Integrated Plan, the licensee discussed procedure development. The licensee stated that procedure(s) will be developed identifying the actions to be taken when an ELAP event occurs and that Operators will transition from the SBO procedure to the ELAP procedure once the determination is made that restoration of AC power is not likely to occur within the 4 hour licensing basis for the SBO. The licensee stated that the ELAP procedure will contain guidance for additional load shedding of station batteries, bypassing additional RCIC trips, venting the containment using the containment hardened vent, and implementing any additional compensatory measures to promote cooling in required areas of the Reactor Building, Control Room, and critical switchgear areas.

On page 29 of its Integrated Plan, the licensee identified that an RHR room cooler and its supporting equipment will be needed to support implementation of its Phase 3 mitigation strategy for core cooling.

On page 49 of its Integrated Plan, the licensee discussed potential need for cooling fans in its Phase 2 mitigation strategy. The licensee stated that the results of GOTHIC modeling of the heat up of key rooms and areas during the ELAP will determine the Phase 2 equipment and strategies and that when the heat load calculations are completed, portable generators will be identified to support cooling fan operation in the key areas of the plant as needed.

On page 52 of its Integrated Plan, the licensee listed an open item to complete evaluation of the conditions of the RHR pump rooms under an ELAP event and determine whether additional actions are needed to remove heat from the rooms prior to and during operation of the pump.

During the audit the licensee was asked to provide a discussion of battery room ventilation to prevent hydrogen accumulation while recharging the batteries in Phases 2 and 3 of its mitigation actions. In response to this request the licensee stated that Columbia's batteries are of the calcium flat plate design that generate much less hydrogen than antimony plate batteries when being recharged or on float voltage. The licensee stated that GOTHIC analyses of the Vital Island will evaluate hydrogen generation in the battery rooms and that the results of those analyses will determine the need, if any, for measures needed to control hydrogen concentrations in the battery rooms. The licensee stated that results are expected to be completed such that they will be reported in the February 2014 update of its Integrated Plan.

The licensee also was asked whether a potential need for forced ventilation of the refueling floor has been considered in Columbia's mitigation strategies. In response to this request the licensee stated that GOTHIC analyses are being done to determine the extent of actions required to control ambient conditions on the refueling floor and that results of the GOTHIC analyses will be reported in the August 2014 update of the Integrated Plan.

The licensee was asked to provide a summary of the analyses and technical evaluations performed to demonstrate the adequacy of the ventilation provided in the RCIC room and other vital areas to support equipment operation throughout all phases of an ELAP; the licensee also was asked to provide information on the adequacy of the ventilation provided in the battery room to protect the batteries from the effects of extreme high and low temperatures. In response to these requests the licensee stated that GOTHIC analyses for these areas and rooms are currently in progress and results will be reported in the August 2014 update of Columbia's Integrated Plan.

Comparison of the licensee's descriptions against the guidance in NEI 12-06, Section 3.2.2, Guideline (10), finds that the licensee's considerations generally conform to the guidance related to the loss of ventilation during an ELAP event as contained in NEI 12-06. However, results of the licensee's analyses to determine what measures are needed to control hydrogen concentrations in the battery room and to evaluate the need for forced ventilation on the refueling floor should be reviewed when they become available. This is identified as Confirmatory Item 3.2.4.2.A in Section 4.2. Also, results of GOTHIC analyses that include consideration of RCIC room, SFP area, and battery room temperatures should be reviewed when the analyses are completed and results are available. 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 the successful closure of issues related to the Confirmatory Items, and 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.

The licensee's Integrated Plan does not contain specific mention of heat tracing; however, considerations related to cold weather protection than might be addressed by use of heat tracing are included.

On page 6 its Integrated Plan the licensee stated that equipment will be procured to function in the cold weather conditions applicable to Columbia and will be maintained within a temperature range to ensure it will function when called upon. The licensee further stated that under extreme cold conditions coincident with the ELAP, the surface of the service water spray ponds and circulating water basin could freeze and that actions will be developed to ensure the continued availability of the water inventory from these sources. The licensee also stated that actions will be developed to thaw any frozen service water piping that will be required in Phase 3.

On page 7 of its Integrated Plan, the licensee identified an open item to develop actions to ensure the continued availability of the water inventory sources from the service water ponds and circulating water basin in cold weather and to thaw any frozen SW piping that will be

required in Phase 3.

On page 26 of its Integrated Plan, the licensee stated that the FLEX buildings will have an environmentally-controlled area equipped with an HVAC system to maintain the proper environment to ensure that the portable equipment stored therein will function when required. The licensee also stated that currently it is not planned to store large, diesel-powered equipment in the environmentally controlled area but that this equipment will include block heaters for cold weather starts.

During the audit the licensee was asked to describe Columbia's considerations related to the potential for loss of heat tracing in an ELAP event, as discussed in NEI 12-06, Section 3.2.2, Guideline (12). In response the licensee stated that Energy Northwest will address Columbia's conformance to the NEI guidance in the licensee's Integrated Plan update submittal no later than August 28, 2014. This is identified as Confirmatory Item 3.2.4.3.A in Section 4.1.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01 and, subject to the successful closure of issues related to the 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 18 of its Integrated Plan, the licensee stated that a sound powered phone system is used to maintain communication between personnel in the control room and personnel in the plant. The licensee stated that procedures and supplies currently exist and are staged to allow RCIC to be started locally in the event there is no ac or dc power available. It is reasonable to assume that portable lighting and procedures for its use are included in the supplies currently staged for a RCIC "black start."

During the audit the licensee was asked to provide more detailed information about use of portable lighting and the time for which installed backup, battery powered lighting might remain available. In response to this request, the licensee stated that the standard equipment carried by operators with duties in the plant (i.e., outside the main control room) includes flashlights and the requirement to carry flashlights is currently specified in the procedure for equipment operator rounds and will be added to the procedure for operating policies, programs and practices. The licensee stated that lighting in the main control room would be maintained

throughout the event by the dc powered control room emergency lighting system.

In its response the licensee also provided additional information related to its communications system. The licensee stated that its method of communication was described in its letter dated October 30, 2012, (ADAMS Accession No. ML12319A079) in response to an information request related to "Emergency Preparedness Communications." The NRC staff reviewed the October 30, 2012 assessment, and determined that the licensee's communications assessment was reasonable, and that the interim measures and proposed enhancements will help to ensure that communications are maintained. The NRC's safety assessment is documented in a letter dated April 11, 2013, "Columbia Generating Station – Safety assessment in Response to Information Request Pursuant to 10 CFR 50.54(f) – Recommendation 9.3 Communications Assessment" (ADAMS Accession No. ML13091A295). This is identified as Confirmatory Item 3.2.4.4.A, in Section 4.2 below for confirmation that upgrades to the site's communications systems have been completed.

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, and 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) provides that:

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

On page 17 of its Integrated Plan, the licensee stated that its station blackout procedure currently contains guidance for security actions to address the loss of power to security doors. It is reasonable to assume that guidance for access to the protected area is also included or will be developed.

During the audit the licensee was asked to clarify whether its strategy includes provisions for gaining entry to the protected area when no ac power is available. In response to this question, the licensee stated that the Columbia Security organization has procedures for loss of all ac power that include gaining entry into the protected area.

The licensee provided information in its Integrated Plan and in its response to an audit question sufficient to conclude that its plans conform to the recommendations in NEI 12-06, Section 3.2.2, Guideline (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 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) provides that:

> *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.

The licensee's Integrated Plan contains relatively little information about considerations of personnel habitability conditions in specific buildings, areas or rooms where operator or support personnel may be required to perform mitigation actions. It is recognized that all of the details of a flexible strategy cannot be pre-planned, and that awareness of a changing situation ultimately determine the correct actions to take.

On page 10 its Integrated Plan, the licensee stated that areas of the plant requiring access by personnel will be evaluated to ensure conditions will support the actions; and on page 11 the licensee identified an open item, stating that GOTHIC calculations will evaluate the effects of a loss of HVAC on the plant response and an evaluation of the GOTHIC results on equipment qualification will be performed. The licensee also stated that areas of the plant requiring access by personnel will be evaluated to ensure conditions will support the actions.

On page 15 of its Integrated Plan, the licensee stated that training on mitigation of BDB events will be developed and maintained in accordance with the Systematic Approach to Training. The licensee stated that periodic training will be provided to site emergency response leaders on BDB emergency response strategies and implementing guidelines and that emergency response leaders are the emergency response personnel assigned leadership roles, as defined by the Columbia Emergency Plan, for managing emergency responses to design basis and BDB plant emergencies. The licensee also stated that personnel assigned to direct execution of the mitigation strategies for BDB events will receive the necessary training to ensure familiarity with the associated tasks.

On page 16 of its Integrated Plan, the licensee identified open items to provide training to site emergency response leaders on BDB emergency response strategies and implementing guidelines, and to provide training to personnel assigned to direct execution of the mitigation strategies for BDB events to ensure familiarity with the associated tasks.

During the audit the licensee was asked to discuss potential lighting and habitability issues that might affect the licensee's Phase 2 alternate core cooling strategy which involves removal, replacement, and reconfiguration of several RHR system flanges and piping elbows during the ELAP event. In response to this request the licensee stated that connection to the RHR cross-tie flanges (RHR-V-63/A/B/C), including access, route and lighting, will be similar to that currently used in its B.5.b procedure ABN-TSG-005. The licensee stated that RHR-V-63B is located immediately inside a high radiation room, and RHR-V-63A and 63C are located in locked high radiation rooms, near the door. The licensee stated that new procedures will require the operator to obtain keys necessary for access, similar to current procedure ABN-TSG-005. The licensee also stated that operability habitability will be evaluated against the Reactor Building GOTHIC model room temperature results, which is currently in progress.

Information provided in the licensee's Integrated Plan is generally consistent with guidance in NEI 12-06, Section 3.2.2, Guideline (11). However, because analyses addressing personnel habitability issues are still in progress and procedures providing more detailed instructions for some mitigation actions are still under development, the licensee's Integrated Plan did not include sufficient information to conclude that it conforms to the guidance in NEI 12-06, Section 3.2.2, Guideline (11) or provides an acceptable alternative to that guidance. This is identified as Confirmatory Item 3.2.4.6.A in Section 4.2.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01 and, subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to personnel habitability – 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 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 [condensate storage tanks] 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 licensee provided a description of Columbia's strategies to maintain core cooling on pages 17 through 31 of its Integrated Plan.

In Columbia's primary strategy, the initial source of cooling water is from the CST, with the CST water injected by the RCIC system. This is part of the normal RCIC system alignment and function. The alternate water source for the RCIC pump suction is the suppression pool, which is a seismically robust, Class I structure. The turbine-driven RCIC pump is driven by decay steam from the reactor and is designed to auto-start on low level (Level 2) to maintain reactor RPV water level. RCIC does not require ac power to operate and is currently credited in Columbia's station blackout procedures. The RCIC turbine can be manually started by operator actions in the main control room or from a location outside the main control room. The licensee stated that procedures and supplies currently exist and are staged to allow RCIC to be started locally [i.e., in the RCIC pump room] in the event there is no ac or dc power available.

Water inventory in the CST will be depleted as RCIC injection continues, and when water level in the CST drops below a predefined minimum level, RCIC suction will be swapped to the suppression pool. The RCIC system is described in Columbia's FSAR Section 5.4.6 which states that there is an automatic switch over to the suppression pool as the water source for the RCIC pump. The FSAR states that this automatic switchover feature for RCIC consists of two Class 1E level switches mounted on a standpipe in the pump suction line and that the standpipe is designed, fabricated and installed to Seismic Category I, Quality Class I, and ASME Section III, Class 2 standards. The licensee stated that portable equipment will be required to replenish the water inventory in the CST. The licensee stated that CST inventory can be made up with water from the standby service water spray ponds, the circulating water basin, or an FP bladder tank and that diverse pumping sources are available from two installed diesel powered fire pumps, a pumper truck, a portable low-head diesel powered pump, and a portable high-head diesel powered pump. The licensee stated that its strategy of utilizing the circulating water basin, the standby service water spray ponds, or the fire protection bladder tank limits the amount of debris, such as river grass, that could be transferred into the reactor pressure vessel.

In the event that RCIC becomes unavailable, injection to the reactor vessel will be accomplished by portable diesel powered pumps. This injection strategy will require the reactor to be fully depressurized; and the potential sources for water injected to the vessel are the same as described above.

During the audit, the licensee was asked whether Columbia's CST is qualified for all potential ELAP-related external events and to provide additional discussion of the instrumentation to switch RCIC suction from the CST to the suppression pool. In response, the licensee stated that Columbia's CSTs are two steel tanks, 45 feet in diameter and 35 feet high connected in parallel. The licensee stated that the tanks are located adjacent to each other and are enclosed in and protected by a seismically designed retaining concrete structure. The licensee stated that the tanks are built to augmented Seismic Class II standards and designed, fabricated, and tested to ASME Code Section III, subsection ND-3800 requirements. The licensee stated that the Seismic Category II CSTs are located inside an 18 foot high Seismic Category I concrete

wall which is designed to retain the fluid from both tanks and that the concrete retaining wall provides protection against high winds and tornado missiles but the top portion of the metal tanks remains exposed. The licensee stated that Columbia screens out of tornado risks in accordance with NEI 12-06, Section 7.2.1, and that based Columbia's latitude and longitude the recommended tornado design wind for Columbia is 127 miles per hour for a 10^{-6} per year probability level. The licensee noted that NEI 12-06, Section 7.2.1 states that tornado with the capacity to do significant damage are generally considered to be those with winds about 130 miles per hour. The licensee summarized qualification of its CSTs by stating that although the CST metal tanks are provided with significant protection against high winds and missiles and are seismic Category II, the tanks are not considered to be qualified for all potential ELAP-related external events, but that RCIC suction from the suppression pool will remain available.

With regard to CST level instrumentation, the licensee stated that upon reaching CST low level indication on the redundant, safety related level switches (RCIC-LS-15A/B), automatic switch-over of RCIC suction to the suppression pool occurs, without interruption of RPV injection. The licensee stated that the redundant level transmitters for this function are fail-safe, located in the Reactor Building inside the RHR-C pump room and are protected from potential ELAP events including seismic, tornado/high winds, flooding and missiles. The licensee stated that automatic switchover is assured if the CST water volume is not available.

During the audit the licensee provided additional information about the preferred water sources for its mitigation strategy. The licensee stated that the preferred water source is from the CST, but if that is not available the water in the suppression pool will next be used. The licensee stated that the preferred source of makeup to the CST or the suppression pool is via the fire protection system, but that if the fire protection system is not available hoses can be run from the spray pond or the circulating water basin to the CST or to the RHR system (for injection into the RPV or the suppression pool) using a pumper truck or a portable high head diesel pump. The licensee stated that the water sources are listed in order of declining operational preference when considering both water quality and ease of access.

The information contained in the licensee's Integrated Plan and in the licensee's response to audit questions conforms 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 provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to water sources if these requirements are implemented as described.

3.2.4.8 Electrical Power Sources/Isolations and Interactions

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

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

The licensee's Integrated Plan provides limited discussion related to electrical isolation and protection that may be needed to support use of portable generators or other electrical equipment.

On page 23 of its Integrated Plan, the licensee stated that in Phase 2 of its mitigation strategy

the DG4 hookup and requisite switching within the electrical distribution system is estimated to take four hours to accomplish. The licensee also stated that alternate connection points to the electrical distribution system will be identified and installed and that a cross-connect will be provided between the Division 1 and 2 480 VAC buses to allow repowering key instrumentation on Division 2.

On pages 24 and 25 of its Integrated Plan, the licensee identified two proposed modifications that support the connection points and cross-connect described above; and on pages 27 and 30 these are included in the lists of “deployment conceptual modifications.”

On page 29 of its Integrated Plan, the licensee described its Phase 3 strategy to use a portable 4160 VAC portable DG from the RRC to provide power to an RHR pump and support equipment so that long-term core cooling can be established by placing one loop of RHR into the shutdown cooling mode.

During the audit the licensee was asked to describe how electrical isolation will be maintained so that (a) Class 1E equipment is protected from faults in portable/FLEX equipment, and (b) multiple sources do not attempt to power electrical buses.

In response to part (a) of these requests, the licensee stated that at the onset of the ELAP, the Class 1E emergency DGs are assumed to be unavailable to supply the Class 1E buses and that portable diesel generators would be used in response to an ELAP in FLEX strategies for Phases 2 and 3. The licensee also stated that portable DGs will have adequate overcurrent protection when connected to Class 1E equipment and that existing protective features for the Class 1E loads will not be affected.

In response to part (b) of the audit question, the licensee stated that at the point when ELAP mitigation activities require tie-in of FLEX diesel generators, in addition to existing electrical interlocks, procedural controls, such as inhibiting DG start circuits and breaker rack-outs, will be employed to prevent simultaneous connection of both the FLEX DGs and the Class 1E DGs to the same ac distribution system or component. The licensee stated that FLEX strategies, including the transition from installed sources to portable sources (and vice versa), will be addressed in the FLEX procedures.

During the audit the licensee was asked to provide a summary of the sizing calculations for the FLEX DGs to show that they can supply the loads assumed in Phase 2 and Phase 3 of Columbia’s mitigation strategy. In response to this request the licensee stated that finalization of the sizing calculation for the FLEX DGs for Phase 2 and Phase 3 is not complete and that completion of this activity is necessary to provide a comprehensive response to the question. The licensee stated that Energy Northwest anticipates that this information will be submitted in the February 2014 update to Columbia’s Integrated Plan. This is identified as Confirmatory Item 3.2.4.8.A in Section 4.2

During the audit the licensee was asked to provide single-line diagrams showing the proposed connections of Phase 2 and Phase 3 electrical equipment and showing protection information (e.g., breaker, relay, or fuse) and rating for the equipment used. The licensee provided single-line electrical diagrams as requested.

Based on information in the licensee’s Integrated Plan describing use of portable DGs to charge batteries and locally energize equipment and on the licensee’s response to audit questions discussing its provisions and procedures to ensure appropriate electrical separation and

isolation between the portable and the permanently installed diesel generators, and describing current status of the diesel generator sizing and requirements calculations, the licensee has provided reasonable assurance that its plan conforms to the recommendations in NEI 12-06, Section 3.2.2, Guideline (13).

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 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, consideration (5) states:

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

On page 9 of the Integrated Plan, the licensee stated that fuel for the diesel powered FLEX equipment is primarily stored in the underground diesel fuel storage tanks and that fuel for gasoline powered FLEX equipment is stored in an above ground fuel tank and other smaller containers. The licensee stated that the designs of the fuel storage tanks and containers will be verified to be robust with respect to seismic events, floods and high winds and that additional above-ground storage and transport capability will be added if necessary.

On page 23 of the Integrated Plan, the licensee stated that fuel consumption and supply requirements for the portable equipment used in response to an ELAP and LUHS have been evaluated in order to identify sources of stored fuel, fuel transfer strategies, and estimated timing. The licensee stated that Columbia will use a combination of diesel and gasoline powered equipment and that diverse sources of diesel fuel are available including the three underground diesel storage tanks for the EDGs and an underground auxiliary boiler storage tank. The licensee stated that each diesel driven fire pump has a diesel fuel tank located adjacent to the engine. The licensee stated that sources of gasoline include an above ground fuel tank and that currently one gasoline powered transfer pump and a set of equipment for transferring fuel from the tanks are available. The licensee stated that additional pumps and equipment will be procured to provide the required N+1 capability. The licensee stated that portable trailers, tanks, carts and/or cans will be available for use and that vehicles to refuel and deploy the FLEX equipment will be available on site.

On page 24 of the Integrated Plan, the licensee stated that procedures will be developed to address fueling the portable equipment.

On page 28 of the Integrated Plan, the licensee identified an open item related to fuel supply which states that an evaluation will be completed to ensure a diverse supply of fuel is available

and maintained, and diverse means will be provided for refueling the portable equipment.

On page 53 of the Integrated Plan, the licensee's list of BWR portable equipment for Phase 2 includes gasoline-powered fuel transfer pumps.

The licensee is crediting existing underground diesel fuel storage tanks and an existing above ground gasoline storage tank as the initial sources of its fuel supply for portable equipment. The licensee stated that the designs will be verified to be robust with respect to seismic events, floods and high winds. However, the licensee's Integrated Plan did not provide information about whether these existing tanks are Seismic Category I or Seismic Category II components or whether the tanks are protected against missiles potentially generated by high winds.

During the audit, the licensee was asked to provide additional information clarifying the seismic classification of the diesel and gasoline fuel storage tanks and to explain how the tanks will be confirmed to be robust with regard to seismic events or high winds with associated missiles. In response, the licensee stated that diverse sources of diesel fuel are available including three underground seismic Category I diesel storage tanks, two for the emergency diesel generators and one for the HPCS diesel generator. The licensee stated that the procedural minimum capacity for these tanks is (a) 55,000 gallons for the Division 1 EDG tank; (b) 57,780 gallons for the Division 2 EDG tank; and (c) 33,000 gallons for the HPCS DG. The licensee stated that in addition to the credited safety related Seismic Category I underground diesel generator tanks, the 33,000 gallon underground diesel fuel tank for the auxiliary boiler may also be available. The licensee stated that gasoline will be used to power small supporting tools and components, especially those with low temperature sensitivity for starting and that the preferred operational source will be an above ground gasoline tank. The licensee stated that a storage facility will be provided as a backup with a currently estimated capacity of four 55 gallon drums of gasoline with a hand transfer pump and that at least one storage facility will be qualified for non-coincident seismic, flooding, and high wind (including missiles) event.

The licensee stated that, operationally, the preferred source of diesel fuel is the above ground tank used for station vehicles, but that this tank is not missile-protected and the seismic qualification of the tank is under review. The licensee stated that if this tank is unavailable, the buried underground Seismic Category I storage tanks will be available and that these tanks can be accessed from within the protected area. The licensee also stated gasoline will fuel minor portable equipment, such as diesel fuel lift pumps and portable lighting stanchions, to support the main equipment. The licensee stated that its method for determining robustness will be described in the February 2014 update to its Integrated Plan.

During the audit, the licensee was asked to describe its plans for supplying fuel to FLEX equipment and to explain how fuel quality will be assured if fuel is stored for extended periods of time. In response, the licensee stated that the fuel transfer pumps and suction hoses will be used to extract fuel from storage tanks into portable transport containers such as trailer-mounted fuel tanks, mobile fuel carts and/or gas cans. The licensee stated that primary access roads will be cleared and used for fuel vehicle distribution routes and that in the event these pathways are inaccessible, the mobile hand-carts and fuel cans will be used to manually transport fuel to FLEX equipment. The licensee stated that plant diesel fuel tanks are routinely sampled for fuel quality in accordance with Technical Specification Requirements and existing procedures. The licensee stated that Columbia's gasoline fuel tanks are not tested for fuel quality due to high consumption rate and that the above ground gasoline tank is replenished with approximately 1200-1500 gallons on a bi-weekly basis.

Based on the information in its Integrated Plan and additional information in its response to an audit question, the licensee is providing reasonable considerations of issues related to refueling gasoline and diesel powered equipment used by portable equipment to implement Columbia's mitigation strategies. This conforms to the recommendations in NEI 12-06, Section 3.2.2, Guideline (13), and in NEI 12-06, Section 3.2.1.3, 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 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.

In several sections of its Integrated Plan, the licensee described an intention to conserve or enhance dc power availability by stripping loads from existing battery arrays or, potentially, installing additional battery arrays. Examples are on pages 12, 17-19, 22, 32, 35, 54, 56, and 58 of the licensee's Integrated Plan.

On page 22 of its Integrated Plan, the licensee stated that the 125 volt batteries are available for 10 hours without recharging and the 250 volt batteries are available for 17 hours without recharging. On page 35 of its Integrated Plan, the licensee stated that the battery for the CHV system valve solenoids and instrumentation will be designed to support at least 24 hours of operation without any outside power source.

During the audit the licensee was asked to provide additional information related to its dc power sources and plans for battery load reduction.

The licensee was asked to provide the direct current load profile for the mitigation strategies to maintain core cooling, containment and spent fuel pool cooling during all modes of operation. In

response to this request, the licensee provided summary tabulations of battery amperage as a function of time for its Division 1 250 volt and 125 volt batteries. Amperage values were provided for a time span from beginning of the ELAP scenario until recharging of the batteries is credited to become available. For the 250 volt batteries the time span covered from 0 to 17 hours; and for the 125 volt batteries the time span covered from 0 to 10 hours. The licensee stated that the load profiles are different depending on whether the RCIC pump's suction is aligned to the CST or to the suppression pool because the two scenarios utilize different valve and equipment actuations. The data provided by the licensee included both the CST suction scenario and the suppression pool suction scenario.

The licensee was asked to provide a detailed discussion of the loads that will be shed from the dc buses, including equipment locations, operator actions needed to be performed, and the time needed to complete each load-shed action. In its response to this request the licensee stated that the initial ELAP load shed actions are directed by Columbia's existing SBO procedures and provided a tabulation of loads to be shed, breakers required to be opened, breaker location and required completion times. Initial 250 volt loads to be shed support instrumentation and indications located in the main control room that is not needed for ELAP mitigation following verification that all control rods have fully inserted. The licensee stated that the purpose of these load sheds is to reduce the main control room heat load; and these loads, typically, are required to be shed within 30 minutes of event initiation. The SBO procedure directs additional 250 volt load sheds for equipment supporting feedwater turbine and main turbine operation. The licensee stated that the purpose of these load sheds is to preserve the battery capacity; and the required time for shedding these loads is within 1 hour for the feedwater turbine emergency oil pumps and 2 hours for the main turbine emergency oil pump. The licensee identified 125 volt loads shed in accordance with current SBO procedures as circulating oil pumps that support the emergency diesel generators (assumed to be non-functional in an ELAP scenario) and lighting related to the remote shutdown room; these loads are required to be shed within 1 hour. In addition to dc loads specified to be shed by existing SBO procedures, the licensee identified the following loads to be shed during an ELAP event: (a) the main turbine seal oil backup pump shed from the 250 volt batteries within 2 hours; (b) instrumentation related to reactor recirculation pumps shed from the 125 volt batteries within 1 hour; and (c) reactor building HVAC annunciator panels and control power for several breakers not credited for ELAP mitigation shed from the 125 volt batteries within 1 hour. DC loads that the licensee identified to be shed were reviewed and confirmed not to be required for operation of any of the equipment credited for ELAP event mitigation.

The licensee stated that the load shed actions will be accomplished by opening breakers or pulling fuses at the various identified locations. The licensee also stated that the ability of operators to complete the load shed actions within the times stated will be validated and that the validations are identified as open items and tracked in its open item tracking system. This is identified as Confirmatory Item 3.2.4.10.B in Section 4.2. The licensee stated that to meet the objectives of the FLEX strategies, it is necessary to reduce energized dc loads and that this approach is consistent with the guidance of NEI 12-06 which does not require that defense in depth and redundancy for design basis accidents be maintained. The licensee also stated that this approach is consistent with the NEI 12-06 strategy of enhancing defense in depth for beyond design basis accidents while not requiring redundancy of equipment.

The licensee was asked to discuss considerations related to removing the main generator's battery driven hydrogen seal oil pump from service and whether the licensee's evaluation has included consequences of a potential fire or explosion resulting from release of hydrogen from the main generator housing. In response to this request, the licensee stated that to conserve

battery capacity the air-side seal oil backup pump will be stopped by opening the associated breaker within the first two hours. The licensee further stated that existing SBO procedures direct operators to depressurize the main generator manually if the air side seal oil system fails. The licensee stated that the ELAP load shedding procedure is in the process of being developed and that the procedure will also direct operators to depressurize the main generator manually before shedding the air side seal oil backup pump if the generator is pressurized with hydrogen. This is identified as Confirmatory Item 3.2.4.10.C in Section 4.2. The licensee stated that these actions are expected to preclude a potential fire and/or explosion from the hydrogen. The licensee's response to the audit question is acceptable because it describes an acceptable operational action to depressurize the main generator before stopping the battery-driven seal oil backup pump, and this action will control the release of hydrogen and minimize the potential for a hydrogen release that might result in a fire or explosion.

During the audit the licensee was asked to provide the minimum voltage that must be maintained and the basis for the minimum voltage on the dc buses. In response to this request, the licensee stated that based on its Energy Northwest calculation, "Calculation for Battery and Battery Charger 250 VDC, 125 VDC, and 24 VDC" the minimum battery voltage for 250 VDC battery E-B2-1 is 210 volts and the minimum voltage for 125 VDC battery E-B-1 is 105 volts. The licensee made its battery calculation available for further review. Review of the calculation noted that the calculation's Document Summary states that the calculation was prepared in accordance with the requirements of IEEE 485, "Practice for Sizing Lead-Acid Batteries for Stationary Applications"; and the calculation also includes comparisons against the battery manufacturer's published data. Based on the licensee's application of IEEE 485 (discussed further below) and consideration of the battery manufacturer's data, the licensee's response to the audit question is acceptable.

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

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

The Generic Concern related to extended battery duty cycles required clarification of the capability of the existing vented lead-acid station batteries to perform their expected function for durations greater than 8 hours throughout the expected service life. 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 that satisfy NRC Order EA-12-049. 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 compliance with NRC Order EA-12-049.

The NRC staff concluded that the position paper provides an acceptable approach for demonstrating that the licensees are capable of implementing mitigation strategies. The NRC staff evaluated the licensee's application of the guidance in its development of the technical evaluation report documenting compliance with NRC Order EA-12-049.

During the audit, the licensee informed the NRC that Energy Northwest intends to follow this generic resolution.

Information provided by the licensee in its Integrated Plan and its responses to audit questions conform to the recommendations in NEI 12-06, Section 3.2.2, Guideline (6). The licensee's actions and information already completed show that the licensee is appropriately considering issues related to dc power requirements and load reductions to conserve dc power. However, the documentation provided by the licensee is not currently adequate to confirm that all items related to resolution of the Generic Concern are fully addressed. As the licensee develops further calculations, evaluations and procedures related to dc power requirements, the updated documentation should be reviewed to confirm adherence to the NRC staff's position related to this concern. This is identified as Confirmatory Item 3.2.4.10.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 Items, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to load reduction to conserve dc power if these requirements are implemented as described.

3.3 PROGRAMMATIC CONTROLS

3.3.1 Equipment Maintenance and Testing

NEI 12-06, Section 3.2.2, in the paragraph following Guideline (15) provides that:

> In order to assure reliability and availability of the FLEX equipment required to meet these capabilities, the site should have sufficient equipment to address all functions at all units on-site, plus one additional spare, i.e., an N+1 capability, where "N" is the number of units on-site. Thus, a 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 provides that:

1. FLEX mitigation equipment should be initially tested or other reasonable means used to verify performance conforms to the limiting FLEX requirements. Validation of source manufacturer quality is not required.
2. Portable equipment that directly performs a FLEX mitigation strategy for the core, containment, or SFP should be subject to maintenance and testing[1] guidance provided in INPO AP 913, Equipment Reliability Process, to verify proper function. The maintenance program should ensure that the FLEX equipment reliability is being achieved. Standard industry templates (e.g., EPRI) and associated bases will be developed to define specific maintenance and testing including the following:
   a. Periodic testing and frequency should be determined based on equipment type and expected use. Testing should be done to verify design requirements and/or basis. The basis should be documented and deviations from vendor recommendations and applicable standards should be justified.
   b. Preventive maintenance should be determined based on equipment type and expected use. The basis should be documented and deviations from vendor recommendations and applicable standards should be justified.
   c. Existing work control processes may be used to control maintenance and testing. (e.g., PM Program, Surveillance Program, Vendor Contracts, and work orders).
3. The unavailability of equipment and applicable connections that directly performs a FLEX mitigation strategy for core, containment, and SFP should be managed such that risk to mitigating strategy capability is minimized.
   a. The unavailability of installed plant equipment is controlled by existing plant processes such as the Technical Specifications. When installed plant equipment which supports FLEX strategies becomes unavailable, then the FLEX strategy affected by this unavailability does not need to be maintained during the unavailability.
   b. Portable equipment may be unavailable for 90 days provided that the site FLEX capability (N) is available.
   c. Connections to permanent equipment required for FLEX strategies can be unavailable for 90 days provided alternate capabilities remain functional.
   d. Portable equipment that is expected to be unavailable for more than 90 days or expected to be unavailable during forecast site specific external events (e.g., hurricane) should be supplemented with alternate suitable equipment.
   e. The short duration of equipment unavailability, discussed above, does not constitute a loss of reasonable protection from a diverse storage location protection strategy perspective.
   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.

[1] Testing includes surveillances, inspections, etc.

On page 14 of its Integrated Plan, with regard to maintenance and testing, the licensee stated that portable FLEX equipment will be initially tested or otherwise evaluated to ensure acceptable performance and that periodic maintenance and testing of portable equipment will be developed based on INPO AP 913, "Equipment Reliability Process," and standard industry templates currently being developed.

The licensee further stated that unavailability of equipment and applicable connections that directly perform a FLEX mitigation strategy for core, containment, and SFP will be managed in accordance with NEI 12-06 Section 11.5.3.

The NRC staff reviewed the licensee's Integrated Plan and determined that the Generic Concern related to maintenance and testing of FLEX equipment is applicable to the plant. This Generic Concern has been resolved generically through the NRC endorsement of the EPRI technical report on preventive maintenance of FLEX equipment, submitted by NEI by letter dated October 3, 2013 (ADAMS Accession No. ML13276A573). The NRC 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 can use to develop preventative maintenance programs for FLEX equipment. The database describes maintenance tasks and maintenance intervals that have been evaluated as sufficient to provide for the readiness of the FLEX equipment. The NRC staff has determined that the technical report provides an acceptable approach for developing a program for maintaining FLEX equipment in a ready-to-use status. . The NRC staff will evaluate the resulting program through the audit and inspection processes.

During the audit the licensee stated that Energy Northwest will use the EPRI report and database as input for Columbia's program for FLEX equipment maintenance. The licensee stated, however, that Energy Northwest is not committing to the EPRI guidelines at this time because the EPRI guidelines need to be compared with existing procedures for establishing PM activities and frequencies and that any changes to PM tasks need to be fully evaluated. The licensee stated that Columbia's maintenance and testing program for FLEX equipment will be documented in the next Integrated Plan updated following finalization of the program.

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 programmatic controls for equipment maintenance and testing if these requirements are implemented as described.

3.3.2 Configuration Control

NEI 12-06, Section 11.8 provides that:

1. The FLEX strategies and basis will be maintained in an overall program document. This program document will also contain a historical record of previous strategies and the basis for changes. The document will also contain the basis for the ongoing maintenance and testing programs chosen for the FLEX equipment.
2. Existing plant configuration control procedures will be modified to ensure that

changes to the plant design, physical plant layout, roads, buildings, and miscellaneous structures will not adversely impact the approved FLEX strategies.

3. Changes to FLEX strategies may be made without prior NRC approval provided:
   a) The revised FLEX strategy meets the requirements of this guideline.
   b) An engineering basis is documented that ensures that the change in FLEX strategy continues to ensure the key safety functions (core and SFP cooling, containment integrity) are met.

On page 15 in its Integrated Plan, with regard to configuration control, the licensee stated that its FLEX strategies and basis are being maintained consistent with existing plant configuration control processes and that procedures will ensure that changes to the plant design, physical plant layout, roads, buildings, and structures used for the storage of portable FLEX equipment will not adversely impact the approved FLEX strategy. The licensee also stated that changes to FLEX strategies may be made without prior NRC approval provided: a) the revised FLEX strategy conforms to the recommendations in NEI 12-06; and 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.

The licensee's discussion of configuration control on page 15 of its Integrated Plan conforms to the guidance in NEI 12-06, Section 11.8.

During the audit the licensee was asked to whether any of its proposed modifications are expected to require prior NRC review and approval. In its response to this question the licensee stated that all proposed modifications will be evaluated in accordance with 10 CFR 50.59 to determine whether prior NRC approval is required pursuant of 10 CFR 50.90 and that if any of these evaluations determine that prior NRC approval is required, Energy Northwest will inform the NRC Project Manager as soon as practical following that determination. The licensee further stated that the periodic updates of its Integrated Plan will identify any planned modifications that it determines may be implemented without NRC approval per 10 CFR 50.90 and that currently Energy Northwest does not anticipate any of the modifications requiring prior NRC approval, but neither the final design nor the 10 CFR 50.59 screening/evaluation process have been completed for all modifications. This response is acceptable because it is in accordance with requirements in 10 CFR 50.59 and 10 CFR 50.90, and it conforms to the guidance 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 programmatic controls for configuration control if these requirements are implemented as described.

3.3.3 Training

NEI 12-06, Section 11.6 provides that:

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

accepted training process.[2]

2. Periodic training should be provided to site emergency response leaders[3] on beyond design-basis emergency response strategies and implementing guidelines. Operator training for beyond-design-basis event accident mitigation should not be given undue weight in comparison with other training requirements. The testing/evaluation of Operator knowledge and skills in this area should be similarly weighted.

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

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

5. Where appropriate, the integrated FLEX drills should be organized on a team or crew basis and conducted periodically; with all time-sensitive actions to be evaluated over a period of not more than eight years. It is not the intent to connect to or operate permanently installed equipment during these drills and demonstrations.

On page 15 in its Integrated Plan, with regard to a training plan, the licensee stated that training on mitigation of BDB events will be developed and maintained in accordance with the Systematic Approach to Training and that periodic training will be provided to site emergency response leaders on BDB emergency response strategies and implementing guidelines. The licensee further stated that emergency response leaders are those utility emergency response personnel assigned leadership roles, as defined by the Columbia Emergency Plan, for managing emergency response to design basis and BDB plant emergencies and that personnel assigned to direct execution of the mitigation strategies for BDB event will receive the necessary training to ensure familiarity with the associated tasks.:

The licensee's discussion of its training plan conforms to the guidance in NEI 12-06, Section 11.6 related to training.

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

3.4 OFFSITE RESOURCES

NEI 12-06, Section 12.2 lists the following minimum capabilities for offsite resources for which

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

each licensee should establish the availability of:

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

On pages 15 and 16 of its Integrated Plan, the licensee discussed its plans for obtaining resources from the RRC. The licensee stated that the industry is establishing two RRCs to support utilities during BDB events that will store key support equipment and that equipment will be moved from an RRC to a local Assembly Area, established by the SAFER team and Energy Northwest. The licensee stated that communications will be established between Columbia and the SAFER team, and required equipment moved to the site as needed. The licensee also 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 stated that Columbia is currently identifying the equipment that would be requested from the RRC in support of the ELAP/LUHS event and that the process of identifying this equipment will be iterative, since completion of detailed analyses will provide more clarification of what additional equipment may be needed. The licensee stated that a location for the delivery of the RRC-supplied equipment is yet to be determined but will be at a radius of approximately 25 miles from the site. The licensee also stated that Columbia has executed a contract to ensure support is available from the off-site resource.

On page 16 of its Integrated Plan, the licensee identified two open items related to obtaining off-site resources: (1) establishing a staging area for the receipt of offsite resources; and (2) establishing a "playbook" with the RRC to define and coordinate RRC and plant actions in response to an event.

On page 29 of its Integrated Plan, the licensee stated that Phase 3 core cooling will be

accomplished by placing one loop of RHR into the shutdown cooling mode and that this will be accomplished by providing power from a 4160 VAC FLEX portable DG and supplying the RHR heat exchanger with service water pumped by a large portable FLEX pump via connections to either division of service water piping. The licensee stated that both the portable 4160 VAC DG and the large portable pump will be obtained from the RRC and that procedures for obtaining these resources will be developed.

During the audit the licensee was asked to provide additional discussion of how Columbia will ensure the availability of off-site resources to support its mitigation strategies. In response to this request the licensee stated that Energy Northwest is actively involved in industry initiatives to establish the RRCs which are required for implementation of Phase 3 of the Energy Northwest FLEX strategy. The licensee stated that the industry has contracted with the SAFER organization through the Pooled Equipment Inventory Company (PEICo) to establish and operate the RRC's as part of PEICo's existing Pooled Inventory Management (PIM) program. The licensee stated that Energy Northwest will use the ongoing programmatic provisions of the contract with PIM to address the considerations in NEI 12-06, Section 12.2.

The licensee's statements are consistent with the guidance in NEI 12-06, Section 12.2, and express the licensee's intention to follow that guidance. On this basis, the licensee's Integrated Plan provides reasonable assurance that it will follow the guidance in NEI 12-06 with regard to offsite resources.

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

4.0 OPEN AND CONFIRMATORY ITEMS

4.1 OPEN ITEMS

Item Number	Description	Notes
3.2.3.A	The NRC staff considers the adoption of Revision 3 to the Boiling Water Reactor Owner's Group (BWROG) Emergency Procedures Guidelines (EPG) Severe Accident Guidelines (SAG) by licensees to be a Generic Concern (and thus an open item) because the BWROG has not addressed the potential for the revised venting strategy to increase (relative to currently accepted venting strategies) the likelihood of detrimental effects on containment response for events in which the venting strategy is invoked. In particular it has not been shown that the potential for negative pressure transients, hydrogen combustion, or loss of containment overpressure (as needed for pump NPSH) is not significantly different when implementing Revision 3 of the EPG/SAG vs. Revision 2 of the EPG/SAG. Revision 3 provides for earlier venting than previous revisions. The BWR procedures are structured such that the new venting strategy is not limited to use during the BDBEEs that are the subject of EA-12-049, but could also be implemented during a broad range of events. Resolution of issues related to NRC acceptance of EPG/SAG Revision 3, including any associated plant-specific evaluations, will be needed to resolve this open item.	
3.2.3.B	The licensee's proposed strategy for maintaining containment appears to be in contrast to the requirements and intent of the original Order EA-12-050 HCVS which was incorporated into the NEI 12-06 guidance strategies for Mark I and Mark II containments. Several of the technical and operational considerations of Order EA-12-050 are not addressed by the information provided by the licensee, and the proposed strategy, as a whole, may not be acceptable to the NRC staff.	

4.2 CONFIRMATORY ITEMS

Item Number	Description	Notes
3.1.1.3.A	During the audit, the licensee stated that, with regard to NEI 12-06, consideration 1, currently the critical parameters to be monitored have been defined and a procedure for obtaining the readouts has been drafted and is under review and that consideration 2 (impacts from large internal flooding sources) will be addressed in future six-month updates of the Integrated Plan. When this information becomes available, it should be reviewed to confirm acceptability.	

Item Number	Description	Notes
3.1.2.1.A	The licensee stated that information related to Columbia's considerations of the potential effects of a local intense precipitation event will be included in the February 2014 update to the Integrated Plan. This information should be reviewed to confirm adequate consideration of this event.	
3.1.2.4.A	When Columbia's site "playbook" describing its coordination with the RRC is developed, the playbook should be reviewed to confirm that it adequately addresses potential regional impacts that might affect transportation of off-site equipment during an extreme, regional flooding event. Review of the "playbook" should also confirm that potential issues related to obtaining and delivering off-site resources during conditions of snow, ice, and extreme cold are adequately addressed.	
3.1.3.A	The licensee stated that it will perform an evaluation to compare (1) the quantity of water required to dissipate, for 72 hours, the decay heat of the reactor core and spent fuel pool during Phases 1 and 2, with (2) the volume of water normally in the spray ponds. The licensee stated that results of that evaluation will be reported in the February 2014 update to their Integrated Plan. This information should be reviewed when available to confirm acceptability.	
3.1.4.2.A	The licensee's considerations related to manual operations during cold weather conditions and its development of plans for ice and snow removal and appropriate haul paths should be confirmed during an on-site audit. Review should include procedural enhancements related to transport of FLEX equipment under conditions of snow or ice. Issues related to delivery of off-site equipment during conditions of snow and ice and extreme cold should be confirmed to be adequately addressed.	
3.2.1.1.A	From the June 2013 position paper, benchmarks must be identified and discussed which demonstrate that MAAP4 is an appropriate code for the simulation of an ELAP event at the licensee's facility.	
3.2.1.1.B	The collapsed RPV level must remain above Top of Active Fuel (TAF) and the cool down rate must be within technical specification limits.	
3.2.1.1.C	MAAP4 must be used in accordance with Sections 4.1, 4.2, 4.3, 4.4, and 4.5 of the June 2013 position paper.	
3.2.1.1.D	In using MAAP4, the licensee must identify and justify the subset of key modeling parameters cited from Tables 4-1 through 4-6 of the "MAAP4 Application Guidance, Desktop Reference for Using MAAP4 Software, Revision 2" (Electric Power Research Institute Report 1020236). This should include response at a plant-specific level regarding specific modeling options and parameter choices for key models that would be expected to substantially affect the ELAP analysis performed for that licensee's plant. Although some	

Item Number	Description	Notes
	suggested key phenomena are identified below, other parameters considered important in the simulation of the ELAP event by the vendor / licensee should also be included. a. Nodalization b. General two-phase flow modeling c. Modeling of heat transfer and losses d. Choked flow e. Vent line pressure losses f. Decay heat (fission products / actinides / etc.)	
3.2.1.1.E	The specific MAAP4 analysis case that was used to validate the timing of mitigation strategies in the Integrated Plan must be identified and should be available on the ePortal for NRC staff to view. Alternately, a comparable level of information may be included in the supplemental response. In either case, the analysis should include a plot of the collapsed vessel level to confirm that TAF is not reached (the elevation of the TAF should be provided) and a plot of the temperature cool down to confirm that the cool down is within technical specification limits.	
3.2.1.2.A	When the licensee's evaluations related to its open item OI-FLEX-08 are completed, the evaluations should be reviewed to confirm that issues related to primary system leakage from the recirculation pump seals have been adequately addressed.	
3.2.1.5.A	Confirm open item, OI-FLEX-05, which states, "The procedural interface in NEI 12-06, Section 5.3.3.1 (alternate instrument readouts) will be developed once the critical monitoring parameters are identified.	
3.2.1.4.A	When supporting design requirements and calculations are completed to establish and confirm portable FLEX equipment requirements and capabilities, subsequent review will be needed to confirm that equipment credited by the licensee is adequate to perform its credited mitigation function(s).	
3.2.1.8.A	Results of supporting analyses, when completed, should be reviewed to confirm that performance criteria specified for the licensee portable, diesel driven pumps (pumper truck, high-head pump and low-head pump) are adequate to support their intended uses in all Phase 2 mitigation strategy scenarios.	
3.2.2.A	Closure of open items related to Columbia's SFP cooling strategies will need to be reviewed and evaluated to confirm that the strategies are consistent with guidance in NEI 12-06 or that the strategies are based on an acceptable alternative to the NEI 12-06 guidance.	

Item Number	Description	Notes
3.2.2.B	When the GOTHIC analyses are completed and actions based on the results are fully developed, additional review will be needed to confirm that the licensee's strategy for venting of the refueling floor is consistent with guidance in NEI 12-06 or provides an acceptable alternative to that guidance.	
3.2.2.C	Actions to be taken by the licensee in the event of an ELAP occurring when a full core offload is in the SFP should be reviewed when they are documented in the Integrated Plan update to confirm that the proposed actions are adequate to maintain satisfactory SFP cooling.	
3.2.2.D	The licensee should provide clarification of whether Columbia's SFP makeup strategy includes provisions for providing SFP makeup without accessing the refueling floor, as recommended in NEI 12-06, Table 3-1 and Table C-3.	
3.2.4.2.A	Results of the licensee's analyses to determine what measures are needed to control hydrogen concentrations in the battery room and to evaluate the need for forced ventilation on the refueling floor should be reviewed when they become available.	
3.2.4.2.B	Results of GOTHIC analyses that include consideration of RCIC room, SFP area, and battery room temperatures should be reviewed when the analyses are completed and results are available.	
3.2.4.3.A	The licensee stated that Energy Northwest will address its considerations related to NEI 12-06, Section 3.2.2, Guideline (12), related to potential loss of heat tracing, in an Integrated Plan updated no later than August 28, 2014. When provided, the licensee's considerations should be confirmed to be acceptable.	
3.2.4.4.A	The NRC staff reviewed the licensee's communications assessment (ML12319A079) and determined that it was reasonable, and that the interim measures and proposed enhancements will help to ensure that communications are maintained. The NRC's safety assessment is documented in a letter dated April 11, 2013, "Columbia Generating Station – Safety assessment in Response to Information Request Pursuant to 10 CFR 50.54(f) – Recommendation 9.3 Communications Assessment" (ADAMS Accession No. ML13091A295). The licensee's upgrades to Columbia's communications systems should be reviewed and confirmed to be acceptable when the changes are implemented.	

Item Number	Description	Notes
3.2.4.6.A	Analyses addressing personnel habitability issues are still in progress and procedures providing more detailed instructions for some mitigation actions are still under development, the licensee's Integrated Plan did not include sufficient information to conclude that it conforms to the guidance in NEI 12-06, Section 3.2.2, Guideline (11) or provides an acceptable alternative to that guidance. When analyses are completed, they should be reviewed to confirm acceptability of the results.	
3.2.4.8.A	During the audit the licensee was asked to provide a summary of the sizing calculations for the FLEX DGs to show that they can supply the loads assumed in Phase 2 and Phase 3 of Columbia's mitigation strategy. In response to this request the licensee stated that finalization of the sizing calculation for the FLEX DGs for Phase 2 and Phase 3 is not complete and that completion of this activity is necessary to provide a comprehensive response to the question. The licensee stated that Energy Northwest anticipates that this information will be submitted in the February 2014 update to it Integrated Plan. When submitted, the requested information should be reviewed to confirm that results are acceptable.	
3.2.4.10.A	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. 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 that satisfy NRC Order EA-12-049. 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 compliance with NRC Order EA-12-049.	
3.2.4.10.B	Confirm that the ability of operators to complete specified load shed actions within the times stated is validated.	

Item Number	Description	Notes
3.2.4.10.C	Confirm the licensee's development of the ELAP load shedding procedure and that the procedure includes directions for operators to depressurize the main generator manually before shedding the air side seal oil backup pump if the generator is pressurized with hydrogen.	