Mega-Tech Services, LLC

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

Revision 1

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Byron Station, Units 1 and 2
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1.0 BACKGROUND

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

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

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

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

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

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

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

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

2.0 EVALUATION PROCESS

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

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

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

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

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

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

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

3.0 TECHNICAL EVALUATION

By letter dated February 28, 2013, (ADAMS Accession No. ML13060A364), and as supplemented by the first six-month status report in letter dated August 28, 2013 (ADAMS Accession No. ML13241A279), Exelon Generation Company, LLC (the licensee or Exelon) provided Byron Station, Units 1 and 2 (Byron) Integrated Plan for compliance with Order EA-12-049. The Integrated Plan describes the strategies and guidance under development for implementation by Exelon for the maintenance or restoration of core cooling, containment, and SFP cooling capabilities following a beyond-design-basis external event (BDBEE), including modifications necessary to support this implementation, pursuant to Order EA-12-049. By letter dated August 28, 2013 (ADAMS Accession No. ML13234A503), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049. That letter described the process used by the staff in its review, leading to the issuance of an interim staff evaluation and audit report. The purpose of the staff's audit is to determine the extent to which the licensees are proceeding on a path towards successful implementation of the actions needed to achieve full compliance with the Order.

3.1 EVALUATION OF EXTERNAL HAZARDS

Sections 4 through 9 of NEI 12-06 provide the NRC-endorsed methodology for the determination of applicable extreme external hazards in order to identify potential complicating factors for the protection and deployment of equipment needed for mitigation of BDBEEs leading to an extended loss of all alternating current (ac) power (ELAP) and loss of normal access to the ultimate heat sink (UHS). These hazards are broadly grouped into the categories discussed below in Sections 3.1.1 through 3.1.5 of this evaluation. Characterization of the applicable hazards for a specific site includes the identification of realistic timelines for the hazard; characterization of the functional threats due to the hazard; development of a strategy for responding to events with warning; and development of a strategy for responding to events without warning.

3.1.1 Seismic Events.

NEI 12-06, Section 5.2 states:

> All sites will address BDB 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.

The licensee's screening for seismic hazards, as presented in their Integrated Plan, has screened in this external hazard. The licensee confirmed on page 1 of their Integrated Plan that they will address BDB seismic consideration in the implementation of FLEX strategies consistent with NEI 12-06. The licensee further indicated that through test borings the soils are not susceptible to liquefaction. The licensee also stated that the seismic re-evaluation pursuant to the 10 CFR 50.54(f) letter of March 12, 2012 had not been completed and therefore was not assumed in their Integrated Plan.

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

3.1.1.1 Protection of FLEX Equipment – Seismic Hazard

NEI 12-06, Section 5.3.1 states:

> 1. FLEX equipment should be stored in one or more of following three configurations:
>
>   a. In a structure that meets the plant's design basis for the Safe Shutdown

Earthquake (SSE)(e.g., existing safety-related structure).

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

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

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

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

In various sections of its Integrated Plan the licensee stated that storage structures to provide protection of FLEX equipment have not been constructed at this time, but will be constructed to meet the requirements of NEI 12-06, Section 11.0 and satisfy the site compliance date. The licensee further stated that required FLEX equipment needed for strategy implementation will be installed in a robust FLEX building ready for hookup and use. Hoses and electrical connectors will be completed as needed to support the site coping strategy and will be stored within the FLEX building. Procedures and programs will be developed to address storage structure requirements, haul path requirements, and FLEX equipment requirements relative to the external hazards applicable to Byron. This is identified as Confirmatory Item 3.1.1.1.A in Section 4.2 below.

The licensee's plan to meet the storage structure considerations of NEI 12-06, Section 11.0 encompasses the storage structure considerations of Section 5.3.1.1 for the seismic hazard.

The licensee's plan did not address the securing of large portable equipment to protect them during a seismic event or to ensure unsecured and/or non-seismic components do not damage the equipment during a seismic event as specified by NEI-12-06, Section 5.3.1.2 and 5.3.1.3. In response to the NRC audit process, the licensee stated that the storage building will be equipped with tie-downs to ensure FLEX equipment is protected from seismic events. In addition, other components within the FLEX storage building will be secured to ensure they do not damage FLEX equipment during a seismic event.

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

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 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 [mitigation] strategy relies on a water source that is not seismically robust, e.g., a downstream dam, the deployment of coping capabilities should address how water will be accessed. Most sites with this configuration have an underwater berm that retains a needed volume of water. However, accessing this water may require new or different equipment.
4. If power is required to move or deploy the equipment (e.g., to open the door from a storage location), then power supplies should be provided as part of the deployment.
5. A means to move the equipment should be provided that is also reasonably protected from the event.

With regard to FLEX equipment movement from storage locations to deployment points, on page 6 of the Integrated Plan the licensee stated that transportation routes will be developed from the equipment storage area to the FLEX staging areas. An administrative program will be developed to ensure pathways remain clear or compensatory actions will be implemented to ensure all strategies can be deployed during all modes of operation. This administrative program will also ensure the strategies can be implemented in all modes by maintaining the portable FLEX equipment available to be deployed during all modes. As discussed in Section 3.1.1, the licensee has determined that the site is not susceptible to the effects of soil liquefaction.

With regards to protection of connections, on page 16, 26, 44, and 52 of the Integrated Plan the licensee stated that FLEX piping, valves, and connections (electrical & fluid) will meet NEI 12-06 protection requirements. There will be an administrative program created to protect the connections from blockage during outages and non-outage times. The licensee further indicated that the UHS FLEX support equipment will be staged in a robust building and transported to a pre-identified staging location with a debris removal tool such as a Ford F-750 with snow plow or equivalent, and hoses will be completed as need to support the site coping strategy.

The licensee's approach provides a means to move FLEX equipment, but does not provide any information on how the means to move the FLEX equipment is reasonably protected from the event. In response to the NRC audit process, the licensee indicated that the F750 and the F-250s or equivalent used to deploy the FLEX equipment would be stored in the FLEX storage building.

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 – seismic hazard, 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 should be addressed.
>
> 1. Seismic studies have shown that even seismically qualified electrical equipment can be affected by beyond-design-basis seismic events. In order to address these considerations, each plant should compile a reference source for the plant operators that provides approaches to obtaining necessary instrument readings to support the implementation of the coping strategy (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 equipment for those plants that could be impacted by failure of a not seismically robust downstream dam.

The licensee's Integrated Plan did not provide any information on the availability of a reference source for obtaining instrument readings using a portable instrument to support coping strategy implementation. In response to the NRC audit process, the licensee stated that a procedure is being developed to provide guidance on how and where to measure key instruments at containment penetrations using a portable instrument. This is identified as Confirmatory Item 3.1.1.3.A in Section 4.2 below.

The licensee's Integrated plan did not provide any information on: 1) non-robust internal flooding sources that do not require ac power; 2) the use of ac power to mitigate ground water in critical locations; or 3) if there is a potential impact by the failure of a non-seismically robust downstream dam.

In response to the NRC audit process for 1) above, the licensee indicated that for non-robust internal flooding in the turbine building (TB) would only impact the core cooling strategy and obtaining diesel oil. The core cooling strategy will have modifications to permanently install piping above the potential TB flood level. For diesel oil the FLEX generator will energize the diesel oil transfer pump and the discharge will be modified with a tee to allow access above the TB flood level. Non-safety related piping and support arrangements in the auxiliary building (AB) are designed to withstand sustained loads (pressure and weight), as well as the seismic loading generated by the safe shutdown earthquake (SSE) event. Should failures occur in the AB the floor drains would direct the water to the sump and which could eventually spill over into the SX pump room on the 330' level. Within 2 hours of the event an operator is dispatched to SX pump room 330' elevation to unisolate the diesel driven auxiliary feedwater pump alternate cooling line, which should be accessible at this time. Once this action is completed FLEX strategy actions are conducted above the 364' AB elevation, which is expected to be maintained accessible.

In response to the NRC audit process for 2) above, the licensee indicated that they do not rely on the use of ac power to mitigate ground water.

In response to the NRC audit process for 3) above, the licensee indicated that the site is not susceptible to the failure of a downstream down as the site grade level is 160.7 feet above the maximum surface water location. This appears to be a misunderstanding of the potential impacts of failure of downstream dams, which would lower the available water level for use in the mitigating strategies, which could require the deployment of additional equipment to access the water source. This is identified as Confirmatory Item 3.1.1.3.B in Section 4.2 below.

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

3.1.1.4 Considerations in Using Offsite Resources – Seismic Hazard

NEI 12-06, Section 5.3.4 states:

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

On page 8 of the Integrated Plan, the licensee stated that Byron has contractual agreements in place with the Strategic Alliance for FLEX Emergency Response (SAFER) but had not yet identified the local staging area and method of transportation to the site. Development of Byron's playbook is an open item. Closure of this item will be communicated in a future 6-month update. This is identified as Confirmatory Item 3.1.1.4.A in Section 4.2 below.

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

3.1.2 Flooding.

NEI 12-06, Section 6.2 states:

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

NEI 12-06, Section 6.2.1 states:

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

On page 1 of the Integrated Plan, the licensee indicated that Byron is considered a Dry site per the Byron UFSAR. The plant grade elevation is at 869.0 feet and the grade floors of the safety related building are at elevation 870.0 feet. The Probable Maximum Flood (PMF) along the Rock River does not affect the site, since the maximum water surface elevation is 708.3 feet, a minimum of 160.7 feet below the plant grade. The probable maximum precipitation (PMP) falling on the plant area was considered in the analysis of local intense precipitation on the plant site. The maximum water level is elevation 870.90 feet at the plant site due to PMP. To prevent water due to PMP from entering areas where essential equipment/systems are located, reinforced concrete curbs or steel barriers are provided.

On page 3 of the Integrated Plan, the licensee indicated that flood re-evaluations pursuant to the 10 CFR 50.54(f) letter of March 12, 2012 are not completed and therefore not assumed in their Integrated Plan.

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

3.1.2.1 Protection of FLEX Equipment – Flooding Hazard

The licensee screened as a "dry site" and therefore does not need to address storage of FLEX equipment for protection in the context of a flooding hazard.

3.1.2.2 Deployment of FLEX Equipment – Flooding Hazard

The licensee screened as a "dry site" and therefore does not need to address deployment of FLEX equipment in context of a flooding hazard.

3.1.2.3 Procedural Interfaces – Flooding Hazard

The licensee screened as a "dry site" and therefore does not need to address procedural interfaces in the context of flooding hazard.

3.1.2.4 Considerations in Using Offsite Resources – Flooding Hazard

The licensee screened as a "dry site" and therefore does not need to address using offsite resources in the context of a flooding hazard.

3.1.3 High Winds

NEI 12-06, Section 7, provides the NRC-endorsed screening process for evaluation of high wind hazards. This screening process considers the hazard due to hurricanes and tornadoes. The first part of the evaluation of high wind challenges is determining whether the site is potentially susceptible to different high wind conditions to allow characterization of the applicable high wind hazard.

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

The screening for high wind hazard associated with tornadoes should be accomplished by comparing the site location to NEI 12-06, Figure 7-2, from U.S. NRC, "Tornado Climatology of the Contiguous United States," NUREG/CR-4461, Revision 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.

High wind event considerations are treated in four primary areas: protection of portable equipment, deployment of portable equipment, procedural interfaces, and considerations in using off-site resources. These areas are discussed further in Sections 3.1.3.1 through 3.1.3.4, below.

On page 1 and 2 of the Integrated Plan regarding the determination of applicable extreme external hazards, the licensee stated that NEI 12-06 identifies Byron in a region in which it would not experience severe winds from Hurricanes. However, NEI 12-06 identified Byron in Region 1 and is susceptible to tornado winds of 200 mph.

Based on the above, the licensee is required to consider tornado hazards in the development of FLEX 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 screening for high wind hazards, if these requirements are implemented as described.

3.1.3.1 Protection of FLEX Equipment - High Winds Hazard

NEI 12-06, Section 7.3.1 states:

These considerations apply to the protection of FLEX equipment from high wind hazards:

1. For plants exposed to high wind hazards, FLEX equipment should be stored in one of the following configurations:

    a. In a structure that meets the plant's design basis for high wind hazards (e.g., existing safety-related structure).

    b. In storage locations designed to or evaluated equivalent to ASCE 7-10, *Minimum Design Loads for Buildings and Other Structures* given the limiting tornado wind speeds from Regulatory Guide 1.76 or design basis hurricane wind speeds for the site.

        - Given the FLEX basis limiting tornado or hurricane wind speeds, building loads would be computed in accordance with requirements of ASCE 7-10. Acceptance criteria would be based on building serviceability requirements not strict compliance with stress or capacity limits. This would allow for some minor plastic deformation, yet assure that the building would remain functional.

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

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

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

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

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

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

In various sections of its Integrated Plan the licensee stated that storage structures to provide protection of FLEX equipment have not been constructed at this time, but will be constructed to meet the requirements of NEI 12-06, Section 11.0 and satisfy the site compliance date. The licensee further stated that required FLEX equipment needed for strategy implementation will be installed in a robust FLEX building ready for hookup and use. Hoses and electrical connectors will be completed as needed to support the site coping strategy and will be stored within the FLEX building. Procedures and programs will be developed to address storage structure requirements, haul path requirements, and FLEX equipment requirements relative to the external hazards applicable to Byron. Once locations are finalized implementation strategies and routes will be assessed for hazard impact, and will be communicated in a future 6-month update following identification. This is combined with Confirmatory Item 3.1.1.1.A in Section 4.2 below.

The licensee plan to meet the storage structure considerations of NEI 12-06, Section 11.0 encompasses the storage structure considerations of Section 7.3.1 for the tornado hazard.

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

3.1.3.2 Deployment of FLEX Equipment - High Winds Hazard

NEI 12-06, Section 7.3.2 states:

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

these extreme wind storms should be included.

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

5. The ability to move equipment and restock supplies may be hampered during a hurricane and should be considered in plans for deployment of FLEX equipment.

The licensee screened out for hurricanes, therefore consideration 1, 2, and 5 above are not applicable to the licensee, and therefore not addressed in the Integrated Plan.

With regards to debris removal and towing capability, on page 56 of the Integrated Plan, the licensee identifies a pickup truck for use for debris removal and refuel delivery capability but did not mention how towing of the FLEX equipment is provided, or how the pickup truck is provided reasonable protection from the tornado hazard. In response to the NRC audit process, the licensee indicated that the F-750 and two F-250s (or equivalent) would be equipped with snowplows for debris removal. Further, the F-250s will be utilized for towing of the FLEX equipment and the F-750 and the F-250s (or equivalent) would be stored in the FLEX storage building, which is protected against all applicable hazards.

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 in a high wind hazard, if these requirements are implemented as described.

3.1.3.3 Procedural Interfaces - High Winds Hazard

NEI 12-06, Section 7.3.3, states:

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

With regards to procedural interfaces, the licensee's Integrated Plan did not contain any information on this subject for tornados. In response to the NRC audit process, the licensee indicated that response to a tornado is contained in an abnormal operating procedure, which will direct entry into the SBO procedure and into FLEX deployment should the tornado result in an ELAP.

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 in a high wind hazard, if these requirements are implemented as described.

3.1.3.4 Considerations in Using Offsite Resources – High Winds Hazard

NEI 12-06, Section 7.3.4 states:

Extreme storms with high winds can have regional impacts that could have a significant impact on the transportation of off-site resources.

1. Sites should review site access routes to determine the best means to obtain resources from off-site following a hurricane.

2. Sites impacted by storms with high winds should consider where equipment delivered from off-site could be staged for use on-site.

On page 8 of the Integrated Plan, the licensee stated that Byron has contractual agreements in place with the Strategic Alliance for FLEX Emergency Response (SAFER) but had not yet identified the local staging area and method of transportation to the site. Development of Byron's playbook is an open item. Closure of this item will be communicated in a future 6-month update. This is included with Confirmatory Item 3.1.1.4.A in Section 4.2 below.

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

3.1.4 Snow, Ice and Extreme Cold

As discussed in part in NEI 12-06, Section 8.2.1:

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

On page 2 of the Integrated Plan, the licensee stated that NEI 12-06 identifies Byron in an area in which it could receive 25 inches of snow over 3 days. NEI 12-06 identifies Byron in a region of Ice Storm Severity Level 5, catastrophic destruction to lines of extreme amount of ice. In addition, the licensee stated extreme temperatures range from a maximum of 103°F to a minimum of -22°F and minimum temperatures are less than or equal to 0°F about 16 times per year.

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 spare (N+1) set of 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.).

In various sections of its integrate plan the licensee indicated that storage structures to provide protection of FLEX equipment have not been constructed at this time, but will be constructed to meet the requirements of NEI 12-06, Section 11.0 and satisfy the site compliance date. The licensee further stated that required FLEX equipment needed for strategy implementation will be installed in a robust FLEX building ready for hookup and use. Hoses and electrical connectors will be completed as needed to support the site coping strategy and will be stored within the FLEX building. Procedures and programs will be developed to address storage structure requirements, haul path requirements, and FLEX equipment requirements relative to the external hazards applicable to Byron. Once locations are finalized implementation strategies and routes will be assessed for hazard impact, and will be communicated in a future 6-month update following identification. This is combined with Confirmatory Item 3.1.1.1.A in Section 4.2 below.

The licensee plan to meet the storage structure considerations of NEI 12-06, Section 11.0 encompasses the storage structure considerations of Section 8.3.1 for the snow, ice, and extreme cold hazard.

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

3.1.4.2 Deployment of Portable Equipment - Snow, Ice and Extreme Cold Hazard

NEI 12-06, Section 8.3.2 states:

> There are a number of considerations that apply to the deployment of FLEX equipment for snow, ice, and extreme cold hazards:

1. The FLEX equipment should be procured to function in the extreme conditions applicable to the site. Normal safety-related design limits for outside conditions may be used, but consideration should also be made for any manual operations required by plant personnel in such conditions.

2. For sites exposed to extreme snowfall and ice storms, provisions should be made for snow/ice removal, as needed to obtain and transport equipment from storage to its location for deployment.

3. For some sites, the ultimate heat sink and flow path may be affected by extreme low temperatures due to ice blockage or formation of frazil ice. Consequently, the evaluation should address the effects of such a loss of the UHS on the deployment of FLEX equipment. For example, if UHS water is to be used as a makeup source, some additional measures may need to be taken to assure that the FLEX equipment can utilize the water.

With respect to procurement of equipment to function in the extreme conditions applicable to the site, on page 7 of the Integrated Plan the licensee stated equipment associated with these strategies will be procured as commercial equipment with design, storage, maintenance, testing, and configuration control as outlined in JLD-ISG-2012-01 section 6 and NEI 12-06 section 11.

On page 56 of the Integrated Plan the licensee lists a pickup truck for debris removal, but does not specify whether this equipment would be capable of removing snow and ice. In response to the NRC audit process, the licensee indicated that the F-750 and two F-250s (or equivalent) would be equipped with snowplows for debris [snow] removal.

The licensee's plans did not provide sufficient information associated with the loss of the UHS due to effects of extreme low temperature as identified in NEI 12-06, Section 8.3.2, consideration 3. During the audit process, the licensee indicated that its essential service water piping, used to support Phase 1 core cooling activities, is sufficiently underground to protect it from environmental effects and the suction line in the UHS is well below the surface to protect it from ice blockage. In addition, the licensee indicated that an over-ground temporary hose, which is used for the core cooling and spent fuel pool make-up FLEX pump, will require administrative controls to ensure a trickle flow of water to prevent freezing and also ensure that a back-up hose is available. The licensee indicated that the suction for this temporary hose from the UHS is from a dry hydrant with its source well below the surface to protect it from ice blockage.

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 in snow, ice, and extreme cold hazard, if these requirements are implemented as described.

3.1.4.3 Procedural Interfaces - Snow, Ice and Extreme Cold Hazard

NEI 12-06, Section 8.3.3 states:

> The only procedural enhancements that would be expected to apply involve addressing the effects of snow and ice on transport the FLEX equipment. This

> includes both access to the transport path, e.g., snow removal, and appropriately equipped vehicles for moving the equipment.

As provided in the licensee's response in Section 3.1.4.2 above, the F-750 and two F-250s (or equivalent) would be equipped with snowplows for debris [snow] removal.

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 snow, ice, and extreme cold hazard, if these requirements are implemented as described.

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

NEI 12-06, Section 8.3.4, states:

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

On page 8 of the Integrated Plan, the licensee stated that Byron has contractual agreements in place with the Strategic Alliance for FLEX Emergency Response (SAFER) but had not yet identified the local staging area and method of transportation to the site. Development of Byron's playbook is an open item. Closure of this item will be communicated in a future 6-month update. This is included with Confirmatory Item 3.1.1.4.A in Section 4.2 below.

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

3.1.5 High Temperatures

NEI 12-06, Section 9 states:

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

On page 2 of Integrated Plan the licensee stated that Byron will address high temperature considerations in the implementation of FLEX strategies consistent with NEI 12-06.

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

3.1.5.1 Protection of 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.

In various sections of the Integrated Plan the licensee stated that structures to provide protection of FLEX equipment will be constructed to meet the requirements of NEI 12-06 Rev. 0, Section 11. Temporary locations will be used until building construction completion. Procedures and programs will be developed to address storage structure requirements, haul path requirements, and FLEX equipment requirements relative to the external hazards applicable to Byron.

The licensee's Integrated Plan did not contain sufficient information to conclude that maintaining FLEX equipment within a range to ensure its likely function when called upon will be included in the design aspects of the FLEX storage structure. This is identified as Confirmatory Item 3.1.5.1.A in Section 4.2 below.

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

3.1.5.2 Deployment of 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.

On page 56 of the Integrated Plan, the licensee lists a pickup truck for use to support Core, SFP, and accessibility purposes.

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 in a high temperature hazard, if these requirements are implemented as described.

3.1.5.3 Procedural Interfaces – High Temperature Hazard

NEI 12-06, Section 9.3.3 states:

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

On page 7 of the Integrated Plan the licensee stated that equipment associated with these strategies will be procured as commercial equipment with design, storage, maintenance, testing, and configuration control as outlined in JLD-ISG-2012-01 section 6 and NEI 12-06 section 11.

The licensee's Integrated Plan did not provide information to conclude that the effects of high temperatures on FLEX equipment have been evaluated for operation in the locations they are intended to operate. This is identified as Confirmatory Item 3.1.5.3.A in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to the procedural interfaces – high temperature 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 beyond-design-basis external events in order to maintain or restore core cooling, containment and spent fuel pool cooling capabilities. The phases consist of an initial phase using installed equipment and resources, followed by a transition phase using portable onsite equipment and consumables and a final phase using offsite resources.

To meet these EA-12-049 requirements, Licensees will establish a baseline coping capability to prevent fuel damage in the reactor core or spent fuel pool and to maintain containment capabilities in the context of a beyond-design-basis external event that results in the loss of all ac power, with the exception of buses supplied by safety-related batteries through inverters, and loss of normal access to the UHS. As discussed in NEI 12-06, Section 1.3, plant specific analysis will determine the duration of each phase.

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

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

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

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

During the NRC audit process, the licensee was requested to specify which analysis performed in WCAP-17601 is being applied to Byron. Additionally, justify the use of that analysis by identifying and evaluating the important parameters and assumptions demonstrating that they are representative of Byron and appropriate for simulating the ELAP transient. This is identified as Confirmatory Item 3.2.1.A in Section 4.2 below.

3.2.1.1. Computer Code Used for ELAP Analysis.

NEI 12-06, Section 1.3 states:

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

The licensee has provided a Sequence of Events (SOE) in its Integrated Plan, which included the time constraints and the technical basis for the site. That SOE was based on an analysis using the industry-developed MAAP4 computer code. The NRC staff questioned the capability of the MAAP4 code to predict the behavior of the reactor coolant system during an ELAP event with sufficient accuracy. The staff's questions generally arose from the observation that the MAAP4 code uses simplified models, correlations, and user-specified inputs in lieu of detailed mechanistic models. In particular, the staff noted that the PWR version of the MAAP4 code lacks an explicit momentum balance and further relies upon a lumped representation of RCS loops, both of which could substantially affect predictions of when the flow in the RCS loops transitions from single-phase natural circulation to two-phase natural circulation and reflux condensation cooling.

Based upon the NRC staff’s concerns with PWRs’ reliance upon ELAP simulations performed with the MAAP4 code, the licensee decided during the audit to reference generic ELAP analysis that had been performed with the NOTRUMP computer code. Although NOTRUMP has been reviewed and approved for performing small break LOCA analysis for PWRs, the NRC staff had not previously examined its technical adequacy for simulating an ELAP event. In particular, the ELAP scenario is differentiated from typical design-basis small-break LOCA scenarios in several key respects, including the absence of normal ECCS injection and the substantially reduced leakage rate, which places significantly greater emphasis on the accurate prediction of primary-to-secondary heat transfer, natural circulation, and two-phase flow within the RCS. As a result of these differences, concern arose associated with the use of the NOTRUMP code for ELAP analysis for modeling of two-phase flow within the RCS and heat transfer across the SG tubes as single-phase natural circulation transitions to two-phase flow and the reflux condensation cooling mode. This concern resulted in the following Confirmatory Item:

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

It was unclear to the staff that the generic analysis in WCAP-17601 is capable of resolving whether nitrogen injection from the cold leg accumulators will occur at Byron under ELAP conditions. Therefore, during the NRC audit process, the NRC staff requested that the licensee (1) clarify whether calculations have been performed consistent with the PWROG-recommended methodology in Attachment 1 to the PWROG's interim core cooling position paper for PA-PSC-0965 to verify that the intended ELAP mitigation strategy will not result in injection of nitrogen from cold leg accumulators or (2) provide justification that the existing calculational methods for determining whether nitrogen injection will occur consider the potential for heating due to the rise of containment temperatures due to loss of normal ventilation, reactor coolant pump seal leakage, etc. In response to the NRC audit question the licensee stated that the site currently follows the previous PWROG guidance to stop RCS depressurization at 190 psi. Additional analysis is planned to stop depressurization at 300 psi per the new PWROG guideline. A calculation is being performed to determine the amount of water injected by the accumulators without injection of nitrogen. The licensee indicated that their intent is to be consistent with the PWROG methodology. All deviations from WCAP methodology will be communicated in a future 6-month update. This is identified as Confirmatory Item 3.2.1.1.B in Section 4.2 below.

The licensee was requested to clarify whether the Phase 2 mitigating strategy for core cooling discussed on page 12 of the Integrated Plan provides symmetric makeup flow to each of the four reactor coolant system loops, or whether it would result in the feeding of a single steam generator. If a symmetric flow will be provided, the licensee was requested to further clarify how the flow to each steam generator would be coordinated (e.g., between the main control room and local equipment operators) and controlled. Alternatively, if flow to a single steam generator will be provided, the licensee was requested to present analysis demonstrating that this strategy will be successful, accounting for the potential for increased concentrations of boric acid in the single active steam generator. In response to the NRC audit question, the licensee stated the Phase 1 strategy is for the diesel-driven auxiliary feedwater (DDAF) pump to provide core cooling using the normal SG injection path. Cooldown and depressurization is planned to be completed with the DDAF pump. The site plans on having this pump available indefinitely. If it fails a FLEX pump will be available. The auxiliary feedwater (AF) injection lines are being modified to allow the FLEX pump the ability to provide flow to all SGs. Control of feed flow and power operated relief valve (PORV) position will be coordinated between the field operators and the control room via sound powered phones. The feed flow control valves are air operated valves (AOVs) with manual override. The PORVs are hydraulically operated that can be manually operated via a locally operated hydraulic hand pump. In response to another NRC request associated with RCP seals, the licensee stated that they will be feeding all four SGs and will be steaming all four SGs symmetrically.

As stated on page 12 of the Integrated Plan, the Phase 2 strategy for maintaining core cooling includes a portable FLEX pump taking suction on the RWST and discharging into the auxiliary feedwater lines to the SGs. Page 15 further stated that, given a minimum RWST inventory of 423,000 gallons, the total inventory would be depleted in 23 hours. The licensee was requested to address the following issues associated with this strategy:

a. Clarify whether boiling off significant quantities of borated coolant from the RWST in the steam generators could lead precipitated boric acid accumulating in the steam generators. If precipitation could occur, please provide adequate basis for concluding that precipitated boric acid would not restrict primary-to-secondary heat transfer via the fouling steam generator tubes or obstruction of the passage of water through the steam generator. In response to the NRC audit process the licensee stated that additional analysis will be performed for SG fouling/plugging from extended use of SX water, RWST, and well water. This is identified as Confirmatory Item 3.2.1.1.C in Section 4.2 below.

b. Clarify whether concentration of the boric acid in the coolant on the secondary side of the steam generator would create corrosion concerns for the primary-to-secondary system pressure boundary. If so, clarify the permissible exposure timeframe and discuss how corrosion concerns will be mitigated. In response to the NRC audit process the licensee stated the concern of corrosion and contact time will be identified in the above analysis.

c. Clarify why the design-basis safety-related source of inventory for the auxiliary feedwater system would not be available for ELAP mitigation. In response to the NRC audit process the licensee stated the designed source of water is from the UHS and was designed to provide adequate cooling to get the unit to cold shutdown and into shutdown cooling.

d. In other parts of the submittal, RWST inventory is to be used for other purposes, including makeup to the RCS (page 24) and spent fuel pool (page 40). Identify the quantity of RWST coolant that would be required to supply adequate makeup to each destination (i.e., reactor core, steam generators, spent fuel pool) and confirm that adequate RWST inventory would be available. In response to the NRC audit process the licensee stated the RWST would only be used if the DDAF pump fails and if the UHS is not yet available (i.e. over ground hose not setup).

e. Clarify why RWST level instrumentation would not be necessary to ensure a smooth transition to alternate water sources when it nears depletion. In response to the NRC audit process the licensee stated that RWST level instrument has been identified as a required instrument and will be used to monitor the level and to determine when makeup is required.

f. Clarify how long-term boration of the reactor and spent fuel pool will be provided for after the RWST has been depleted. In response to the NRC audit process the licensee stated that the 450,000 gallons of the RWST would be utilized starting at approximately 8 hours into the event for RCS boration and inventory control. SFP makeup will mainly be provided by the deep well system. An analysis on the length of time the RWST will last has yet to be completed. If needed, additional boration equipment needed during Phase 3 will be added to the site playbook with the RRC. This is identified as Confirmatory Item 3.2.1.1.D in Section 4.2 below.

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

3.2.1.2 RCP Seal Leakage Rates

NEI 12-06, Section 1.3 states:

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

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

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

- WCAP-17601-P, Revision 1, "Reactor Coolant System Response to the Extended Loss of AC Power Event for Westinghouse, Combustion Engineering and Babcock & Wilcox NSSS Designs" dated January 2013 (ADAMS Accession No. ML13042A011 and ML13042A013 (Non-Publically Available)).

- A position paper dated August 16, 2013, entitled "Westinghouse Response to NRC Generic Request for Additional Information (RAI) on Reactor coolant (RCP) Seal Leakage in Support of the Pressurized Water reactor Owners Group (PWROG)" (ADAMS Accession No. ML13190A201 (Non-Publically Available)).

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

1. For the plants using Westinghouse RCPs and seals that are not the SHIELD shutdown seals, the RCP seal initial maximum leakage rate should be greater than or equal to the upper bound expectation for the seal leakage rate for the ELAP event (21 gpm/seal) discussed in the PWROG white paper addressing the RCP seal leakage for Westinghouse plants. If the RCP seal leakage rates used in the plant-specific ELAP analyses are less than the upper bound expectation for the seal leakage rate discussed in the whitepaper, justification should be provided. If the seals are changed to non-Westinghouse seals, the acceptability of the use of non-Westinghouse seals should be addressed, and the RCP seal leakage rates for use in the ELAP analysis should be provided with acceptable justification. This is identified as Confirmatory Item 3.2.1.2.A in Section 4.2 below.

2. In some plant designs, such as those with 1200 to 1300 psia SG design pressures and no accumulator backing of the main steam system power-operated relief valve (PORV) actuators, the cold legs could experience temperatures as high as 580 ^{0}F before cooldown commences. This is beyond the qualification temperature (550 ^{0}F) of the O-rings used in the RCP seals. For those Westinghouse designs, a discussion of the information (including the applicable analysis and relevant seal leakage testing data) should be provided to justify that (1) the integrity of the associated O-rings will be maintained at the temperature conditions experienced during the ELAP event, and (2) the seal leakage rate of 21 gpm/seal used in the ELAP is adequate and acceptable. This is identified as Confirmatory Item 3.2.1.2.B in Section 4.2 below.

3. Some Westinghouse plants have installed or will install the SHIELD shutdown seals, or other types of low leakage seals, and have credited or will credit a low seal leakage rate (e.g., 1 gpm/seal) in the ELAP analyses for the RCS response. For those plants, information should be provided to address the impacts of the Westinghouse 10 CFR Part 21 report, "Notification of the Potential Existence of Defects Pursuant to 10 CFR Part 21," dated July 26, 2013 (ADAMS No. ML13211A168) on the use of the low seal leakage rate in the ELAP analysis.

   During the NRC audit process the licensee was asked several questions concerning the use of low leakage RCP seals. In response, the licensee stated that use of RCP safe shutdown/low leakage seals was not assumed in the strategy. Therefore, the Confirmatory Item associated with shutdown/low leakage seals is not applicable.

4. If the seals are changed to the newly designed Generation 3 SHIELD seals, or non-Westinghouse seals, the acceptability of the use of the newly designed Generation 3 SHIELD seals, or non-Westinghouse seals should be addressed, and the RCP seal leakages rates for use in the ELAP analysis should be provided with acceptable justification. This is identified as Confirmatory Item 3.2.1.2.D in Section 4.2 below.

During the NRC audit process, the licensee was requested to provide the value of the maximum leak-off for each RCP seal in gpm assumed in the ELAP analysis. In response, the licensee stated that the maximum leak-off for each RCP seal in gpm is assumed to be 21 gpm per pump in the ELAP analysis.

During the NRC audit process, the licensee was requested to provide the manufacturer's name and model number for the RCPs and the RCP seals. Further, the licensee was requested to discuss whether or not the RCP and seal combination complies with a seal leakage model described in WCAP-17601. In response, the licensee provided the manufacturer's name and model number as Westinghouse Model 93AS RCPs. The licensee's response did not provide the manufacturer and model number of the RCP seals and did not discuss whether or not the RCP and seal combination complies with a seal leakage model described in WCAP-17601. This is identified as Confirmatory Item 3.2.1.2.E in Section 4.2 below.

During the NRC audit process, the licensee was requested to confirm that the primary ELAP strategy is to perform a symmetric cooldown using all RCS loops. In response, the licensee stated that they will be feeding all four SGs and will be steaming all four SGs symmetrically.

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 RCP seal leakage rates, if these requirements are implemented as described.

3.2.1.3 Decay Heat

NEI Section 3.2.1.2 states in part:

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

Westinghouse completed generic analyses for Westinghouse plants as documented in WCAP-17601-P. During the NRC audit process the licensee was requested to provide the following information: Address the applicability of assumption 4 on page 4-13 of WCAP-17601, which states that "Decay heat is per ANS 5.1-1979 + 2 sigma, or equivalent." If the ANS 5.1-1979 + 2 sigma model is used in the ELAP analysis, specify the values of the following key parameters used to determine the decay heat: (1) initial power level, (2) fuel enrichment, (3) fuel burnup, (4) effective full power operating days per fuel cycle, (5) number of fuel cycles, if hybrid fuels are used in the core, and (6) fuel characteristics based on the beginning of the cycle, middle of the cycle, or end of the cycle. Address the adequacy of the values used. If the different decay heat model is used, describe the specific model and address the acceptability of the model and the analytical results.

In response to the NRC audit process, the licensee stated that they would use WCAP-17601-P as the baseline methodology for establishing the FLEX strategy response. A Byron future update will discuss the details of the WCAP-17601-P methodology. This is identified as Confirmatory Item 3.2.1.3.A in Section 4.2 below.

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

3.2.1.4 Initial Values for Key Plant Parameters and Assumptions

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

On page 3 of the Integrated Plan the licensee listed the conditions for the baseline case to include: dc battery banks are available; ac and dc electrical distribution is available; DDAF pump is available and will start in auto or manual as needed; local manual control of SG Power Operated Relief Valves (PORVs); plant initial response is the same as SBO, WCAP-17601-P; and, no additional single failures of any SSC are assumed (beyond the initial failures that define the ELAP/LUHS scenario in NEI 12-06).

The baseline assumptions included in the Integrated Plan did not include all of the relevant baseline assumptions assumed in NEI 12-06, Sections 3.2.1.2, 3.2.1.3, 3.2.1.4, and 3.2.1.5, or include a listing of the initial plant parameters and assumptions used within the code analyses. An example would be the operating history of the plant prior to the event. Because the code analyses greatly influence the SOE and various time constraints, it is important that the input parameters to these analyses reflect the initial plant conditions and assumptions. The licensee was requested to provide the details of the input parameters used in the code analyses to demonstrate conformance with NEI 12-06, Sections 3.2.1.2, 3.2.1.3, 3.2.1.4, and 3.2.1.5. In response to the NRC audit process, the licensee stated that they will use the WCAP-17601-P as the baseline methodology for establishing the FLEX strategy response. Additional confirmatory evaluations may be needed; however, preliminary evaluations have confirmed that the WCAP-17601-P analyses are bounding for Byron. Implementation of FLEX strategy response actions may be based on more restrictive limits where indicated by plant-specific analyses. The Byron FLEX Integrated Plan strategy will be revised in the February 2014, 6-month update to incorporate changes based on use of WCAP-17601-P as the baseline methodology. This is identified as Confirmatory Item 3.2.1.4.A in Section 4.2 below.

The licensee was requested to list the safety and non-safety systems or equipment that are credited in the ELAP analysis and included in the mitigation strategies. For all the systems or equipment, justify that they are available and reliable to provide the desired functions on demand during the ELAP conditions. In response to the NRC audit process the licensee listed the components and systems used for ELAP mitigation and provided justification that they would be available in accordance with NEI 12-06, Section 3.2.1.3 and are reliable to provide the desired functions.

The licensee was requested to provide an evaluation on how long the DDAF pump can run without support equipment, e.g. ventilation, dc, etc. In response to the NRC audit process the licensee stated that the DDAF pump has three support systems of concern. 1. The DDAF pump has a diesel day tank containing 420 gallons of fuel (controlled by Technical Specifications (TS)) projected to last 7 hours. FSG guidelines are being developed to ensure it can be refilled within that time. Calculation BRW-10-0146-M/BYR10-103, Rev. 1 confirms that even at the TS minimum, fuel will last greater than 7 hours. 2. DDAF batteries are available to provide starting and control power projected to last 8 hours. FSG guidelines are being developed to ensure FLEX power is provided to maintain this source. 3. DDAF pump room temperature conditions will be evaluated to ensure equipment will remain available and for human occupancy. The DDAF pump has a shaft driven SX booster pump providing forced cooling water flow through the room cooler. The DDAF pump also has a shaft driven cooling fan providing forced air circulation through the room cooler. Calculations are being performed to validate 8 hours run time limit and the room environment. The site phase 2 staffing study will ensure the required time can be met. This is identified as Confirmatory Item 3.2.1.4.B in Section 4.2 below.

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

3.2.1.5 Monitoring Instrumentation and Controls

NEI 12-06, Section 3.2.1.10 states in part:

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

On pages 10 and 11 of the Integrated Plan the licensee listed instrumentation to include the instruments listed above. In addition, the licensee indicated that the following parameters will be evaluated for use as the detailed strategy is developed. Closure of this item will be communicated in a future 6-month update. This is identified as Confirmatory Item 3.2.1.5.A in Section 4.2 below.

- Core Exit Thermocouple (CET) Temperature
- RCS Accumulator Level
- Reactor Vessel Level Indicating (RVLIS)
- AFW Flow
- Battery Capacity / DC Bus Voltage
- Neutron Flux

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 Sequence of Events

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

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

On page 5 of the Integrated Plan, the licensee outlines the SOE timeline. The times to complete actions in the events timeline are based on operating judgment, the conceptual designs, and the current supporting analyses. The final timeline will be time validated once detailed designs are completed and procedures are developed, the results will be provided in a future 6-month update. This is identified as Confirmatory Item 3.2.1.6.A in Section 4.2 below.

The PWR Portable Equipment Tables for Phases 2 and 3 on pages 55-60 of the Integrated Plan list several pumps. For Phase 2, the table lists three high head pumps of 40 gpm at 1500 psia for injection to the RCS, three medium head pumps of 300 gpm at 300 psia for injection to the SGs, and two general usage self prime pumps of 1100 gpm at 500 ft. head. For Phase 3, diesel high pressure positive displacement pumps of 1000-3000 psi shutoff head and 60 gpm capacity, a low pressure pump of 300 psi shutoff head and 2500 gpm max flow, a low pressure pump of 500 psi shutoff head and 500 gpm max flow, and a low pressure pump of 150 psi shutoff head and 5000 gpm max flow. During the NRC audit process the licensee was requested to provide the following information:

a. Specify the required times for the operator to realign each of the above discussed pumps and confirm that the required times are consistent with the results of the ELAP analysis.

b. A number of pump capacities and pressures are identified as the requirements given in WCAP-17601-P. Discuss the analyses that are used to justify that the listed flow rates and corresponding pressures of the portable pumps are valid for use at Byron.

The information requested for the above items should include a discussion of the computer codes/methods and assumptions used in the analyses, and address the adequacy of the computer codes/methods and assumptions.

In response to an NRC audit question on operator timing (Item a above), the licensee stated that for the required times, the high head pump should provide borated water flow (if required) to the RCS within 8 hours (estimated as the time of peak xenon concentration in the core), based on WCAP-17601-P recommendations. Site calculations are being performed to determine the actual time make-up and boration are required. The medium head pump is a backup to the DDAF pump for core cooling. Since additional failures are not required to be assumed, there is no deployment time limit, but this pump will be deployed as soon as staffing permits. The low head pump is used to transport water from the UHS to the FLEX pumps available for core cooling supporting the medium head pump. The medium and low pressure pumps can also provide make-up to the SFP. The time limit of 12 hours in non-outage conditions and 8 hours in an outage condition were conservatively chosen to ensure adequate cooling of the SFP.

In response to an NRC audit question on pump performance (Item b above), the licensee stated that the number of phase 2 pumps are associated with meeting the spare capability (N+1) guidance of NEI 12-06. The pump performance values were chosen based on WCAP 17601-P recommendations. Analysis validating pump capacities to meet the above limits are being completed as part of the modification process. The phase 3 equipment listed was based on the initial RRC equipment list they planned on purchasing. This equipment should only be required as a backup to the site FLEX equipment. The final list of RRC equipment will be reviewed to ensure it is adequate to meet the site needs. This is identified as Confirmatory Item 3.2.1.6.B in Section 4.2 below.

Although the SOE indicates that no time constraint exists, the time targeted for connecting the high pressure FLEX pump and supplying borated water makeup is specified as 8 hours (pending calculations to confirm or modify the timing of the boration and quantity). It was not clear from a review of the Integrated Plan that establishing high-pressure borated makeup for reactivity control is the most effective utilization of plant operators at this juncture of an ELAP. In particular, considering the potential for boron injection via accumulator discharge, and in consideration of other risk beneficial actions that operators may take (e.g., promptly establishing a backup supply of makeup to the steam generators), it is not clear whether boration of the reactor coolant system should take precedence over other operator actions that may provide greater risk benefit. Therefore, the NRC staff requested that the licensee provide a discussion of the timing for the need to supply borated makeup water to the RCS and any time constraints associated with the strategy. In response to the NRC audit process, the licensee stated the borated water flow to the RCS is based on WCAP-17601-P recommendations (around peak Xenon). Site calculations are being performed to determine the actual time make up and boration are required. This information will be factored into the ELAP action priority.

During the NRC audit process the licensee was requested to discuss how the plant specific guidance, mitigation strategies, and the associated administrative controls will be developed and implemented to assure that the required operator actions are consistent with that assumed in the ELAP analysis and can be reasonably achievable within the required completion times. In response the licensee stated that plant specific guidance, mitigation strategies, and the associated administrative controls will be developed consistent with WCAP 17601-P guidelines. From the onset of the ELAP event the station governing procedure will be BCA 0.0, Loss of All AC Power. From this procedure the mitigation strategies of the new FSGs will be directed. The Phase 2 staffing study will assure the strategies can be reasonably achieved within the required times. Additional information pertaining to procedures will be provided in the February 2014 update. This is identified as Confirmatory Item 3.2.1.6.C in Section 4.2 below.

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

3.2.1.7 Cold Shutdown and Refueling

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

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

The generic concern related to shutdown and refueling requirements is applicable to Byron. This generic concern has been resolved 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.

Exelon informed the NRC of its plan to abide by and implement this generic resolution for Byron.

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

3.2.1.8 Core Sub-Criticality

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

> All plants provide means to provide borated RCS makeup.

On page 9 of the Integrated Plan the licensee indicates that within 90 minutes, operators will cool down the plant at approximately 75°F/hr to 420°F (Tcold). SG pressure will be approximately 300 psia at this temperature. SG pressure of 300 psia corresponds to RCS pressure necessary to inject safety injection (SI) accumulators. This will ensure RCS pressure is above the minimum pressure to preclude injection of accumulator nitrogen into the RCS.

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

The NRC staff reviewed the licensee's Integrated Plan and determined that the generic concern associated with the modeling of the timing and uniformity of the mixing of a liquid boric acid solution injected into the RCS under natural circulation conditions potentially involving two-phase flow was applicable to Byron.

The Pressurized Water Reactor Owners Group submitted a position paper, dated August 15, 2013 (withheld from public disclosure due to proprietary content), which provides test data regarding boric acid mixing under single-phase natural circulation conditions and outlined applicability conditions intended to ensure that boric acid addition and mixing would occur under conditions similar to those for which boric acid mixing data is available. During the audit process, the licensee informed the NRC staff of its intent to abide by the generic approach discussed above. The NRC staff concluded that the August 15, 2013, position paper was not adequately justified and has not endorsed this position paper. As such, resolution of this concern for Byron is identified as Open Item 3.2.1.8.A in Section 4.1.

In the sequence of events, action item 9, the licensee stated that FLEX pumps are available to supply borated water to the RCS. However, the only source of borated water discussed was the RWST. It is unclear if an alternate source of borated water is available should the RWST be unavailable and there is a need to inject borated water into the RCS. In response to the NRC audit process, the licensee stated that the plant has two RWSTs, each with a capacity of 450,000 gallons, and each being a robust structure. Either tank can be used to provide borated water to either unit.

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 core sub-criticality, if these requirements are implemented as described.

3.2.1.9 Use of Portable Pumps

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

> Regardless of installed coping capability, all plants will include the ability to use portable pumps to provide RPV/RCS/SG makeup as a means to provide diverse capability beyond installed equipment. The use of portable pumps to provide RPV/RCS/SG makeup requires a transition and interaction with installed systems. For example, transitioning … 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.

On page 12 of the Integrated Plan the licensee stated that Phase 2 core cooling will be achieved with a portable FLEX diesel pump and SG PORVs. The pump suction will come from the RWST and/or UHS fed from the well water pumps powered from the portable FLEX DG. The discharge will be into the AFW lines downstream of the containment isolation valves into the SGs. The PORVs will be used to control SG pressure. On page 24 of the Integrated Plan the licensee stated that RCS inventory control during Phase 2 will utilize a portable pump for strategy implementation. On page 55 the licensee lists three high head FLEX pumps (40 gpm at 1500 psia), and three medium head FLEX pumps (300 gpm at 300 psia) identified for core use. On page 56 the licensee lists two portable diesel FLEX pumps (1100 gpm at 500 ft. head) for core and SFP use.

In various sections of the Integrated Plan the licensee stated that they have not finalized the engineering designs for compliance with NRC Order EA-12-049. Detailed designs based on the current conceptual designs will be developed to determine the final plan and associated mitigating strategies. Once these have been fully developed, the licensee will update the Integrated Plan for Byron during a scheduled 6-month update. This update will include any changes to the initial designs as submitted in the February 28, 2013 Integrated Plan. This is identified as Confirmatory Item 3.2.1.9.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 use of portable pumps, if these requirements are implemented as described.

3.2.2 Spent Fuel Pool Cooling Strategies

NEI 12-06, Table 3-2 and Appendix D summarize one acceptable approach for the SFP cooling strategies. This approach uses a portable injection source to provide 1) makeup via hoses on the refuel deck/floor capable of exceeding the boil-off rate for the design basis heat load; 2) makeup via connection to spent fuel pool cooling piping or other alternate location capable of exceeding the boil-off rate for the design basis heat load; and alternatively 3) spray via portable monitor nozzles from the refueling deck/floor capable of providing a minimum of 200 gallons per minute (gpm) per unit (250 gpm to account for overspray). This approach will also provide a vent pathway for steam and condensate from the SFP.

As described in NEI 12-06, Section 3.2.1.7 and JLD-ISG-2012-01, Section 2.1, strategies that have a time constraint to be successful should be identified and a basis provided that the time can be reasonably met. NEI 12-06, Section 3 provides the performance attributes, general criteria, and baseline assumptions to be used in developing the technical basis for the time constraints. Since the event is a beyond-design-basis event, the analysis used to provide the technical basis for time constraints for the mitigation strategies may use nominal initial values (without uncertainties) for plant parameters, and best-estimate physics data. All equipment used for consequence mitigation may assume to operate at nominal setpoints and capacities. NEI 12-06, Section 3.2.1.2 describes the initial plant conditions for the at-power mode of operation; Section 3.2.1.3 describes the initial conditions; and Section 3.2.1.6 describes SFP initial conditions.

NEI 12-06, Section 3.2.1.1 provides the acceptance criterion for the analyses serving as the technical basis for establishing the time constraints for the baseline coping capabilities described in NEI 12-06, which provide an acceptable approach to meeting the requirements of EA-12-049 for maintaining SFP cooling. This criterion is keeping the fuel in the SFP covered.

On page 38 of the Integrated Plan the licensee stated that initial SFP makeup will be accomplished with gravity drain from the RWST. Procedure development will be tracked as an Open item. The closure of this item will be documented in a future 6-month update. Spent Fuel Pool (SFP) makeup is not a time constraint with the initial condition of both units in Mode 1 at 100% power, since the worst-case fuel pool heat load conditions only exist during a refueling outage. Under non-outage conditions, the maximum SFP heat load is 38.5 Mbtu/hr. Loss of SFP cooling with this heat load and an initial SFP temperature of 141 °F results in a time to boil of 7 hours, and 81.96 hours to the top of active fuel. Therefore, completing the equipment line-up for initiating SFP makeup at 12 hours into the event ensures adequate cooling of the spent fuel is maintained. The worst case SFP heat load during an outage is 61.4 Mbtu/hr. Loss of SFP cooling with this heat load and an initial SFP temperature of 163 °F results in a time to boil of 3.1 hours, and 50.16 hours to the top of active fuel. Therefore, completing the equipment line-up for initiating SFP make-up within 8 hours into the event ensures adequate cooling of the spent fuel is maintained. Operator judgment was use to determine the fuel pool timelines. Formal calculations will be performed to validate this information during development of the SFP cooling strategy detailed design, and will be provided in a future 6-month update. Evaluation of the spent fuel pool area for steam and condensation has not yet been performed. The results of this evaluation and the vent path strategy, if needed, will be provided in a future 6-month update. This is identified as Confirmatory Item 3.2.2.A in Section 4.2 below.

On page 39 of the Integrated Plan the licensee stated that the SFP level instrumentation will be installed in accordance with NRC Order EA 12-051 and NEI 12-02, Revision 0.

On page 41 of the Integrated Plan, the licensee stated that SFP cooling will be achieved with a portable FLEX diesel pump. The pump suction will come from the RWST and/or UHS with make-up from Well Water. The discharge will be into the SFP**.** On page 56 of the Integrated Plan, the licensee listed two portable diesel FLEX pumps, each with a capacity of 1100 gpm at 500 feet head to support core and SFP cooling use.

On page 38 of the Integrated Plan the licensee stated that the completion of system alignments and the initiation of flow to the spent fuel pool may occur after the pool has begun to boil for the worst-case spent fuel pool heat load. During the NRC audit process the licensee was requested to clarify whether operator actions in the vicinity of the spent fuel pool would be necessary to set up equipment and initiate flow following the initiation of boiling in the spent fuel pool. If local operator actions would be relied upon once spent fuel pool boiling has initiated, please provide justification that the resulting environmental conditions satisfy habitability requirements for the time duration necessary to complete the actions. In response to the NRC audit process the licensee stated that there are manual actions that must be completed in the SFP area to set up pool makeup temporary hoses and to make the RCS inventory control alternate connection. The site plans to perform these actions prior to the onset of boiling as directed in the FSGs.

The licensee’s approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01 and 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 SFP cooling, if these requirements are implemented as described.

3.2.3 Containment Functions Strategies

NEI 12-06, Table 3-2 and Appendix D provide some examples of acceptable approaches for demonstrating the baseline capability of the containment strategies to effectively maintain containment functions during all phases of an ELAP. One of these acceptable approaches is by analysis.

In support of the original Integrated Plan, the licensee performed MAAP calculations to demonstrate that no Phase 1, 2, or 3 actions would be required to remove heat and protect the containment functions following an ELAP event. However, the MAAP analysis, which determined the limiting case occurs when Auxiliary Feedwater flow is not established, was terminated at 2.6 hours when the water level in the reactor vessel reached the top of active fuel. This was insufficient to demonstrate that the proposed strategy of taking no action would be successful in meeting the intent of the order and protecting the containment functions in all Phases of an ELAP. In the NRC audit process, the licensee was requested to clarify that additional MAAP analyses will be performed which demonstrate that containment functions will be maintained throughout all Phases of an ELAP. In response to this request, the licensee stated that additional analysis will be performed using WCAP-17601-P as the baseline methodology to demonstrate the temperature and pressure will be maintained within acceptable limits throughout all phases of an ELAP. Review of the additional containment analyses has been identified as Confirmatory Item 3.2.3.A in Section 4.2 below.

In the Integrated Plan, there are no instruments specified which will provide the operators with the temperature inside the containment. Excessive temperatures could result in a loss of containment integrity due to the failure of containment penetration seals or other portions of the containment boundary. Furthermore, excessive temperatures could result in the failure of necessary measurement instruments located in the containment. The NRC staff requested that the licensee provide a discussion and the technical basis for concluding that the temperature inside containment will not need to be monitored to inform the operators of the potential to exceed the limits of penetration seals or other equipment. In response to the NRC audit process the licensee stated that containment temperature will be evaluated as an additional parameter for monitoring containment. This is identified as Confirmatory Item 3.2.3.B in Section 4.2 below.

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

3.2.4 Support Functions

3.2.4.1 Equipment Cooling – Cooling Water

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

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

Portable FLEX equipment used for coping strategies identified in the Integrated Plan that would require some form of cooling are portable diesel powered pumps and generators. These self-contained commercially available units would not be expected to require an external cooling system nor would they require ac power or normal access to the UHS.

On page 10 of the Integrated Plan, the licensee stated that modifications will be necessary to prevent the DDAF pump from overheating due to cooling water recirculation flow paths within the SX system cycling and overheating the pump within 1 hour. The staff determined it was necessary for confirmation that this modification has been performed to prevent DDAF pump from overheating due to cooling water recirculation flow paths within the SX system cycling and overheating the pump within 1 hour. This is identified as Confirmatory Item 3.2.4.1.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 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 in part:

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

On page 49 of the Integrated Plan, the licensee stated that critical ventilation assets may be required to support DDAF pumps, station battery rooms, miscellaneous electric equipment rooms, and fuel handling building personnel habitability and/or component survivability. Specific analyses of these rooms are open items and will be addressed as part of the detailed engineering design phase. During the NRC audit process a number of questions associated with ventilation effects on equipment operation were asked.

Updated information provided by the licensee as part of the audit response identified that the DDAF pump room cooler and shaft driven fan that will provide normal cooling for the room per design and they will be confirmed by calculations.

The licensee also stated the SG PORV's are manually operated within the MSSV room next to an outside access door and this door would be open to allow access for manual operation of the valves. This will allow the operator to exit the room minimizing heat stress times and maintain communication with the control room.

The licensee indicated that the evaluation of the rooms would be documented in a future 6-month update. This is identified as Confirmatory Item 3.2.4.2.A in Section 4.2 below.

The licensee did not provide a discussion in the Integrated Plan regarding the effects of extreme high/low temperatures (i.e., temperatures above/below those assumed in the sizing calculation for each battery) on each battery's capability to perform its function for the duration of the ELAP event. The licensee also did not provide a discussion on the need for hydrogen gas ventilation for the station battery rooms when the batteries are being recharged during Phase 2 and 3.

The licensee provided updated information as part of the audit response process which stated that operating conditions can change the available capacity of the battery and these factors will be considered in the battery coping evaluation. The available capacity of the battery decreases as its temperature decreases and also sustained high ambient temperature can result in reduced battery life. The licensee also provided updated information stating that hydrogen buildup as a result of loss of ventilation is being evaluated. This has been 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, 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.

In its Integrated Plan, the licensee did not address the loss of heat tracing. The licensee screened in for extreme cold, ice and snow and thus there is a need for the licensee to address loss of heat tracing effects on FLEX strategies in its Integrated Plan.

During the NRC audit process, the licensee was requested to provide additional justification that the proposed mitigation strategies are adequate for extreme cold weather events, addressing the following specific items:

(a) Considering an ELAP under extreme cold weather conditions with the plant in a shutdown or refueling mode, could significant surface icing exist on sources of makeup water on which FLEX pumps will take suction? If so, clarify how the mitigation strategy will adequately address this scenario. In response to the NRC audit process the licensee stated that the site consists of two reactors with alternate refueling outages (Spring and Fall) maintaining at least one heat source for the UHS typically both units during the winter. In the event of a BDBEE, both units will trip, but it is reasonable to assume it will take a few days for the UHS to cool and form an ice layer. In addition, with the operation of the DDAF pump there will be approximately 600 gpm of flow back to the UHS, which will aid in the prevention of ice formation.

(b) Discuss whether the potential for an extreme cold event to result in boric acid precipitation or the freezing of water in equipment that would be subject to abnormally low temperatures (e.g., installed piping, instrument lines, and tanks; FLEX piping and hoses, FLEX equipment used to prepare additional borated coolant) has been analyzed and verified as being unable reduce or interrupt the flow of coolant necessary to mitigate an ELAP. In responding, account for the potential for loss of normal heating, heat tracing, etc., due to the ELAP event. In response to the NRC audit process, the licensee stated that the RWSTs are the source of borated water. The tanks are insulated and contain a minimum of 450,000 gallons of water during online operations. The RWST heaters are energized at 48 °F to maintain tank temperature during abnormally cold conditions. The RWSTs contain 2300 ppm borated water. If an ELAP would occur during abnormally cold conditions, boric acid precipitation may occur within outside stagnant FLEX temporary hose line and may eventually occur within the RWSTs as they cool. Byron will develop a FLEX strategy to ensure an RCS inventory an boration water source is available for a BDBEE. Addressing potential adverse effects from the loss of heat tracing and normal heating on any equipment credited for ELAP mitigation is Confirmatory Item 3.2.4.3.A in Section 4.2 below.

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

The licensee's Integrated Plan did not provide any information on whether plant procedures and guidance will include lighting such as flashlights or headlamps necessary for ingress and egress to plant areas required for deployment of the strategies. In response to the NRC audit process, the licensee stated that the site has Appendix R lighting, with battery backup, installed throughout the plant. These lights should last for about 8 hours. The site has purchased 10 stand mounted floodlights, 5 portable light strings and 6 5500 watt portable diesel generators to assist with temporary lighting. These lights will be positioned where needed depending on the event and operator needs. Additionally, operators will be provided flashlights to assist with executing the strategies.

The NRC staff has reviewed the licensee communications assessment (ADAMS Accession Nos. ML12306A199 and ML13056A135) in response to the March 12, 2012 50.54(f) request for information letter for Byron and, as documented in the staff analysis (ADAMS Accession No. ML13114A067) has determined that the assessment for communications is reasonable, and the analyzed existing systems, proposed enhancements, and interim measures will help to ensure that communications are maintained. Therefore, there is reasonable assurance that the guidance and strategies developed by the licensee will conform to the guidance of NEI 12-06 Section 3.2.2 (8) regarding communications capabilities during an ELAP. This has been identified as Confirmatory Item 3.2.4.4.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 lighting and portable communications, if these requirements are implemented as described.

3.2.4.5 Protected and Internal Locked Area Access

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

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

The licensee's Integrated Plan did not provide any discussion on the development of guidance and strategies to the access protected and internal locked areas. In response to the NRC audit process, the licensee stated that during a BDBEE with an ELAP, the site security doors electronic latches will fail in the latched position. The operators currently have ample security keys with the main control room that will be used to open these doors to ensure the overall integrated strategy can be successfully executed. In addition, site security will be available to assist in allowing access to the required vital areas. The turbine building and fuel handling track way doors have electric motors, which can be bypassed locally and operated with a manual pull chain operator.

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

3.2.4.6 Personnel Habitability – Elevated Temperature

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

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

Section 9.2 of NEI 12-06 states,

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

On page 38 of the Integrated Plan, the licensee stated that an evaluation of the spent fuel pool area for steam and condensation has not yet been performed. The results of this evaluation and the vent path strategy, if needed, will be provided in a future 6-month update. This has been previously included with Confirmatory Item 3.2.2.A in Section 4.2 below.

On page 49 of the Integrated Plan, the licensee stated that operational command and control will be maintained within the main control room. Habitability conditions will be evaluated and a strategy will be developed to maintain main control room habitability. The strategy and associated support analyses will be provided in a future 6-month update. Critical ventilation assets may be required to support DDAF pumps, station battery rooms, miscellaneous electric equipment rooms, and fuel handling building personnel habitability and/or component survivability. Specific analyses of these rooms are open items and will be addressed as part of the detailed engineering design phase. Closure of these items will be documented in a future 6-month update. This is identified as Confirmatory Item 3.2.4.6.A in Section 4.2 below.

In response to the NRC audit process the licensee stated that the SG PORVs are manually operated within the main steam stop valve (MSSV) room next to an outside access door. This door will be opened to allow access for manual operation and allow the operator to exit the room/area to assure potential heat stress stay times and enhance communications with the control room.

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, if these requirements are implemented as described.

3.2.4.7 Water Sources.

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

> *Plant procedures/guidance should ensure that a flow path is promptly established for makeup flow to the steam generator/nuclear boiler and identify backup water sources in order of intended use. Additionally, plant procedures/guidance should specify clear criteria for transferring to the next preferred source of water.*
>
> Under certain beyond-design-basis conditions, the integrity of some water sources may be challenged. Coping with an ELAP/LUHS may require water supplies for multiple days. Guidance should address alternate water sources and water delivery systems to support the extended coping duration. Cooling and makeup water inventories contained in systems or structures with designs that are robust with respect to seismic events, floods, and high winds, and associated missiles are assumed to be available in an ELAP/LUHS at their nominal capacities. Water in robust UHS piping may also be available for use but would need to be evaluated to ensure adequate NPSH can be demonstrated and, for example, that the water does not gravity drain back to the UHS. Alternate water delivery systems can be considered available on a case-by-case basis. In general, all CSTs should be used first if available. If the normal source of makeup water (e.g., CST) fails or becomes exhausted as a result of the hazard, then robust demineralized, raw, or borated water tanks may be used as appropriate.
>
> Heated torus water can be relied upon if sufficient [net positive suction head] NPSH can be established. Finally, when all other preferred water sources have been depleted, lower water quality sources may be pumped as makeup flow using available equipment (e.g., a diesel driven fire pump or a portable pump drawing from a raw water source). Procedures/guidance should clearly specify the conditions when the operator is expected to resort to increasingly impure water sources.

The licensee addressed water sources, including the use of the UHS fed from well water pumps, and RWSTs for coping strategies in its Integrated Plan for RCS cooling, RCS inventory control, and SFP cooling. In addition, a backup water source will be established with a FLEX diesel pump and temporary hoses taking suction from the UHS via a dry hydrant to be installed to support this strategy. Makeup flow is immediately established to the SG during the initial phase of the ELAP strategies.

On page 12 of the Integrated Plan the licensee identifies the pump suction for the portable FLEX diesel pump used to provide water into the AFW lines for core cooling as coming from the RWST and/or the UHS fed from the well water pumps powered from a portable FLEX DG. The licensee was requested to provide more information on the power supply for the well water pump the licensee intends to use during Phase 2. In response to the NRC audit process, the licensee stated that well water pumps are powered from the UHS switchgear busses 131Z and 132Z. They will have additional 150 kw diesel generator stored in the FLEX storage building and deployed outside the switchgear room. The diesel generator will be tied into the bus via the same type of electrical connection used for the division 2 power restoration. Isolation will be verified by opening the supply breaker to the affected busses prior to connection.

On page 9 of the Integrated Plan the licensee stated it will obtain water from the SX system, yet the assumptions state a loss of normal access to the UHS. The licensee stated the transfer from CST to SX is lost when ac is lost. The licensee was requested to provide additional information on water supply to the diesel driven AFW pump, and whether it is qualified to survive seismic, high winds, and flooding events. In response to the NRC audit process, the licensee stated that the SX piping from the UHS to the DDAF pump is qualified to survive seismic, high winds, and flooding events. Although the motive force is lost, i.e. the pumps with no prospect for recovery, gravity will supply the motive force to provide the necessary net positive suction head to the DDAF pump. The licensee stated that time validation studies show that flow from the DDAF pump can be established within 50 minutes if the CSTs are lost. This time is less than the times for steam generator dryout calculated with the MAAP4 code and in a generic calculation with NOTRUMP in WCAP-17601-P. However, a significant difference in the predicted dryout times for these two calculations was observed, and the staff requested that the licensee clarify which (if any) of these calculations contains initial conditions and analytical assumptions that are representative of Byron. A satisfactory answer to this question was not provided during the audit. Therefore, justification of the time at which steam generator dryout would occur is considered Confirmatory Item 3.2.4.7.A in Section 4.2 below.

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

3.2.4.8 Electrical Power Sources/Isolations and Interactions.

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

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

On page 55 and 56 of the Integrated Plan, the licensee lists four 480V/500kw generators, and six portable 5500w generators.

The licensee's Integrated Plan omits discussion of electrical isolation and interactions for the portable FLEX generator and the 480V ESF busses to prevent simultaneously supplying power to the same bus from different sources. The licensee was requested to discuss how electrical isolation and interaction is achieved. In response to the NRC audit process, the licensee stated that electrical isolation will be provided as part of the FSG guidance. The feed breakers for the 480V busses will be opened prior to repowering with the FLEX generator. This has been identified as Confirmatory Item 3.2.4.8.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, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to electrical power sources/isolations and Interactions, if these requirements are implemented as described.

3.2.4.9 Portable Equipment Fuel.

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

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

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

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

On page 49 of the Integrated Plan, the licensee stated that a portable diesel generator will provide power to one division of the 480V ESF busses. Repowering at this level will permit MCCs powering critical equipment such as diesel fuel oil transfer pumps.

In various sections of the Integrated Plan the licensee stated that for Phase 3, a support component would be a portable refuel vehicle with a large diesel oil bladder to support refilling the FLEX diesel tanks.

Although the licensee's plan provides for repowering the diesel fuel oil transfer pumps, there is no discussion of how the fuel oil will be assessed in the plant specific analysis to ensure sufficient quantities are available as well as to address delivery capabilities. The licensee was requested to provide a discussion on portable equipment fuel delivery. In response to the NRC audit process, the licensee stated that the discharge of the fuel oil transfer pump is being modified with a tee and isolation valve within the B main diesel generator rooms. This connection, along with temporary hoses and reenergizing the fuel oil transfer pumps will provide a fuel source for the FLEX equipment. The F-750 is being equipped with two 118-gallon tanks to provide fuel delivery capability. The Unit 1 & 2 "B" fuel oil tanks contain 100,000 gallons. There are other large (125,000 and 50,000 gallon) storage tanks that are not robust, but would be used if available. It is reasonable to assume the supply would last until roads can be reopened and local tanks can replenish the supply. The complete analysis of fuel usage requirements will be developed after the specific FLEX equipment is identified and the fuel usage is determined. The licensee did not address actions to maintain the quality of fuel stored in the tanks for extended periods of time. This is identified as Confirmatory Item 3.2.4.9.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, 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.

On page 5 of the Integrated Plan the licensee stated that the EC calculation shows the dc bus 112 voltage will be below acceptable values after 3.6 hours without operator action. The licensee was requested to provide the minimum voltage that must be maintained and the basis for the minimum voltage on the dc bus. In response to the NRC audit process, the licensee stated that for this event a minimum allowable battery voltage of 107.8 VDC was used as the acceptance criteria for determining battery adequacy. The instrument inverters have a minimum dc input value of 105 VDC thus the voltage used is conservative. The EC-evaluation accounts for the minimum inverter voltage capability and the voltage drop between the battery and inverter.

On page 48 of 67, in the Integrated Plan, the licensee stated that dc power is required to maintain control of ESF equipment and vital instrumentation. Battery chargers are de-energized during a BDBEE leading to loss of dc and associated functions. The present 125 VDC battery coping time is approximately 3 hours 36 minutes, without load shedding and can be extended to 5 hours 40 minutes with deep load shedding consistent with procedure BCA 0.0, Loss of All AC Power. The license was requested to provide the following information:

a. Provide the direct current (dc) load profile for the mitigating strategies to maintain core cooling, containment, and spent fuel pool cooling during all modes of operation.

b. Provide a detailed discussion on the loads that will be shed from the dc bus, the equipment location (or location where the required action needs to be taken), and the required operator actions needed to be performed and the time to complete each action. In your response, explain which functions are lost as a result of shedding each load and discuss any impact on defense in depth and redundancy.

c. Are there any plant components that will change state if vital ac or dc is lost, de-energized, during this evolution of dc load shed? When the operators manipulate dc breakers to load shed, will plant components actuate, de-energize pumps, etc.? The staff is particularly interested that a safety hazard is not created, such as de-energizing the dc powered seal oil pump for the main generator, which would allow the hydrogen to escape to the atmosphere, which may cause an explosion or fire, and may be compounded by high heat from the main turbine bearings if not cooled.

In response to the NRC audit process the licensee the licensee stated that the details of each load that will be shed and which components will change state is being developed and will be communicated in future updates. The load shedding is performed within 4 panels close to the control room all on the same elevation. It is reasonable to assume an operator can travel to and locate these panels within 5 minutes even if an alternate path is required. It is also reasonable to assume that the breakers can be identified an opened within 25 minutes. Times will be validated as part of the phase 2 staffing study.

In regards to loads that are shed, they have been pre-evaluated in existing station emergency procedures and no new issue will be created in our load shed. The seal oil pump is powered from a 250V battery and will not be shed. The FSGs being developed will cover the generator hydrogen dumping before it can leak into the turbine building.

The licensee is requested to describe the electrical power requirements for Phase 3 of the mitigating strategies Integrated Plan and provide the capacity of the power sources. In addition, provide a summary of the sizing calculation for the FLEX generators to show that they can supply the loads assumed in phases 2 and 3. In response to the NRC audit process, the licensee stated the sizing calculation for the FLEX generators and analysis for the capacity of the power sources/electrical power requirement for Phase 2 and 3 will be performed as part of the detailed design process. Initial results indicate a 150kw diesel generator will suffice. This is identified as Confirmatory Item 3.2.4.10.A in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to load shed 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, following item (15) states:

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

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

NEI 12-06, Section 11.5 states:

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

2. Portable equipment that directly performs a FLEX mitigation strategy for the core, containment, or SFP should be subject to maintenance and testing[1] guidance provided in INPO AP 913, Equipment Reliability Process, to verify proper function. The maintenance program should ensure that the FLEX equipment reliability is being achieved. Standard industry templates (e.g., EPRI) and associated bases will be developed to define specific maintenance and testing including the following:

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

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

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

3. The unavailability of equipment and applicable connections that directly performs a FLEX mitigation strategy for core, containment, and SFP should be managed such that risk to mitigating strategy capability is minimized.

    a. The unavailability of installed plant equipment is controlled by existing plant processes such as the Technical Specifications. When installed plant equipment which supports FLEX strategies becomes unavailable, then the FLEX strategy affected by this unavailability does not need to be maintained during the unavailability.

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

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

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

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

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

On page 8 of the Integrated Plan, the licensee stated they will implement an administration program for FLEX to establish responsibilities, and testing & maintenance requirements. A plant system designation will be assigned to FLEX equipment, which requires configuration controls associated with systems. This will establish responsibilities, maintenance and testing requirements for all components associated with FLEX. Unique identification numbers will be assigned to all FLEX components included in the system. Equipment associated with these strategies will be procured as commercial equipment with design, storage, maintenance, testing, and configuration control as outlined in JLD-ISG-2012-01 section 6 and NEI 12-06 section 11. Installed structures, systems and components pursuant to 10 CFR 50.63 (a) will continue to meet the augmented quality guidelines of Regulatory Guide 1.155, Station Blackout. Standard industry preventive maintenance (PM) will be developed to establish maintenance and testing frequencies based on type of equipment and will be within EPRI guidelines. Testing procedures will be developed based on the industry PM templates and Exelon standards.

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 would maintain FLEX equipment such that it would be readily available for use. The technical report provided sufficient basis to resolve this concern by describing a database that licensees could use to develop preventative maintenance programs for FLEX equipment. The database describes maintenance tasks and maintenance intervals that have been evaluated as sufficient to provide for the readiness of the FLEX equipment. The NRC staff has determined that the technical report provides an acceptable approach for developing a program for maintaining FLEX equipment in a ready-to-use status. The NRC staff will evaluate the resulting program through the audit and inspection processes.

During the NRC audit process, the licensee stated that the EPRI PM templates for maintenance and testing of the FLEX equipment have yet to be issued. The templates will be reviewed and applied to the FLEX equipment as part of the standard Exelon process. Model work requests, surveillance tests and maintenance procedures will be developed, as appropriate, to control and implement the recommended maintenance/testing 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 provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to maintenance and testing, if these requirements are implemented as described.

3.3.2 Configuration Control.

NEI 12-06, Section 11.8 states:

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

On page 4 of the Integrated Plan, the licensee state that the pre-planned strategies developed to protect the public health and safety will be incorporated into the unit emergency operating procedures in accordance with established EP change processes, and their impact to the design basis capabilities of the unit evaluated under 10 CFR 50.59. The plant Technical Specifications contain the limiting conditions for normal unit operations to ensure that design safety features are available to respond to a design basis accident and direct the required actions to be taken when the limiting conditions are not met. The result of the beyond-design-basis event may place the plant in a condition where it cannot comply with certain Technical Specifications, and, as such, may warrant invocation of 10 CFR 50,54(x) and/or 10 CFR 73.55(p) (Ref. 3).

On page 7 of the Integrated Plan, the licensee stated that a plant system designation will be assigned to FLEX equipment, which requires configuration controls associated with systems.

Unique identification numbers will be assigned to all FLEX components included in the system. Equipment associated with these strategies will be procured as commercial equipment with configuration control as outlined in JLD-ISG-2012-01 section 6 and NEI 12-06 section 11.

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

3.3.3 Training.

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

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

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

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

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

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

On pages 8 and 9 of the Integrated Plan, the licensee stated that training materials for FLEX will be developed for all station staff involved in implementing FLEX strategies. For accredited training programs, the Systematic Approach to Training (SAT) will be used to determine training needs. For other station staff, a training overview will be developed and communicated. Closure of this item will be communicated in a future 6-month update.

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

3.4 OFFSITE RESOURCES

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

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

On page 9 of the Integrated Plan, the licensee stated that they have contractual agreements in place with the SAFER. The industry will establish two (2) RRCs located in Tennessee and Arizona to support utilities during beyond design basis events. Each RRC will hold five (5) sets of equipment, four (4) of which will be able to be fully deployed when requested, the fifth set will have equipment in a maintenance cycle. Equipment will be moved from an RRC to a local Assembly Area, established by the SAFER team and the utility. Communications will be established between the affected nuclear site and the SAFER team and required equipment moved to the site as needed. First arriving equipment, as established during development of the nuclear site's playbook will be delivered to the site within 24 hours from the initial request. Development of Byron Station's playbook will be communicated in a future 6-month update.

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

4.0 OPEN AND CONFIRMATORY ITEMS

4.1 OPEN ITEMS

Item Number	Description	Notes
3.2.1.8.A	Core Subcriticality - The NRC staff concluded that the August 15, 2013, position paper on boron mixing was not adequately justified and has not endorsed this position paper.	

4.2 CONFIRMATORY ITEMS

Item Number	Description	Notes
3.1.1.1.A	Storage & Protection of FLEX equipment – Confirm final design of FLEX storage structure conforms to NEI 12-06, Sections 5.3.1, 7.3.1, and 8.3.1 for storage considerations for the hazards applicable to Byron.	
3.1.1.3.A	Procedural Interface Considerations (Seismic) – Confirm procedure for measuring key instruments at containment penetrations using portable instrument.	
3.1.1.3.B	Impact of failure of a not seismically robust downstream dam – Confirm that the site is either not situated with not seismically robust downstream dams or the potential failure of such a dam has been accounted for in the development of the guidance and strategies.	
3.1.1.4.A	Off-Site Resources – Confirm RRC local staging area and method of transportation to the site in future 6-month update..	
3.1.5.1.A	Protection of Equipment (High Temperature) – Confirm FLEX storage structure will maintain FLEX equipment at a temperature range to ensure its likely function when called upon.	
3.1.5.3.A	Deployment of Equipment (High Temperature) – Confirm that the effects of high temperature on FLEX equipment have been evaluated in the locations they are intended to operate.	
3.2.1.A	RCS cooling & RCS inventory control - Specify which analysis performed in WCAP-17601 is being applied to Byron. Additionally, justify the use of that analysis by identifying and evaluating the important parameters and assumptions demonstrating that they are representative of Byron and appropriate for simulating the ELAP transient.	
3.2.1.1.A	NOTRUMP – Confirm that the use of NOTRUMP in the ELAP analysis is limited to the flow conditions before reflux condensation initiates. This includes specifying an acceptable definition for reflux condensation cooling.	

3.2.1.1.B	ELAP Analysis – Confirm calculations to verify no nitrogen injection into RCS during depressurization.	
3.2.1.1.C	Confirm analysis for SG plugging due to the use of abnormal water sources (RWST, well water, SX water)	
3.2.1.1.D	Complete analysis for length of time prior to depletion of the RWST and determine whether additional boration equipment is needed for Phase 3 coping strategy.	
3.2.1.2.A	RCP Seal Leakage - For the plants using Westinghouse RCPs and seals that are not the SHIELD shutdown seals, the RCP seal initial maximum leakage rate should be greater than or equal to the upper bound expectation for the seal leakage rate for the ELAP event (21 gpm/seal) discussed in the PWROG white paper addressing the RCP seal leakage for Westinghouse plants (Reference 2). If the RCP seal leakage rates used in the plant-specific ELAP analyses are less than the upper bound expectation for the seal leakage rate discussed in the whitepaper, justification should be provided. If the seals are changed to non-Westinghouse seals, the acceptability of the use of non-Westinghouse seals should be addressed, and the RCP seal leakage rates for use in the ELAP analysis should be provided with acceptable justification.	
3.2.1.2.B	RCP Seal Leakage - In some plant designs, such as those with 1200 to 1300 psia SG design pressures and no accumulator backing of the main steam system power-operated relief valve (PORV) actuators, the cold legs could experience temperatures as high as 580 ^{0}F before cooldown commences. This is beyond the qualification temperature (550 ^{0}F) of the O-rings used in the RCP seals. For those Westinghouse designs, a discussion of the information (including the applicable analysis and relevant seal leakage testing data) should be provided to justify that (1) the integrity of the associated O-rings will be maintained at the temperature conditions experienced during the ELAP event, and (2) the seal leakage rate of 21 gpm/seal used in the ELAP is adequate and acceptable.	
3.2.1.2.D	RCP Seal Leakage Rates - If the seals are changed to the newly designed Generation 3 SHIELD seals, or non-Westinghouse seals, the acceptability of the use of the newly designed Generation 3 SHIELD seals, or non-Westinghouse seals should be addressed, and the RCP seal leakages rates for use in the ELAP analysis should be provided with acceptable justification.	
3.2.1.2.E	RCP Seal Leakage Rates – The licensee is requested to provide the manufacturer and model number of the RCP seals and discuss whether or not the RCP and seal combination complies with a seal leakage model described in WCAP-17601.	
3.2.1.3.A	Decay Heat - Verify that the Integrated Plan update provides the details of the WCAP 17601-P methodology to include the values of the following key parameters used to determine the decay heat: (1) initial power level, (2) fuel enrichment, (3) fuel burnup, (4) effective full power operating days per fuel cycle, (5) number of fuel cycles, if hybrid fuels are used in the core, and (6) fuel	

	characteristics based on the beginning of the cycle, middle of the cycle, or end of the cycle. Address the adequacy of the values used.	
3.2.1.4.A	Initial Values for Key Plant Parameters and Assumptions – Confirm WCAP-17601-P analyses are bounding for Byron for strategy response or verify plant-specific analyses if more restrictive limits are used due to more restrictive plant specific limits.	
3.2.1.4.B	Initial Values for Key Plant Parameters and Assumptions – Confirm calculations to validate 8 hours run time limit on DDAF pump batteries and DDAF room temp for pump operation and human occupancy. Also, confirm site phase 2 staffing study confirms the required time can be met for refilling diesel day tank.	
3.2.1.5.A	Monitoring Instruments and Control – Confirm additional parameters evaluated for use in plant procedures/guidance or to indicate imminent or actual core damage.	
3.2.1.6.A	Sequence of Events – Confirm that the final timeline has been time validated after detailed designs are completed and procedures are developed. The results will be provided in a future 6-month update.	
3.2.1.6.B	Sequence of Events – Confirm analysis to validate Phase 2 pump capacities.	
3.2.1.6.C	Sequence of Events – Confirm that Phase 2 staffing study ensures that the FLEX strategies can be reasonably achieved within the required times.	
3.2.1.9.A	Use of portable pumps – Confirm final design of strategies meets "use of portable pumps" guideline in NEI 12-06 Section 3.2.2 Guideline 13.	
3.2.2.A	SFP cooling – Verify procedure for SFP makeup via gravity drain; confirm verification of timeline for performing the strategy; and confirm evaluation of SFP area for steam and condensation affects.	
3.2.3.A	Containment – Confirm containment reanalysis supports no Phase 1, 2, and 3 mitigation strategies are required because containment pressure and temperature are maintained within acceptable limits.	
3.2.3.B	Containment – Confirm evaluation performed for the need to monitor containment temperature.	
3.2.4.1.A	Equipment cooling – Confirm modification has been performed to prevent DDAF pump from overheating due to cooling water recirculation flow paths within the SX system cycling and overheating the pump within 1 hour.	
3.2.4.2.A	Ventilation – Equipment Cooling - Review licensee's evaluation of loss of ventilation effects on equipment in various rooms (TDAF pump room, battery rooms, control room, miscellaneous electrical equipment rooms)	
3.2.4.2.B	A discussion is needed on the extreme high/low temperature effects of the batteries capability to perform its function for the duration of the ELAP event and hydrogen gas ventilation during recharging batteries during Phase 2 and 3.	

3.2.4.3.A	Heat Tracing – Confirm that potential adverse impacts from a loss of heat tracing and normal heating on any equipment credited for ELAP mitigation are adequately addressed. In particular, ensure an RCS inventory and source of borated water is available for a BDBEE associated with extreme cold, ice, and snow.	
3.2.4.4.A	Communications - Confirm that upgrades to the site's communications systems have been completed.	
3.2.4.6.A	Personnel Habitability - Review licensee's evaluation of loss of ventilation effects on personnel habitability and accessibility.	
3.2.4.7.A	Water Sources - Justify the time to which SG dryout will occur. A satisfactory answer was not provided by the licensee in response to the audit request.	
3.2.4.8.A	Electrical Power Sources / Isolation and interactions – confirm class 1E equipment is protected from faults in portable/FLEX equipment and multiple sources do not attempt to power electrical buses.	
3.2.4.9.A	Portable Equipment Fuel - Confirm that complete analysis of fuel usage requirements has been developed after the specific FLEX equipment is identified and the fuel usage is determined. A discussion is needed on maintaining the quality of fuel stored in the tanks for extended periods of time	
3.2.4.10.A	Load reduction to conserve dc power – Confirm sizing calculations for FLEX generators and details of load shedding.	