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

November 20, 2013

Exelon Generation Company, LLC
Quad Cities Nuclear Power Station
Docket Nos. 50-254, 50-265

Prepared for:

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

Contract NRC-HQ-13-C-03-0039
Task Order No. NRC-HQ-13-T-03-0001
Job Code: J4672
TAC Nos.: MF1048 and MF1049

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# Quad Cities Nuclear Generating Station
# Order EA-12-049 Evaluation

## 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. ML13060A420), and as supplemented by the first six-month status report in letter dated August 28, 2013 (ADAMS Accession No. ML13241A287), Exelon Generation Company, LLC (the licensee) provided Quad Cities Nuclear Generating Station (QCNGS) Integrated Plan for Compliance with Order EA-12-049. The Integrated Plan describes the strategies and guidance under development for implementation by the licensee for the maintenance or restoration of core cooling, containment, and SFP cooling capabilities following a BDBEE, including modifications necessary to support this implementation, pursuant to Order EA-12-049. By letter dated August 28, 2013 (ADAMS Accession No. ML13234A503), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049. That letter described the process used by the NRC staff in its review, leading to the issuance of an interim staff evaluation and audit report. The purpose of the staff's audit is to determine the extent to which the licensees are proceeding on a path towards successful implementation of the actions needed to achieve full compliance with the order.

## 3.1 EVALUATION OF EXTERNAL HAZARDS

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

### 3.1.1 Seismic Events.

NEI 12-06, Section 5.2 states:

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

The licensee's Integrated Plan identified the Safe Shutdown Earthquake (SSE) to be 0.24 g horizontal ground motion with a simultaneous vertical acceleration of 0.16 g. as identified in the QCNPS Updated Safety Analysis Report (USAR). The licensee also confirmed on page 1 of their integrated plan that the site screens in for an assessment for the seismic hazard. The licensee also stated on page 2 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 seismic screening if these requirements are implemented as described.

#### 3.1.1.1 Protection of FLEX Equipment – Seismic Hazard

NEI 12-06, Section 5.3.1 states:

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

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

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

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

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

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

On pages 17, 18 27, 35 and 44 of the Integrated Plan, the licensee stated it plans on storing FLEX equipment in new structures that will be constructed to meet the guidance of NEI 12-06, Section 11. By reference in NEI 12-06, Section 11.3, the structures will conform to the guidance of NEI 12-06, Section 5.3.1, item 1.a or 1.b. During the audit process, the licensee confirmed that the FLEX pumps, generators, hose trailers and haul and debris removal truck will be stored in protected building(s). The licensee also identified that anchor points, sufficient clearance or other applicable means will be used to ensure seismic interactions do not impact the station's ability to implement the FLEX equipment. Also, the equipment will be secured or within secured storage cabinets.

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

> The baseline capability requirements already address loss of non-seismically robust equipment and tanks as well as loss of all AC. So, these seismic considerations are implicitly addressed.
>
> There are five considerations for the deployment of FLEX equipment following a seismic event:
>
> 1. If the equipment needs to be moved from a storage location to a different point for deployment, the route to be traveled should be reviewed for potential soil liquefaction that could impede movement following a severe seismic event.

2. At least one connection point for the FLEX equipment will only require access through seismically robust structures. This includes both the connection point and any areas that plant operators will have to access to deploy or control the capability.

3. If the plant FLEX strategy relies on a water source that is not seismically robust, e.g., a downstream dam, the deployment of FLEX coping capabilities should address how water will be accessed. Most sites with this configuration have an underwater berm that retains a needed volume of water. However, accessing this water may require new or different equipment.

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

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

During the audit process, the licensee identified that studies for liquefaction are being performed and the effects on haul paths are factors that input into the storage building(s) location and that this is to be tracked as an open item in the 6 month update. This has been identified as Confirmatory Item 3.1.1.2.A. in Section 4.2.

With respect to the licensee's plans for deployment of the FLEX equipment, and plans for protection and accessibility of the connection points, it was determined that FLEX equipment and hoses would only be routed through seismically robust (Category I) structures, and that equipment required to move the FLEX equipment will be protected from seismic events. On page 7 of the Integrated Plan, the licensee stated 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 is consistent with consideration 2 identified above.

With respect to the adequacy of the downstream dam and how its loss would affect the availability of water, the Integrated Plan did not provide sufficient information to evaluate conformance with NEI 12-06, consideration 3. During the audit process, the licensee addressed this issue by stating that a downstream failure during a seismic event is a complex issue and is being evaluated. The licensee provided an updated response during the audit process that assessed the adequacy of the downstream dam and how its loss would affect the availability of water. The licensee indicated that further evaluation is necessary to determine if the FLEX pumps are capable of taking suction from a reduced level condition and is evaluating alternative methods such as booster pumps and deep wells. This item remains open pending further evaluation by the licensee. This has been identified as Confirmatory Item 3.1.1.2.B. in Section 4.2.

The Integrated Plan did not provide sufficient information regarding whether there is a need for power to move or deploy the equipment (e.g., to open the door from a storage location) as described by NEI 12-06 Section 5.3.2, consideration 4. This was discussed with the licensee during the audit process in order to allow it to be taken into account in the planned storage building(s) and may be verified during on-site audits. This item remains open pending further development by the licensee. This has been identified as Confirmatory Item 3.1.1.2.C. in Section 4.2.

During the audit process, the licensee identified that the haul and debris removal truck will be stored in a protected building. This is consistent with consideration 5 identified above,

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01 and 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 deployment of FLEX equipment during a 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 that should be addressed.
>
> 1. Seismic studies have shown that even seismically qualified electrical equipment can be affected by BDB seismic events. In order to address these considerations, each plant should compile a reference source for the plant operators that provides approaches to obtaining necessary instrument readings to support the implementation of the coping strategy (see Section 3.2.1.10). This reference source should include control room and non-control room readouts and should also provide guidance on how and where to measure key instrument readings at containment penetrations, where applicable, using a portable instrument (e.g., a Fluke meter). Such a resource could be provided as an attachment to the plant procedures/guidance. Guidance should include critical actions to perform until alternate indications can be connected and on how to control critical equipment without associated control power.
>
> 2. Consideration should be given to the impacts from large internal flooding sources that are not seismically robust and do not require ac power (e.g., gravity drainage from lake or cooling basins for non-safety-related cooling water systems).
>
> 3. For sites that use ac power to mitigate ground water in critical locations, a strategy to remove this water will be required.
>
> 4. Additional guidance may be required to address the deployment of FLEX for those plants that could be impacted by failure of a not seismically robust downstream dam.

A review was conducted of the licensee's plans for the development of the mitigating strategies and it is not possible to conclude that they address determination of necessary instrument readings per NEI 12-06 Section 5.3.3, consideration 1 above, to support the implementation of the mitigating strategies in the event that seismically qualified electrical equipment is affected by BDBEEs. The Integrated Plan does not specify if identified instruments are local instruments (no power required) or ac or dc powered. Additionally, there is no mention of the use of portable instrumentation to measure process variables. This has been identified as Confirmatory Item 3.1.1.3.A. in Section 4.2.

A description of the instrumentation that will be used to monitor portable/FLEX electrical power equipment is needed including their associated measurement tolerances/accuracy to ensure that: 1) the electrical equipment remains protected (from an electrical power standpoint – e.g., power fluctuations) and 2) the operator is provided with accurate information to maintain core cooling, containment, and spent fuel cooling. This has been identified as Confirmatory Item 3.1.1.3.B. in Section 4.2.

During the audit process, the licensee identified that rupture of a large, not seismically robust tank in the Turbine building is not an issue because it would not affect any mechanical or electrical equipment necessary to support the FLEX strategy. There are no large non-seismically robust tanks in the Reactor Building. Intrusion of ground water into the RCIC cubicles is not an issue because the cubicle walls are internal Reactor Building walls and ground water intrusion through the floor would be drained to the Reactor Building sumps through backflow check valves to the Reactor Building Sumps. This is consistent with considerations 2 and 3 listed above.

The issue of a non-seismically robust downstream dam has been addressed in previously identified Confirmatory Item 3.1.1.2.B.

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 procedural interfaces for a seismic hazard if these requirements are implemented as described.

3.1.1.4 Considerations in Using Offsite Resources – Seismic Hazard

NEI 12-06, Section 5.3.4 states:

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

During the audit process, the licensee identified the supplemental work force parking lot located north of the main power block as the local staging area to be used by the Regional Response Center (RRC). This location is above the Maximum Probable Flood level. Transportation to the local staging area will be via tractor trailer truck if roadway conditions can support this mode. If not, the RRC will utilize helicopters for transport of necessary resources to the onsite staging area.

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

### 3.1.2 Flooding

NEI 12-06, Section 6.2 states:

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

NEI 12-06, Section 6.2.1 states in part:

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

On page 1 of the Integrated Plan, the licensee identified a maximum flood elevation of 603'-0" at the site which is above the grade elevation of 594-6". Time is available to relocate equipment and stage necessary measures to support plant response to the rising river level event.

Review of the licensee’s Integrated Plan with respect to screening for extreme external flooding shows that the licensee has screened in the flooding hazard (page 1), which conforms to the guidance found in NEI 12-06. The licensee also stated on page 2 that the flooding 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.

During the audit process, the licensee addressed warning time and long persistence by stating it initiates its current Design Basis response to the flood a minimum of three days prior to the predicted time the flood waters are expected to reach plant grade elevation. The response results in the reactors being in cold shutdown, partially dissembled, and flooded up and combined with the SFPs prior to the flood level reaching grade. FLEX equipment is pre-staged and a long term supply of water from the well water system is established. Both short term and long term supplies of fuel oil are available (fuel tanker for Phase 2 and fuel bladders from offsite for Phase 3). The response addresses the movement and supplies sufficiently for a flood of long persistence.

NEI 12-06 characterizes in Table 6-1 the external flooding hazard in terms of warning time and persistence and having a warning time in days and persistence in months.

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 flooding if these requirements are implemented as described.

#### 3.1.2.1 Protection of FLEX Equipment – Flooding Hazard

NEI 12-06, Section 6.2.3.1 states:

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

On pages 17, 27, 35 and 44 of the Integrated Plan, the licensee stated that storage of FLEX equipment during flooding hazards would be provided by structures constructed to meet the guidance of NEI 12-06, Section 11. Temporary buildings will be used until permanent building(s) is (are) constructed prior to the compliance date. The Integrated Plan also identifies (on the same pages) that FLEX equipment can be relocated to a position that is protected from the flood, either by barriers or by elevation, prior to the arrival of the potentially damaging flood levels since sufficient warning time is available.

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

3.1.2.2 Deployment of FLEX Equipment – Flooding Hazard

NEI 12-06, Section 6.2.3.2 states:

> There are a number of considerations which apply to the deployment of FLEX equipment for external flood hazards:
>
> 1. For external floods with warning time, the plant may not be at power. In fact, the plant may have been shut down for a consideerable time and the plant

configuration could be established to optimize FLEX deployment. For example, the portable pump could be connected, tested, and readied for use prior to the arrival of the critical flood level. Further, protective actions can be taken to reduce the potential for flooding impacts, including cooldown, borating the RCS, isolating accumulators, isolating RCP seal leak off, obtaining dewatering pumps, creating temporary flood barriers, etc. These factors can be credited in considering how the baseline capability is deployed.

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

3. Depending on plant layout, the ultimate heat sink may be one of the first functions affected by a flooding condition. Consequently, the deployment of the FLEX equipment should address the effects of LUHS, as well as ELAP.

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

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

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

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

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

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

On page 1 of the Integrated Plan, the licensee identified that time is available to relocate equipment and stage necessary measures to support plant response to the maximum flood elevation which results from a rising river level event.

During the audit process, the licensee addressed the guidance of NEI 12-06, Section 6.2.3.2, stating it initiates its current Design Basis response to the flood a minimum of three days prior to the predicted time the flood waters are expected to reach plant grade elevation. The response results in the reactors being in cold shutdown, partially dissembled, and flooded up and combined with the SFPs prior to the flood level reaching grade. The diesel generators and pumps are staged above the maximum flood level and are available when needed. All hose and/or pipe routing and lineup will also be performed prior to water reaching plant grade. The diesel pumps take suction from the well water system and provide makeup to the Reactor and SFP. A diesel fuel tanker is staged to support the portable equipment. The Phase 3 Response Equipment/Commodities listing in the Integrated Plan addressed replenishment of food, potable water, and diesel fuel (300-500 gallon bladders) delivered by air.

In addition to the above, on page 43 of the Integrated Plan, the licensee specified that fuel oil for Flex Pumps and Generators will be supplied by the quantity of fuel in the tanks located on the skids of the portable equipment. Make up to the day tanks is from by fuel tanks contained on the back of the Flex Truck. When required, fuel can then be pumped from the [emergency diesel generator] EDG Fuel Storage Day Tanks by accessing the tanks via tank access covers. The licensee stated that a detailed fuel oil supply plan will be developed.

The location and elevation of the EDG Fuel Storage Day Tanks is not specified. It cannot be determined if the tanks are inundated by the flood of if there is access available for the FLEX Truck. It is not clear that the diesel fuel tanker identified above has sufficient capacity to support the FLEX equipment until Phase 3 supplies are available. These items should be addressed in the detailed fuel oil supply plan which the licensee is developing.

There is insufficient information in the plan to conclude there is reasonable assurance that the guidance and strategies developed will conform to the guidance of NEI 12-06 Section 6.2.3.2 consideration 4. Information provided by the licensee as part of the 6-month update process identified open item 13 that stated a detailed fuel oil supply plan will be developed. This has been identified as Confirmatory Item 3.1.2.2.A. in Section 4.2.

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

3.1.2.3 Procedural Interfaces – Flooding Hazard

NEI 12-06, Section 6.2.3.3 states:

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

The updated information the licensee provided during the audit process as documented in Sections 3.1.2.1 and 3.1.2.2 above adequately addresses the considerations in Section 3.1.2.3.

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

3.1.2.4 Considerations in Using Offsite Resources – Flooding Hazard

NEI 12-06, Section 6.2.3.4 states:

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

During the audit process, the licensee identified the supplemental work force parking lot located north of the main power block as the local staging area to be used by the RRC. This location is above the Maximum Probable Flood level. Transportation to the local staging area will be via tractor trailer truck if roadway conditions can support this mode. If not, the RRC will utilize helicopters for transport of necessary resources to the onsite staging area.

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

3.1.3 High Winds

NEI 12-06, Section 7.2.1, provides the NRC-endorsed screening process for evaluation of severe storms with high wind hazard. This screening process considers the hazard due to hurricanes and tornadoes.

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

The screening for high wind hazard associated with tornadoes should be accomplished by comparing the site location to NEI 12-06, Figure 7-2, from U.S. NRC, "Tornado Climatology of the Contiguous United States," NUREG/CR-4461, Rev. 2, February 2007; if the recommended tornado design wind speed for a $10^{-6}$/year probability exceeds 130 mph, the site should address hazards due to extreme high winds associated with tornadoes.

Reviewer review of NEI 12-06 Figure 7.1, identified the licensee does not need to address hazards due to hurricanes.

On page 1 of its Integrated Plan, the licensee stated that it screens in for High Wind Hazard because it is located at 41 ° 43' 46" north latitude and 90° 18' 40.2" west longitude which is in Region 1 of NEI 12-06, Figure 7-2 which has a recommended tornado design speed in excess of 130 mph.

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

3.1.3.1 Protection of FLEX Equipment - High Winds Hazard

NEI 12-06, Section 7.3.1 states:

> These considerations apply to the protection of FLEX equipment from high wind hazards:
>
> 1. For plants exposed to high wind hazards, FLEX equipment should be stored in one of the following configurations:
>
>     a. In a structure that meets the plant's design basis for high wind hazards (e.g., existing safety-related structure).
>
>     b. In storage locations designed to or evaluated equivalent to ASCE 7-10, *Minimum Design Loads for Buildings and Other Structures* given the limiting tornado wind speeds from Regulatory Guide 1.76 or design basis hurricane wind speeds for the site.
>
>         - Given the FLEX basis limiting tornado or hurricane wind speeds, building loads would be computed in accordance with requirements of ASCE 7-10. Acceptance criteria would be based on building serviceability requirements not strict compliance with stress or capacity limits. This would allow for some minor plastic deformation, yet assure that the building would remain functional.
>
>         - Tornado missiles and hurricane missiles will be accounted for in that the FLEX equipment will be stored in diverse locations to provide reasonable assurance that N sets of FLEX equipment will remain deployable following the high wind event. This will consider locations adjacent to existing robust structures or in lower sections of buildings that minimizes the probability that missiles will damage all mitigation equipment required from a single event by protection from adjacent buildings and limiting pathways for missiles to damage equipment.
>
>         - The axis of separation should consider the predominant path of tornados in the geographical location. In general, tornadoes travel

from the West or West Southwesterly direction, diverse locations should be aligned in the North-South arrangement, where possible. Additionally, in selecting diverse FLEX storage locations, consideration should be given to the location of the diesel generators and switchyard such that the path of a single tornado would not impact all locations.

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

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

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

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

The licensee stated it plans on storing FLEX equipment (pages 18, 27, 28, 36 and 44) in new structures that will be constructed to meet the guidance of NEI 12-06, Section 11. By reference in NEI 12-06, Section 11.3, the structures will conform to the guidance of NEI 12-06, Section 7. During the audit process, the licensee confirmed that the FLEX pumps, generators, hose trailers and haul and debris removal truck will be stored in protected building(s).

The licensee also stated that procedures and programs will be developed to address storage structure requirements. Temporary locations will be used until building construction completion.

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

3.1.3.2 Deployment of FLEX Equipment – High Wind Hazard

NEI 12-06, Section 7.3.2 states:

There are a number of considerations which apply to the deployment of FLEX equipment for high wind hazards:

1. For hurricane plants, the plant may not be at power prior to the simultaneous ELAP and LUHS condition. In fact, the plant may have been shut down and the plant configuration could be established to optimize FLEX deployment. For example, the portable pumps could be connected, tested, and readied for

use prior to the arrival of the hurricane. Further, protective actions can be taken to reduce the potential for wind impacts. These factors can be credited in considering how the baseline capability is deployed.

2. The ultimate heat sink may be one of the first functions affected by a hurricane due to debris and storm surge considerations. Consequently, the evaluation should address the effects of ELAP/LUHS, along with any other equipment that would be damaged by the postulated storm.

3. Deployment of FLEX following a hurricane or tornado may involve the need to remove debris. Consequently, the capability to remove debris caused by these extreme wind storms should be included.

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

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

The QCNPS site is not subject to hurricanes; therefore considerations 1, 2, and 5 are not applicable.

On page 7 of the Integrated Plan, the licensee stated that transportation routes will be developed from the equipment storage area to the FLEX staging areas and 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.

On page 8 of the Integrated Plan, the licensee stated that identification of storage and creation of the administrative program are open items and closure of these items will be documented in a six-month update (open item 5 in the August, 2013 six month status report). This has been identified as Confirmatory Item 3.1.3.2.A. in Section 4.2.

On page 54 of the Integrated Plan describing response equipment and commodities necessary in Phase 3, the licensee listed debris clearing equipment.

On page 58 of the Integrated Plan under the Sequence of Events Timeline, the licensee listed various items of portable equipment being utilized before the arrival of debris clearing equipment e.g., FLEX generators (item 17) and FLEX pumps (item 18) at 4 hours.

The licensee's plans for deployment of portable equipment in the event of a high wind event were reviewed to determine whether debris clearing equipment will be available on site to support actions credited in the Events Timeline occurring before the 24 hour equipment arrival. The ability of the onsite FLEX Truck to move debris and transport equipment within the 4 hour time restriction for the pumps and generator was questioned by the reviewer. Updated information provided by the licensee during the audit process addressed this issue by stating, in part, that the placement of FLEX equipment storage building(s) has not been finalized, but possible debris effect on the haul paths and, equipment deployment timelines are factors that input into the building placement decision. The licensee also stated, in part, that on page 50 of the Integrated Plan the BWR Portable Equipment Phase 2, a Heavy Duty Truck is listed which will clear debris. This truck is to be used for multiple functions: to clear debris, transport portable equipment and refuel portable equipment. This truck has a snow plow blade which will be used for debris clearing. The adequacy of the debris removal equipment will be assessed and the effect on the timeline will be reviewed to assure the critical times are capable of being met. This will be tracked as an open item in the 6 month update (Open Item 1 in the six month status report). This had been identified as Confirmatory Item 3.1.3.2.B. in Section 4.2.

During the audit process, the licensee confirmed that the FLEX haul and debris removal truck will be stored in protected building(s). This is consistent with consideration 4.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01 and 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 deployment of FLEX equipment for a high wind hazard if these requirements are implemented as described.

3.1.3.3 Procedural Interfaces – High Wind Hazard

NEI 12-06, Section 7.3.3, states:

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

On pages 18, 27, 36, and 44 of the Integrated Plan, the licensee stated that 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 Quad Cities. This has been identified as open Item 5 in the six-month status report. This has been combined with Confirmatory Item 3.1.3.2.A.

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

3.1.3.4 Considerations in Using Offsite Resources – High Wind Hazard

NEI 12-06, Section 7.3.4 states:

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

Consideration 1 is not applicable since QCNPS is not subject to hurricanes.

During the audit process, the licensee identified the supplemental work force parking lot located north of the main power block as the local staging area to be used by the RRC. Transportation to the local staging area will be via tractor trailer truck if roadway conditions can support this mode. If not, the RRC will utilize helicopters for transport of necessary resources to the onsite staging area.

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

3.1.4 Snow, Ice and Extreme Cold

As discussed in NEI 12-06, Section 8.2.1:

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

On page 2 of the Integrated Plan the licensee stated QCNPS is located at 41° 43' 46" north latitude and 90° 18' 40.2" west longitude. The guidelines provided in NEI 12-06 section 8.2.1 generally include the need to consider extreme snowfall at plant sites above the 35th parallel, which includes the QCNPS site. Also, The QCNPS site is located within the region characterized as ice severity level 5 on NEI 12-06, Figure 8-2, "Maximum Ice Storm Severity Maps". Consequently, the QCNPS site is subject to severe icing conditions that could also cause catastrophic destruction to electrical transmission lines. Thus, the QCNPS site screens in for an assessment for 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 provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to screening for the snow, ice and extreme cold hazard if these requirements are implemented as described.

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

NEI 12-06, Section 8.3.1 states:

> These considerations apply to the protection of FLEX equipment from snow, ice, and extreme cold hazards:
>
> 1. For sites subject to significant snowfall and ice storms, portable FLEX equipment should be stored in one of the two configurations.
>
>    a. In a structure that meets the plant's design basis for the snow, ice and cold conditions (e.g., existing safety-related structure).

b. In a structure designed to or evaluated equivalent to ASCE 7-10, *Minimum Design Loads for Buildings and Other Structures* for the snow, ice, and cold conditions from the site's design basis.

c. Provided the N sets of equipment are located as described in a. or b. above, the N+1 equipment may be stored in an evaluated storage location capable of withstanding historical extreme weather conditions such that the equipment is deployable.

2. Storage of FLEX equipment should account for the fact that the equipment will need to function in a timely manner. The equipment should be maintained at a temperature within a range to ensure its likely function when called upon. For example, by storage in a heated enclosure or by direct heating (e.g., jacket water, battery, engine block heater, etc.).

On pages 18, 28, 36, and 45 of the Integrated Plan, the licensee stated it plans on storing FLEX equipment in new structures that will be constructed to meet the guidance of NEI 12-06, Section 11. By reference in NEI 12-06, Section 11.3, the structures will conform to the guidance of NEI 12-06, Section 8.3.1. The licensee also stated that procedures and programs will be developed to address storage structure requirements. Temporary locations will be used until building construction completion.

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

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

NEI 12-06, Section 8.3.2 states:

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

On page 7 of the Integrated Plan the licensee stated that 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. Also, the 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.

On page 9 of the integrated plan, the licensee stated the equipment associated with the FLEX 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. This is consistent with consideration 1 above.

On page 50 of the Integrated Plan, the list of portable equipment for Phase 2 lists debris clearing equipment (heavy duty truck), but does not specify whether this equipment would be capable of removing snow or ice. Updated information provided by the licensee as part of the audit process addresses this issue by stating that the truck used for debris removal has a snow plow blade. This is consistent with consideration 2 above.

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 its present plan is the installation of dry hydrants from which the FLEX pumps will take suction close to the bottom of the discharge bay; thus, the pump suction will not be impacted by blockage from the formation of surface ice and frazil ice during extreme cold conditions.

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

3.1.4.3 Procedural Interfaces – Snow, Ice and Extreme Cold Hazard

NEI 12-06, Section 8.3.3, states:

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

As discussed in Section 3.1.4.2, the licensee has supplied sufficient information to enable conclusion that its plans address the effects of snow and ice on transporting the equipment.

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

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

NEI 12-06, Section 8.3.4 states:

> Severe snow and ice storms can affect site access and can impact staging areas for receipt of offsite materials and equipment.

During the audit process, the licensee identified the supplemental work force parking lot located north of the main power block as the local staging area to be used by the RRC. Transportation to the local staging area will be via tractor trailer truck if roadway conditions can support this mode. If not, the RRC will utilize helicopters for transport of necessary resources to the onsite staging area.

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

3.1.5 High Temperatures

NEI 12-06, Section 9 states:

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

On page 2 of the Integrated Plan, the licensee stated the guidelines provided in NEI 12-06, Section 9.2 includes the need to consider high temperature at all plant sites in the lower 48 states. Extreme high temperatures are not expected to impact the utilization of off-site resources or the ability of personnel to implement the required FLEX strategies. Site industrial safety procedures currently address activities with a potential for heat stress to prevent adverse impacts on personnel. The licensee identified QCNPS screens in for an assessment for extreme High Temperature.

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 FLEX Equipment – High Temperature Hazard

NEI 12-06, Section 9.3.1, states:

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

On pages 18, 19, 28, 36, and 45 of the Integrated Plan, the licensee stated it plans on storing FLEX equipment in new structures that will be constructed to meet the guidance of NEI 12-06, Section 11. By reference in NEI 12-06, Section 11.3, the structures will conform to the guidance of NEI 12-06, Section 9.2. During the audit process, the licensee confirmed that the FLEX pumps, generators, hose trailers and haul and debris removal truck will be stored in protected building(s).

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

3.1.5.2 Deployment of FLEX Equipment – High Temperature Hazard

NEI 12-06, Section 9.3.2 states:

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

On page 2 of the Integrated Plan the licensee stated extreme high temperatures are not expected to impact the utilization of off-site resources or the ability of personnel to implement the required FLEX strategies. Also, site industrial safety procedures currently address activities with a potential for heat stress to prevent adverse impacts on personnel.

On page 7 and 8 of the Integrated Plan the licensee stated that deployment of FLEX is expected for all modes of operation and that an administrative program will be developed that will ensure the strategies can be implemented in all modes by maintaining the portable FLEX equipment available to be deployed during all modes.

On page 9 of the integrated plan, the licensee stated the equipment associated with the FLEX 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 approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to deployment of FLEX equipment for the high temperature hazard if these requirements are implemented as described.

3.1.5.3 Procedural Interfaces – High Temperature Hazard

NEI 12-06, Section 9.3.3 states:

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

On page 9 of the integrated plan, the licensee stated the equipment associated with the FLEX 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 pages 18, 19, 28, 36, and 45 of the Integrated Plan the licensee stated that protection of associated portable equipment from high temperatures hazards would be provided by procedures and programs that will be developed to address storage structure requirements, haul path requirements, and FLEX equipment requirements relative to the external hazards applicable to Quad Cities.

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 during for the 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 BDBEEs in order to maintain or restore core cooling, containment and SFP cooling capabilities. The phases consist of an initial phase using installed equipment and resources, followed by a transition phase using portable onsite equipment and consumables and a final phase using offsite resources.

To meet these EA-12-049 requirements, Licensees will establish a baseline coping capability to prevent fuel damage in the reactor core or SFP and to maintain containment capabilities in the context of a 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 described in NEI 12-06, Section 1.3, "[p]lant-specific analyses will determine the duration of each phase." This baseline coping capability is supplemented by the ability to use portable pumps to provide reactor pressure vessel (RPV)/reactor makeup in order to restore core or SFP capabilities as described in NEI 12-06, Section 3.2.2, Guideline (13). This approach is endorsed in NEI 12-06, Section 3, by JLD-ISG-2012-01.

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

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

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

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

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

3.2.1.1. Computer Code Used for ELAP Analysis.

NEI 12-06, Section 1.3 states in part:

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

The licensee provided a Sequence of Events (SOE) on pages 55 through 59 of their Integrated Plan, which included the time constraints and the technical basis for the QCNPS site. The SOE is based on an analysis using the industry-developed Modular Accident Analysis Program (MAAP) Version 4 computer code. MAAP4 was written to simulate the response of both current and advanced light water reactors to [loss of coolant accident] LOCA and non-LOCA transients for probabilistic risk analyses as well as severe accident sequences. The code has been used to evaluate a wide range of severe accident phenomena, such as hydrogen generation and combustion, steam formation, and containment heating and pressurization.

The licensee's position is that MAAP4 is the code of choice for this submittal. While the NRC staff does acknowledge that MAAP4 has been used many times over the years and in a variety of forums for severe and beyond design basis analysis, MAAP4 is not an NRC approved code, and the NRC staff has not examined its technical adequacy for performing thermal hydraulic analyses. Therefore, during the review of the integrated plan, the issue of using MAAP4 was raised as Generic Concern and was addressed by the Nuclear Energy Institute (NEI) in their position paper dated June 2013, entitled "Use of Modular Accident Analysis Program (MAAP4 ) in Support of Post-Fukushima Applications" (ADAMS Accession No. ML13190A201). After review of this position paper, the NRC staff endorsed a resolution through letter dated October 3, 2013 (ADAMS Accession No. ML13275A318). This endorsement contained five limitations on the MAAP4 computer code's use for simulating the Extended Loss of AC Power (ELAP) event for Boiling Water Rectors (BWRs). Those limitations and their corresponding Confirmatory Item number for this TER are provided as follows:

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

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

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

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

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

    (This is Confirmatory Item 3.2.1.1.D)

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

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

3.2.1.2. Recirculation Pump Seal Leakage Models.

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

Reactor coolant system inventory losses and recirculation pump seal leakage are not addressed in the Integrated Plan. The licensee was requested to address seal leakage.

Updated information included in the 6-month response (Document QC-MISC-013, Revision 1, "MAAP Analysis to Support FLEX Initial Strategy") identified that RCS leakage is 38 gpm (including RR pump seal leakage) conservatively assumed to begin at t = 0. This includes 5 gpm unidentified leakage and 1 gpm identified leakage, and 16 gpm recirculation pump seal leakage per pump. The leakage is modeled as a hole of fixed size which yields 38 gpm leakage at 1000 psig.

Justification is needed for the assumptions made in the plant-specific analyses regarding primary system leakage from the recirculation pump seals and other sources that addresses the following items:

1. Discussion of the assumed leakage rate predicted pressure dependence relative to test data.

2. Clarification of whether the leakage was determined or assumed to be single-phase liquid, two-phase mixture, or steam at the donor cell.

3. Comparison of design-specific seal leakage testing conditions to code-predicted thermal hydraulic conditions (temperature, void fraction) during an ELAP and justification if predicted conditions are not bounded by testing.

This has been identified as Confirmatory Item 3.2.1.2.A.in Section 4.2.

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

3.2.1.3 Sequence of Events

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

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

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

commissioned.

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

In response to the need to identify expected time constraints, the Integrated Plan for QCNPS includes a discussion of time constraints on pages 5 through 7 and a Sequence of Events Timeline, Attachment 1A, on pages 55 through 59. The licensee stated on pages 4 and 5 of the Integrated Plan:

> 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, and the results will be provided in a future six-month update. Issuance of BWROG document NEDC-33771P, "GEH Evaluation of FLEX Implementation Guidelines," on 01/31/2013 did not allow sufficient time to perform the analysis of the deviations between the licensee's engineering analyses and the analyses contained in the BWROG document prior to submittal of this Integrated Plan.

Based on the foregoing statement, it is concluded that the information in the Sequence of Events Timeline on pages 55 through 59 will not be complete until the detailed design and procedure development are complete. There is insufficient information to determine that the time constraints for implementing coping strategies for Core Cooling and Maintaining Containment are satisfied.

Information provided by the licensee in the 6-month update confirms that the BWROG document referenced above has been reviewed and the deviations to the assumptions that were used in the test case are itemized on Attachment 1. Nonetheless, the results and the impact on the Sequence of Events timeline are still dependent on the MAAP4 analysis. As stated earlier in this report, there are still Confirmatory Items regarding the use of the MAAP4 analysis. The updated information in the 6-month update did not include analysis of the deviations between the licensee's engineering analyses and the analyses contained in the BWROG document prior to submittal of this Integrated Plan. This has been identified as Confirmatory Item 3.2.1.3.A. in Section 4.2.

On pages 5 and 6 of the Integrated Plan, at time 3.7 hours, the licensee stated that:

> BWROG RCIC System operation in Prolonged Station Blackout – Feasibility Study indicates that RCIC will remain functional as long as Suppression Pool temperature can be maintained less than approximately 230°F. The preliminary MAAP analysis performed for strategy development indicated a maximum Suppression Pool temperature of 222°F. Additional work will be performed during detailed design development to ensure Suppression Pool temperature will support RCIC operation, in accordance with approved BWROG analysis, throughout the event.

Because the licensee plans further review and analysis to ensure Suppression Pool temperature will support RCIC operation, there is insufficient information to conclude that there is reasonable assurance that the plans will conform to NEI 12-06, Section 3.2.1.7 (6). This has been identified as Confirmatory Item 3.2.1.3.B. in Section 4.2.

Page 40 of the licensee's integrated plan noted that safety-related 250 VDC and 125 VDC bus voltages will be maintained by their associated batteries until the portable 480 V generators are placed in service to re-energize the battery chargers. Information is needed on the minimum voltage that must be maintained and the basis for the minimum voltage on the dc bus. This has been identified as Confirmatory Item 3.2.1.3.C. in Section 4.2.

On page 57 of the integrated plan, the licensee indicated that commencement of reactor pressure vessel (RPV) depressurization is not a time constraint and stated that depressurization of the RPV is not time critical; however, depressurization is initiated within 10 minutes of the loss of all ac power. If depressurization is not time critical, clarification is needed as to why operators should be instructed to take this action relatively early in the event when they are attempting to assess plant conditions and discharge other time-critical responsibilities. Conversely, if depressurization must be initiated at 10 minutes, clarification is needed as to why this action is not considered a time constraint.

Updated information provided by the licensee as part of the audit process identified that steps 6, 10 and 19 of the SOE are in alignment with the existing Emergency Operating Procedures.

Based on review of the updated information, the questions related to the initiation of depressurization within 10 minutes have been adequately addressed.

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

3.2.1.4 Systems and Components for Consequence Mitigation

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

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

And,

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

NEI 12-06, Section 3.2.1.12 states:

> Equipment relied upon to support FLEX implementation does not need to be

qualified to all extreme environments that may be posed, but some basis should be provided for the capability of the equipment to continue to function.

Phase 2 of the plan includes coping strategies using on-site portable equipment and modifications to maintain core cooling. The licensee proposed multiple ways of continuing to cool the reactor core during Phase 2. The primary strategy for maintaining core cooling is to make up water in the Suppression Pool so that the RCIC system will continue to have a suction source to inject into the RPV. Based on preliminary MAAP analysis this is not needed until approximately 40 hours into the event. The alternate strategy is to inject into the RPV. The licensee will have diesel driven pumps connected and aligned for Suppression Pool injection or RPV injection 4 hours into the event. The FLEX pump will take suction from the Discharge Bay. Pump discharge will be directed through fire hoses routed from the area near the Discharge Bay either through the turbine building and reactor building or around the Protected Area access road to the east side of the Reactor Building and in through the ½ Trackway. At this location the hose can be connected to one of the two proposed locations discussed in the Integrated Plan to tie into the RHR system via seismically qualified piping. The FLEX pumps identified on page 49 have performance criteria of 1343 gpm at 270 psia.

Although the proposed pump locations, hose routing and connection points are discussed in the plan, insufficient information was presented to confirm the ability of the portable FLEX pumps to deliver the required flow through the system of flex hoses, couplings, valves, elevation changes, etc. for either the primary or the alternate strategy.

Updated information provided by the licensee as part of the audit process identified the required flow for each function and when it is required. The connection points to a flow distribution header were identified. Flow distribution to the specific areas will be based on monitoring reactor level, fuel pool level and suppression chamber pool level rather than establishment of a specific flow rate. The updated information adequately addresses the questions on flow rate and flow distribution.

On page 16 of the Integrated Plan the licensee identified the alternate makeup water source for direct RPV injection involves using a FLEX pump that will take suction from the Discharge Bay.

The water quality from the Discharge Bay is not addressed. Because the water quality is not specified, it cannot be concluded whether deleterious blockage of coolant flow across the fuel assemblies would occur to an extent that would inhibit adequate flow to the core. It is not identified if other water sources might be available. Because of this water quality issue, the licensee was requested to address water quality to enable a conclusion with reasonable assurance that the plan will conform to NEI 12-06, Section 3.2.2, Guideline (5) and Section 11.

Updated information provided by the licensee as part of the audit process stated that the procedures governing use of then portable FLEX pumps during a Fukushima event have not been developed. The integrated plan was developed to meet the criteria put forth in NEI 12-06, which precludes use of CCSTs or Well Water or Fire Protection Pump, etc., leaving the Discharge Bay as the surviving water source. The licensee stated these cleaner water sources will be utilized based on the availability following the initiating event. The current Discharge Bay suction hose for the portable FLEX pumps has a coarse suction strainer. As the procedural guidance for use of the portable Flex pumps is developed, concerns such as priority of water source and actions to be taken to ensure coolant flow across fuel assemblies will be addressed.

The licensee identified this as an action that required further analysis and will be tracked as an open item in the 6 month update [this item is not identified in the August 2013 six month status report]. This has been identified as Confirmatory Item 3.2.1.4.A. in Section 4.2.

Further technical basis or a supporting analysis is needed for the portable/FLEX diesel generator capabilities considering the capacity of the equipment. The staff requested the licensee to provide a summary of the sizing calculation for the FLEX diesel generators to show that they can supply the loads assumed in phases 2 and 3. Updated information provided by the licensee as part of the audit process stated the FLEX generator sizing calculation is currently in progress, and a summary of the results will be provided when completed in a future six month update. This has been identified as Confirmatory Item 3.2.1.4.B. in Section 4.2.

On page 11 of the Integrated Plan, the licensee stated, in part:

> Initial reactor water level control would be accomplished using the RCIC System which is independent of all ac power. HPCI (High Pressure Coolant Injection) would also initially be available to make the initial reactor water level recovery if required.

In the event ELAP conditions significantly damage the CCSTs, information to support the conclusion that the switchover instrumentation will remain operational and that HPCI injection to RPV will remain uninterrupted is needed. Identification of whether the switchover function is automatic, fail-safe, and whether function logic and hardware, related piping, valves, systems, structures, and components (SSCs) to support the switchover function are of safety grade and are qualified for all criteria including tornado/high winds is needed. If not, then justification on how switchover from the CCSTs to the suppression pool will be assured in ELAP conditions if the CCSTs are unavailable is needed.

Updated information provided by the licensee as part of audit process identified that the control logic, level sensors and valve motors that provide the suction transfer are dc powered and therefore are assumed to remain available. The switchover function is automatic in that the function will occur upon detection of 1 of 4 CCST tank level switches detecting low level. These are fail safe; upon loss of power to the logic the function will occur and the HPCI pump suction valves will switch to the unit suppression pool suction. The HPCI system valves, piping and level instruments are all safety grade. The valves are located in the Reactor Building. The Storage tank level switches are located in the Turbine Building which is protected from high winds. The valves are dc powered. The Operators can perform a remote manual transfer from the Main Control Room if the automatic transfer fails.

Based on review of the updated information, the licensee adequately addressed the concerns related to switchover instrumentation remaining operational and HPCI injection to RPV remaining uninterrupted.

In the table entitled “BWR Portable Equipment Phase 2,” the licensee listed all the equipment needed for phase two mitigating strategies. The table does not note whether the equipment listed is the total supplied for both units or for each unit. The licensee was requested to provide clarification regarding the quantity of equipment needed for Phase 2 strategies.

Updated information provided by the licensee as part of the audit process identified that the equipment listed in the table entitled “BWR Portable Equipment Phase 2,” is the total supplied equipment. The required equipment for each unit is one low pressure high capacity self-priming pump, one hose trailer, and one 480 VAC diesel powered generator. This table lists three of each item to account for N + 1 or having one spare required by NEI 12-06 section 3.2.2(15).The licensee’s updated information provided adequate clarification.

In the table entitled “BWR Portable Equipment Phase 3,” starting on page 52 of the integrated plan, the licensee listed all the equipment needed for Phase 3 mitigating strategies. The table does not note whether the equipment listed is the total supplied for both units or for each unit. The licensee was requested to provide clarification regarding the quantity of equipment needed for Phase 3 strategies.

Updated information provided by the licensee as part of audit process identified the Phase 3 strategy is to obtain equipment from the RRC that can be used as back up for any equipment used in the Phase 2 strategy that may require to be replaced. As noted on the table, this equipment had not been procured at the time of the submittal and the table will be updated following procurement of the equipment. As this is backup equipment, this will support the FLEX plan for both units. The licensee’s updated information provided adequate clarification.

In the table entitled “BWR Portable Equipment Phase 3,” the licensee listed additional equipment (Medium Voltage and Low Voltage Diesel Generators) for Phase 3; however, this equipment is not discussed in the body of the licensee’s Integrated Plan. Insufficient information provided for the purpose of the Medium Voltage and Low Voltage Diesel Generators identified in the table and when they would be used.

Updated information provided by the licensee as part of the audit process identified the Phase 3 strategy is to obtain equipment from the RRC that can be used as back up for any equipment used in the Phase 2 strategy that may require to be replaced. As noted on the table this equipment had not been procured at the time of the submittal and the table will be updated following procurement of the equipment. The medium voltage and low voltage diesel generators are backup equipment. The licensee’s updated information adequately answered the question.

The licensee’s integrated plan stated that FLEX equipment would be pre-staged or staged within hours of the initiation of the ELAP. For certain scenarios, such as those involving flooding or high winds, external conditions have the potential to adversely impact staged equipment. Clarification is needed as to how station procedures for equipment staging will address these potential impacts. During the audit process, the license identified two cases that involved pre-staging of equipment, specifically, the pre-staged or staged condition that would be part of a mode 5 activity that would enhance the shutdown safety condition and the flooding condition. High winds could affect the staged equipment. Should equipment damage occur due to being unprotected while staged, the protected equipment, part of N+1, will be deployed and restore the system protection [this is consistent with NEI 12-06, Section 7.3.1.1].

In addition, Quad Cities Station will incorporate the supplemental guidance provided in the NEI position paper entitled “Shutdown / Refueling Modes”, Revision 3, dated August 13, 2013, to enhance the shutdown risk process and procedures.

In the table entitled “BWR Portable Equipment Phase 2,” the licensee identified that three hose trailers containing hoses and fittings are necessary for strategies associated with portable pumps for the core, containment, and SFP cooling functions. The licensee did not include any information regarding working and design pressures of the hoses and fittings. Information is needed on the working and maximum design pressures of the hoses and fittings to be used in the discharge paths of the three FLEX pumps. This has been identified a Confirmatory Item 3.2.1.4.C. in Section 4.2.

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

3.2.1.5 Monitoring Instrumentation and Controls

NEI 12-06, Section 3.2.1.10 provides information regarding instrumentation and controls necessary for the success of the coping strategies. NEI 12-06 provides the following guidance:

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

Within pages 17, 26, 27 and 35 of the Integrated Plan, the licensee listed the following instrumentation: Reactor Water Level and Reactor Pressure, Containment Pressure, Suppression Pool Level, Suppression Pool Temperature, Suppression Pool Pressure and SFP Level.

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

3.2.1.6 Motive Power Valve Controls and Motive Air System

NEI 12-06, Section 12.1 states in part:

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

And,

> Table 12-1 provides a sample list of the equipment expected to be provided to

each site from off- site within 24 hours. The actual list will be specified by each site as part of the site-specific analysis.

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

The Integrated Plan addresses the use of the Hardened Containment Vent System (HCVS), but does not identify what is required to operate it.

The licensee was requested to identify if portable equipment (e.g. nitrogen bottles or other pneumatic supplies) will be required during the ELAP event to support operation of HCVS is needed. If needed, the Integrated Plan needs to describe how these supplies will be protected and deployed to meet the requirements of NEI 12-06.

Updated information provided by the licensee as part of the audit process addressed this issue by stating:

> Order EA-13-109 requires the SACV system to be able of operating with dedicated and permanently installed equipment for at least 24 hours. Quad Cities station intends to meet this requirement; therefore no deployment of portable equipment is required during the first 24 hours. Continued SACV operation beyond 24 hours will be ensured by providing portable backup sources of compressed gas and battery chargers or battery backups. This portable backup equipment will be required to be protected per EA-13-109. Therefore this portable backup equipment will be stored in protected locations such as the FLEX storage buildings, or inside other protected structures, and will use the same deployment path as FLEX equipment. As deployment of this equipment is beyond 24 hours, there is minimal impact on operator actions. The portable backup equipment credited and required for SACV will be independent and in addition to equipment required for FLEX.

It is not clear if the protection provided under Order EA 13-109 is equivalent to that provided under Order EA-12-049. This has been identified as Confirmatory Item 3.2.1.6.A. in Section 4.2.

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

Review of the Integrated Plans for Exelon’s QCNPS revealed that the Generic Concern related to shutdown and refueling requirements is applicable to the plant. This Generic Concern has been resolved generically through the NRC endorsement of Nuclear Energy Institute (NEI) position paper entitled “Shutdown/Refueling Modes” (ADAMS Accession No. ML13273A514); and has been endorsed by the NRC in a letter dated September 30, 2013 (ADAMS Accession No. ML13267A382).

The position paper describes how licensees will, by procedure, maintain equipment available for deployment in shutdown and refueling modes. The NRC staff concluded that the position paper provides an acceptable approach for demonstrating that the licensees are capable of implementing mitigating strategies in all modes of operation.

Exelon has informed the NRC of their plans to abide by this generic resolution, and their plans to address potential plant specific issues associated with implementing this resolution. The NRC staff have determined the issues concerning implementation during cold shutdown and refueling associated with Exelon's submittal is acceptable, per JLD ISG-2012-01 and provides reasonable assurance that the requirements of Order EA-12-049 will be met if these requirements are implemented as described in the licensee's Integrated Plan.

3.2.1.8 Use of Portable Pumps

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

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

NEI 12-06 Section 11.2 states in part:

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

On page 57 of the Integrated Plan, the licensee identified on the SOE Timeline that at 10 minutes the plant is to commence RPV depressurization using ERVs at less than or equal to 80 degree F per hour.

On page 58 of the Integrated Plan, the licensee identified on the SOE Timeline that at 4 hours FLEX pumps are connected and aligned for Suppression Pool injection. Per page 15 of the Integrated Plan, the proposed hose connections to the RHR system piping can supply water via the FLEX pumps from the Discharge Bay directly to the Suppression Pool or to the RPV. If RCIC is in operation, the Suppression Pool needs makeup and if RCIC is not available, injection into the RPV from the FLEX pump is necessary. Page 34 of the integrated Plan describes makeup to the SFP with either via the Fuel Pool Assist connection to the RHR piping or directly from the FLEX pump to the SFP via fire hose. The need for a detailed diesel fuel supply plan is addressed in previously identified Confirmatory Item 3.1.2.2.A. in Section 4.2.

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

### 3.2.2 Spent Fuel Pool Cooling Strategies

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

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

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

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

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

NEI 12-06, Section 3.2.1.3 (7) provides the following information regarding portable/FLEX equipment:

> Other equipment, such as portable ac power sources, portable back up dc power supplies, spare batteries, and equipment for 50.54(hh)(2), may be used provided it is reasonably protected from the applicable external hazards per Sections 5 through 9 and Section 11.3 of this guidance and has predetermined hookup strategies with appropriate procedures/guidance and the equipment is stored in a relative close vicinity of the site.

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

> Each site should establish the minimum coping capabilities consistent with unit-specific evaluation of the potential impacts and responses to an ELAP and LUHS. In general, this coping can be thought of as occurring in three phases:
> - Phase 1: Cope relying on installed plant equipment.
> - Phase 2: Transition from installed plant equipment to on-site FLEX equipment.
> - Phase 3: Obtain additional capability and redundancy from off-site equipment until power, water, and coolant injection systems are restored or commissioned.
>
> In order to support the objective of an indefinite coping capability, each plant will be expected to establish capabilities consistent with Table 3-1 (BWRs) or Table 3-2 (PWRs). Additional explanation of these functions and capabilities are provided in Appendices C and D.

NEI 12-06, Table C-3 specifies that plant specific strategies should be considered for establishing a vent pathway for steam and condensate from the boiling SFP to allow access and prevent equipment problems.

The licensee's Integrated Plan indicates on page 32 that the completion of system alignments and the initiation of flow to the SFP may occur after the pool has begun to boil for the worst-case SFP heat load. Information is needed to identify whether operator actions in the vicinity of the SFP would be necessary to set up equipment and initiate flow following the initiation of boiling in the SFP. If local operator actions would be relied upon once SFP boiling has initiated, justification is needed to determine that the resulting environmental conditions satisfy habitability requirements for the time duration necessary to complete the actions.

Because the evaluation of the SFP area for steam and condensation has not yet been performed, additional information was requested to enable a conclusion that there is reasonable assurance that the plan will conform to NEI 12-06, Appendix C, Table C-3.

Updated information provided by the licensee as part of the audit process addresses this issue. The primary method of SFP makeup involves modifications that enable opening a valve (elevation 647 feet) located below the SFP floor (elevation 690 feet) early into the event and connecting the FLEX hose at ground floor (elevation 595 feet) later into the event. This enables remote operations to supply water to the Refueling floor where the SFP may be boiling. The second method is via a fire hose run up 1 of 3 stairways. The response stated that all actions for hose placement on the refuel floor will be prioritized early in the future FLEX Support Guidelines to assure completion prior to the degradation of conditions on the refuel floor if the secondary method is utilized will be developed. This has been identified as Confirmatory Item 3.2.2.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 SFP cooling strategies if these requirements are implemented as described.

3.2.3 Containment Functions Strategies

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

The licensee identified that the containment design pressure is 56 psig (page 24) and that, in accordance with Revision 3 of the BWROG EPG/SAG (see BWR Venting Strategies below), venting through the Hardened Containment Vent System (HCVS) will be initiated at a DW pressure of approximately 25 psia to maintain Suppression Pool temperatures less than approximately 230 deg. F (page 58).

The licensee describes the use of MAAP analysis with regard to Suppression Pool temperature (pages 5 and 6). See Section 3.2.1: Reactor Core Cooling Strategies, above, for discussion of the capabilities and general applicability of the MAAP code. (Note: There are Confirmatory Items associated with the use of the MAAP code.)

Although NEI 12-06, Table 3-1 indicates heat removal as one of the Safety Functions, the Integrated Plan appears to correlate containment integrity solely with ensuring containment pressure limits are not exceeded. This is evident by the fact that the essential containment instrumentation listed on page 27 of the Integrated Plan does not include a means for measuring drywell temperature. In general, 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. The licensee was requested to address the ability to monitor DW temperature.

Updated information provided by the licensee as part of the audit process stated that power to the DW temperature monitoring instruments will be restored as the 480 V FLEX DG is connected and started. This will power the instrument bus restoring the DW temperature indicators. The updated information adequately addresses the ability to monitor DW temperature.

On page 26 and 27 of the Integrated Plan, the licensee discusses the essential instrumentation needed to support strategy implementation. The pertinent parameters are containment pressure, suppression pool water level and temperature, and suppression pool pressure. The instrumentation and parameters associated with the operation of the HCVS are not identified; however, they will be evaluated as part of the review of EA-13-109. For the purposes of EA-12-049, NEI 12-06, Section 3.2 specifies, in part, that "…installed equipment that is designed to be robust with respect to design basis external events is assumed to be fully available." EA-13-109 requires operation of the HCVS to be by permanently installed equipment for the first 24 hours of the event. Furthermore, Section 3.2.1.3, Condition (9) states that "[n]o additional events or failures are assumed to occur immediately prior to or during the event, including security events." Based on these NRC-endorsed statements, the HCVS instrumentation and power to operate is assumed to perform its intended function as defined in Section 3.2.1.10 of NEI 12-06.

BWR VENTING STRATEGIES

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

The licensee's approach described above, as currently understood, has raised concerns which must be addressed before confirmation can be provided that the approach is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01. These questions are identified as Open Items in Section 4.1.

3.2.4 Support Functions

3.2.4.1 Equipment Cooling – Cooling Water

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

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

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

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

3.2.4.2 Ventilation – Equipment Cooling

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

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

levels which isolate HPCI or RCIC steam lines. Supplemental air flow or the capability to override the isolation feature may be necessary at some plants. The procedures/guidance should identify the corrective action required, if necessary.

Actuation setpoints for fire protection systems are typically at 165-180°F. It is expected that temperature rises due to loss of ventilation/cooling during an ELAP/LUHS will not be sufficiently high to initiate actuation of fire protection systems. If lower fire protection system setpoints are used or temperatures are expected to exceed these temperatures during an ELAP/LUHS, procedures/guidance should identify actions to avoid such inadvertent actuations or the plant should ensure that actuation does not impact long term operation of the equipment.

On page 42 the Integrated Plan the licensee stated that in accordance with QOA 5750-15, "Complete Loss of Control Room HVAC", alternate cooling consisting of providing an alternate air flow to the MCR via a pre-staged portable fan is implemented to maintain the Main Control Room temperature below 120°F.

Procedure QOA 5750-15 identifies 122°F as the maximum operating temperature of the equipment. The MCR conforms to the guidance in NEI 12-06, Section 3.2.2, Guideline (10) with respect to ventilation.

The licensee's plan did not provide any information for other areas as to the need for additional strategies (if any) for providing cooling functions for equipment to assure that coping strategy functionality could be maintained. Additional information is needed as to whether equipment functionality can be maintained in regard to cooling functions for FLEX equipment and permanent equipment used to support FLEX strategies.

Updated information provided by the licensee as part of the audit response identified that the RCIC room cooling function will be restored by connecting the FLEX pump to supply the required flow of water to the room coolers. The room cooler fan power will be restored with the connection of the FLEX generator. This has been identified as Confirmatory Item 3.2.4.2.A. in Section 4.2.

The HPCI system will be utilized if necessary to restore reactor water level early in the event as a backup to the RCIC system. The system will be used only briefly so supplemental cooling is not required due to the short period of use and limited room heat up during that period of use.

On page 43 of the Integrated Plan, the licensee stated: It is expected that the rise in temperature in the Safety Related Battery Rooms due to the loss of ventilation will not adversely affect the functionality of the batteries. Alternate ventilation will be provided to address hydrogen generation and cold weather, as required.

The basis of this conclusion is not clear. A discussion is needed on the effects of extreme high and 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 has not provided analysis on the need for hydrogen gas ventilation for the station battery rooms. If ventilation is needed, analysis requires discussion on the hydrogen gas exhaust path for ventilation of hydrogen gas. A discussion on the accumulation of hydrogen when the batteries are being recharged during Phase 2 and 3 has also not been provided.

Updated information provided by the licensee as part of the audit process stated a modification will change the power source to the existing battery room fan to an emergency lighting cabinet which can be powered by the FLEX generators. Once the FLEX generators are connected, the battery room ventilation fan can be repowered and will restart and the normal method of maintaining acceptable hydrogen concentration is restored. If the existing fan is not available, portable fans powered by the FLEX generator will be used. These actions will be incorporated into FLEX Support Guidelines. The licensee’s 6 month status report identified open item 12 which identifies that alternate ventilation will be provided to address hydrogen generation and cold weather as required. Per telephone conversation on the NRC questions, the licensee noted that high temperature will not adversely affect the batteries from performing their mitigating strategies function but could have impact the long-term health of the batteries. 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 ventilation for equipment cooling strategies if these requirements are implemented as described.

3.2.4.3 Heat Tracing. NEI 12-06, Section 3.2.2, Guideline (12) provides that:

> *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 does not identify any procedures/guidance that addresses the effects of loss of power to heat tracing. The licensee was requested to address heat tracing because the Integrated Plan is silent on this issue. The licensee responded that in Phase 1, RCIC is the primary system being used to restore and maintain reactor water level. This system will take suction from the suppression chamber. As all RCIC system piping is located internal to the reactor building no protection from cold weather is installed and portable heating equipment is not necessary to maintain the system functional in cold conditions. The Condensate Storage Tanks are not credited as a source of water, except during a Local Intense Precipitation event which does not occur during freezing conditions.

During Phases 2 and 3, water will be supplied using portable external FLEX pumps. These pumps once deployed and started will be protected from freezing by establishing and maintaining flow through the hoses and piping. During the system lineup, valving of the Core Spray/RCIC cubicle cooler will be established to provide two functions. First, this flow will provide cooling water to the cubicle cooler which will be placed in operation to support extended operation for the RCIC system. Secondly, the lineup will provide a constant flow path of approximately 100 gpm (see question 25) to keep hoses and piping from freezing during extreme cold conditions. If cold weather exists this flow will be maintained after the RCIC system is shutdown to maintain external hose freeze protection.

All instrumentation used to monitor critical parameters is located internal to the reactor building. No protection from cold weather is installed and portable heating equipment is not necessary to maintain the system functional in cold conditions.

The licensee's response adequately addressed heat tracing.

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

3.2.4.4 Accessibility – Lighting and Communications.

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

> *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 Integrated Plan did not identify procedures/guidance that addresses the identification of the portable lighting (e.g., flashlights or headlamps) systems necessary for ingress and egress to plant areas required for deployment of FLEX strategies. Because the integrated report is silent on this issue, a conclusion cannot be made from the information provided there is reasonable assurance that the plan will conform to NEI 12-06, Section 3.2.2, Guideline (8).

Updated information provided by the licensee as part of the audit process identified that upon initiation of the ELAP event, yet to be drafted procedures will call for issuance of the Safe Shutdown Equipment toolboxes, which will include "hands-free" flashlights to be used for FLEX response actions. This has been identified as Confirmatory Item 3.2.4.4.A. in Section 4.2.

The NRC staff has reviewed the licensee communications assessment ADAMS Accession Nos. ML12306A199 and ML13056A135 in response to the March 12, 2012 50.54(f) request for information letter for Quad Cities Nuclear and 2 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.B. in Section 4.2 below for confirmation that upgrades to the site's communications systems has been completed.

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

3.2.4.5 – Protected and Internal Locked Areas 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.

In its Integrated Plan, the licensee does not identify procedures/guidance with regard to the access to the Protected Area and internal locked areas. Because the integrated report is silent on this issue, a conclusion cannot be made from the information provided there is reasonable assurance that the plan will conform to NEI 12-06, Section 3.2.2, Guideline (9).

Updated information provided by the licensee as part of the audit process stated that upon initiation of the ELAP event, yet to be drafted procedures will call for issuance of the Safe Shutdown Equipment toolboxes with the necessary tools and keys to allow access to all plant areas including security and radiation areas. Also, the security workforce will be available to support FLEX equipment deployment including security door operation for Protected Area and plant access. This has been identified as Confirmatory Item 3.2.4.5.A. in Section 4.2.

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

3.2.4.6 Personnel Habitability – Elevated Temperature

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

> *Plant procedures/guidance should consider accessibility requirements at locations where operators will be required to perform local manual operations.*
>
> Due to elevated temperatures and humidity in some locations where local

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

Section 9.2 of NEI 12-06 states,

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

Main Control Room Habitability

On page 42 of the Integrated Plan the licensee stated QCNPS intends to maintain Operational command and control 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 six-month update. In accordance with QOA 5750-15, "Complete Loss of Control Room HVAC", alternate cooling consisting of providing an alternate air flow to the MCR via a pre-staged portable fan is implemented to maintain the Main Control Room temperature below 120°F (Reference 1).

Procedure QOA 5750-15 requires action if Main Control Room temperature becomes too high. A specific temperature is not identified. There is no mention of 120°F in the procedure. The only identification of temperature in the procedure is identification of 122°F as maximum operating temperature of the equipment. The procedure identifies the storage location of the equipment needed to provide alternate airflow as the Service Building.

At a steady-state condition of 110°F, the environmental conditions within the main control room would remain at the uppermost habitability temperature limit defined in NUMARC 87-00 for efficient human performance. NUMARC 87-00 provides the technical basis for this habitability standard as MIL-STD-1472C, which concludes that 110°F is tolerable for light work for a 4 hour period while dressed in conventional clothing with a relative humidity of ~30%.

Because the strategy and associated support analyses have not been completed, there is insufficient information to conclude that the habitability limits of the control room will be maintained in all Phases of an ELAP. It is understood per the information in the Integrated Plan that the licensee has not yet completed habitability conditions and is expected to provide these in a future update. The 6 month status report identified open item 11 which stated, "Habitability conditions will be evaluated and a strategy will be developed to maintain Main Control Room habitability."

Updated information provided by the licensee as part of the EA-12-049 Mitigation Audit response identified the station is currently using 120 deg. F as the upper limit for the Control Room based on the plant's current design and licensing basis for compliance to the Station Blackout (SBO) Rule. Applicable discussion of this limit is documented in the SER for the SBO Rule, dated December 11, 1990. This discussion documents the 120 deg. F limit and includes reference to Question and Answer 2.2 on Page J-2 of NUMARC 87-00, Rev. 1.

This has been identified as Open Item 3.2.4.6.A. in Section 4.1, below because the SBO scenario for Quad Cities is for 4 hours and MIL-STS-1472C is for four hours. The limit of 120 deg. F is for equipment and the 110 deg. F limit is for habitability. The ELAP events are for much longer times, therefore more discussion is required.

RCIC Room Habitability

QCNPS intends to maintain RCIC Room habitability (page 42). The licensee identified that habitability conditions will be evaluated and a strategy will be developed to maintain RCIC habitability. Preliminary GOTHIC analysis indicates that alternate cooling provided to Units 1 and 2 RCIC within eight hours will ensure RCIC Room temperature does not exceed 150°F.

The 6 month update includes and tracks open item 11 which states, "[h]abitality conditions will be evaluated and a strategy will be developed to maintain RCIC habitability." Confirmatory Item 3.2.4.2.A., identified above, addresses modifications to enable normal cooling of the RCIC room when the FLEX generators are available. As noted below habitability is not needed since the RCIC system can be operated remotely from the Control Room if either batteries or the FLEX generator are available.

On page 12 of the Integrated Plan the licensee indicated that the RCIC system can be operated locally without dc power. The following information was requested to evaluate this assertion:

1. Whether the RCIC system relies on a barometric condenser, and if so, justify that RCIC can be successfully operated to mitigate an ELAP following a loss of dc power.

2. Whether RCIC could be operated locally during an ELAP, given that page 42 of the submittal specifies that the maximum temperature for the RCIC room could reach 150°F.

Updated information provided by the licensee as part of the audit process clarified operation of RCIC locally is not part of the FLEX strategy but was added to the Integrated Plan to clarify the system capability. The Integrated Plan strategy is to restore ac power using protected and deployed 480 V FLEX generators prior to the loss of the 125 V or 250 V battery systems. Upon re-energization of the ac power the 125 and 250 V battery chargers will be restored and provide the necessary power to continue operation of RCIC from the main control room.

The licensee also stated that operation of the RCIC system for extended time does require operation of the barometric condenser. Upon re-powering of the ac and dc battery chargers, the barometric condenser will remain in operation to support RCIC operation. Operation of the RCIC system from the control room is unaffected by local room temperatures of 150°F.

The updated information adequately addresses the issues raised on local operation of RCIC without dc power.

HPCI Room

HPCI has been identified for possible use in adding inventory to the RPV. It is not identified in the Integrated Plan with regard to habitability.

Because the strategy and associated support analyses have not been completed, additional information was requested to enable conclusion that the habitability limits of the control room will be maintained in all Phases of an ELAP. Updated information provided by the licensee as part of the audit process stated that the HPCI system will be utilized if necessary to restore reactor water level early in the event as a backup to the RCIC system. The system will be used only briefly so supplemental cooling is not required due to the short period of use and limited room heat up during that period of use.

On page 2 of the licensee's integrated plan, the licensee stated that site industrial safety procedures currently address activities with a potential for heat stress to prevent adverse impacts on personnel.

Identification of the site industrial safety procedures mentioned above is needed. Identify if they address providing relief efforts for the activities in high temperature areas (e.g., MNCR, RCIC, HPCI and Auxiliary Electric rooms such as protective clothing, short stay time cycles, use of ice vests/packs, supplies of bottled water, etc.). This has been identified as Confirmatory Item 3.2.4.6.B. in Section 4.2,

The Integrated Plan did not identify procedures/guidance that addressed the use of appropriate human performance aids (e.g., component marking, connection schematics, installation sketches, photographs, etc.). Because the integrated report was silent on this issue, a conclusion cannot be made from the information provided there is reasonable assurance that the plan will conform to NEI 12-06, Section 3.2.2, Guideline (11). This has been identified as Confirmatory Item 3.2.4.6.C. in Section 4.2.

SFP Area

On page 34 of the Integrated Plan describing the protection of connections for the transition phase of SFP cooling, the licensee stated:

> 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 six-month update.

The 6 month status report identified open item 9 which stated that the evaluation of the SFP area for steam and condensation and the vent path strategy, if needed, will be provided in a future six-month update.

SFP habitability was previously addressed in Section 3.2.2 above and based on updated information provided by the licensee as part of the audit process this was previously identified as Confirmatory Item 3.2.2.A. The strategy is to enable remote operator action or early operator action to enable SFP cooling without operator exposure to a harsh environment.

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

3.2.4.7 Water Sources.

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

> *Plant procedures/guidance should ensure that a flow path is promptly established for makeup flow to the steam generator/nuclear boiler and identify backup water sources in order of intended use. Additionally, plant procedures/guidance should specify clear criteria for transferring to the next preferred source of water.*
>
> Under certain beyond-design-basis conditions, the integrity of some water sources may be challenged. Coping with an ELAP/LUHS may require water supplies for multiple days. Guidance should address alternate water sources and water delivery systems to support the extended coping duration. Cooling and makeup water inventories contained in systems or structures with designs that are robust with respect to seismic events, floods, and high winds, and associated missiles are assumed to be available in an ELAP/LUHS at their nominal capacities. Water in robust UHS piping may also be available for use but would need to be evaluated to ensure adequate NPSH can be demonstrated and, for example, that the water does not gravity drain back to the UHS. Alternate water delivery systems can be considered available on a case-by-case basis. In general, all CSTs 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.

On page 12 of the Integrated Plan, the licensee stated initial reactor water level control would be accomplished using the RCIC System which normally takes suction from the Contaminated Condensate Storage Tanks (CCSTs). If the CCSTs are not available RCIC suction will transfer automatically, or can be transferred manually, to the Suppression Pool

On page 15 of the Integrated Plan, the licensee identified the strategy of connecting a FLEX pump via a hose to one of the proposed quick hose connections to enable water from the Discharge Bay to be supplied directly to the Suppression Pool or to the RPV.

Updated information provided by the licensee as part of the audit process addressed plant procedures/guidance criteria for transferring to the next preferred available source of water. This is addressed in Section 3.2.1.6 above.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and 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 pages 42 of the Integrated Plan, the licensee identified the following two conceptual modifications to connect a portable generator to provide power to critical loads:

> 1 Primary strategy Install a seismically qualified, fused disconnect panel in the vicinity of Bus 18(28) to allow for quick connection to a staged 480 VAC diesel-powered generator.
> 2 Alternate strategy Install a second seismically qualified, fused disconnect panel in the vicinity of Bus 19(29) to allow for quick connection to a staged 480 VAC diesel-powered generator.
>
> The divisions fed by Buses 18(28) and 19(29) are designed to be cross - connected such that each fused disconnect panel can feed all necessary loads.

The licensee noted that the electrical strategy conceptual design contains features to expedite and simplify implementation, and may not be required in order to meet the event timeline for maintaining the safety function requirements of NEI 12-06.

It is understood that the modifications above are “conceptual,” but the licensee has included a description of the modification and a reference drawing depicting the modification configuration. The licensee plans on using 480VAC portable diesel generator(s) to power various systems following battery depletion. The licensee did not provide any information regarding loading calculations of portable diesel generators(s) or strategy regarding electrical isolation from installed plant equipment. It was determined that there was insufficient information available to conclude that there is reasonable assurance that the licensee will ensure that portable/FLEX diesel generators are adequately sized and isolated from the Class 1E diesel generators to prevent simultaneously supplying power to the same Class 1E bus. This has been identified as Confirmatory Item 3.2.4.8.A. in Section 4.2.

The licensee’s approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to electrical power source 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 43 of the Integrated Plan regarding safety functions support, the licensee stated:

> Fuel oil to Flex Pumps and Generators will be supplied by the quantity of fuel in the tanks located on the skids of the portable equipment. This will then be supplemented by fuel tanks contained on the back of the Flex Truck. When required, fuel can then be pumped from the EDG Fuel Storage Day Tanks by accessing the tanks via tank access covers. A detailed fuel oil supply plan will be developed.

The detailed fuel supply plan should include the following information:

1. EDG fuel oil storage tank volume, fuel oil capacity of the fuel truck, day tank volume, FLEX truck access, and supply pathway.
2. How continued operation to ensure core and SFP cooling is maintained indefinitely (i.e., Phase 2 and 3).
3. How fuel quality will be assured if stored for extended periods of time in the day tanks.

This has been identified as Confirmatory Item 3.2.4.9.A, in Section 4.2

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to 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 56 and 57 of the Integrated Plan the licensee stated that 125 volt load shedding will begin at time 5 minutes and be complete at time 30 minutes, (SOE items 8 and 11, respectively).

On page 6 of the Integrated Plan Item 11 of the timeline, the licensee identified battery durations have been preliminarily evaluated to last at least 7 hours. Alignment of FLEX DG will begin at approximately 1 hour. Three hours later the FLEX DG will be in service. Thus, within 4 hours the FLEX DGs can be in service to supply power to both divisions of Class 1E emergency 480 VAC.

The final analysis needs to address the following:

a. Provide the dc load profile with the required loads for the mitigating strategies to maintain core cooling, containment, and SFP cooling.
b. 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. Identification of which functions are lost as a result of shedding each load and a discussion of any impact on defense in depth and redundancy.
    i) Identification of any plant components that will change state if vital ac or dc is lost, de-energized, during this evolution of dc load shed? Identification if when the operators manipulate dc breakers to load shed, will plant components actuate, de-energize pumps, etc.? Identification if safety hazards are 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?
    ii) Identification of which breakers will operators open as part of the load shed evolutions?
    iii) Identification if the dc breakers to be opened will be physically identified by special markings to assist operators manipulating the correct breakers?

During the audit process, the licensee identified that the 125 VDC load shed procedure (QOA 6900-07) was added to the ePortal and describes the loads shed and identified the loads shed will no longer require dc power during an ELAP event. The dc load profile for the mitigating strategies was evaluated and based on the evaluation the 125 VDC batteries would be expected to last beyond the 8 hour limit of the battery discharge curve.

The evaluation of the 250 VDC batteries determined a coping time is in excess of 7 hours. The 250 VDC system provides power for HPCI and RCIC MOVs, oil pumps and exhausters and instrumentation. This analysis was performed with changes to the load shed procedure to include shed of the HPCI [abnormal operating procedures] AOP, [emergency operating procedures] EOP, Exhauster, drain valves and the Generator [emergency seal oil pump] ESOP at 60 minutes. The HPCI system will be utilized to restore reactor water level following the event initiation and then secured. The RCIC system is also used for the initial reactor water level restoration and is subsequently cycled as necessary to maintain reactor water level. These actions are factored into the battery coping time evaluation. Design changes are in progress to change the ESOP power feed to non-essential 250 V batteries. This battery provides power to only one load presently, the Turbine emergency bearing oil pump. This improves the 250 VDC safety related battery coping time.

The 250 VDC load shed procedure QCOA 6900-05 has direction to shed the Emergency Seal Oil pump. This procedure will be revised as part of the modifications already discussed. New procedure steps will include depressurizing of the hydrogen within the generator prior to securing the ESO pump. These actions will vent the gas external to the turbine building and place the generator in a depressurized state.

Breakers manipulated during the use of QOA 6900-07 and QCOA 6900-05 do not have special markings.

Quad Cities Station confirms that the FLEX strategy station battery run-time was calculated in accordance with the IEEE-485 methodology using manufacturer discharge test data applicable to the licensee's FLEX strategy as outlined in the NEI white paper on Extended Battery Duty Cycles. The detailed licensee calculations, supporting vendor discharge test data, FLEX strategy battery load profile, and other inputs/initial conditions required by IEEE-485 will be available on the licensee's web portal for documents and calculations. The time margin between the calculated station battery run-time for the FLEX strategy and the expected deployment time for FLEX equipment to supply the dc loads is approximately 3-4 hours.

This has been identified as Confirmatory Item 3.2.4.10.A. in Section 4.2 for completion of the design changes and procedural changes.

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

## 3.3 PROGRAMMATIC CONTROLS

### 3.3.1 Equipment Maintenance and Testing.

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

> In order to assure reliability and availability of the FLEX equipment required to meet these capabilities, the site should have sufficient equipment to address all functions at all units on-site, plus one additional spare, i.e., an N+1 capability, where "N" is the number of units on-site. Thus, a two-unit site would nominally have at least three portable pumps, three sets of portable ac/dc power supplies, three sets of hoses & cables, etc. It is also acceptable to have a single resource that is sized to support the required functions for multiple units at a site (e.g., a

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

NEI 12-06, Section 11.5 states:

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

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

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

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

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

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

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

[1] Testing includes surveillances, inspections, etc.

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

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

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

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

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

On pages 49 through 50 of the integrated Plan acceptable levels of N+1 equipment as described in table 3-1 are identified.

On pages 8 and 9 of the Integrated Plan regarding programmatic controls, the licensee stated:

> Quad Cities Nuclear Power Station will implement an administrative program for FLEX to establish responsibilities, and testing and 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 components added to the FLEX plant 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 10CFR50.63(a) will continue to meet the augmented quality guidelines of Regulatory Guide 1.155, Station Blackout. Standard industry PMs (Preventative Maintenance) 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 the licensee standards.

The Integrated Plan did not provide information regarding the control of equipment and connections for unavailability. This has been identified as Open Item 3.3.2.A. in Section 4.1.

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

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

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

3.3.2 Configuration Control

NEI 12-06, Section 11.8 states:

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

On page 9 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.

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

3.3.3 Training.

NEI 12-06, Section 11.6 provides that:

1. Programs and controls should be established to assure personnel proficiency in the mitigation of beyond-design-basis events is developed and maintained. These programs and controls should be implemented in accordance with an accepted training process.[2]

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

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

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

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

On page 9 of the Integrated Plan the licensee stated 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 per change management 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 training if these requirements are implemented as described.

## 3.4 OFFSITE RESOURCES

NEI 12-06, Section 12.2 States:

Each site will establish a means to ensure the necessary resources will be available from off-site. Considerations that should be included in establishing this capability include:

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

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 59 of the Integrated Plan, SOE item 22 identified that at 24 hours initial equipment from the RRC becomes available.

A determination cannot be made from the information in the Integrated Plan as to when the RRC assistance would be requested (not on the timeline) and what administrative procedure or program would trigger that request. The licensee was requested to provide additional information to assess this issue.

Updated information provided by the licensee as part of the audit process stated the playbook for the when and how RRC response center will respond to a Quad Cities Station request has <u>not been developed to date</u>. The procedure for requesting assistance has also not been developed. As the interface process with the SAFER Group is developed the request trigger and method will be determined and integrated into the appropriate Quad Cities station procedure. This has been identified as Confirmatory Item 3.4.A. in Section 4.2.

On pages 9 of the Integrated Plan regarding the RRC Plan, the licensee identified that equipment will be moved from an RRC to a local Assembly Area, established by the SAFER team and the utility.

Based on the evaluation in Section 3.1.1.4 above of updated information provided by the licensee as part of the audit process, the licensee has adequately addressed transportation and the local staging area.

On pages 9 of the Integrated Plan regarding the RRC Plan, the licensee addressed offsite resources as follows:

> Quad Cities Nuclear Power Station (QCNPS) has contractual agreements in place with the Strategic Alliance for FLEX Emergency Response (SAFER
> The industry will establish two (2) Regional Response Centers (RRC) 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.

From the review of the information provided above regarding offsite resources, there was insufficient information to demonstrate that the licensee would meet the guidelines of NEI 12-06, Section 12.2, items (2) through (10). This has been identified as Open Item 3.4.B. in Section 4.1.

Pages 20, 30, 38, and 47 of the licensee's Integrated Plan noted that the Phase 1 and 2 strategies will provide sufficient capability such that no additional Phase 3 strategies are required.

The licensee was requested to provide Information as to how the portable generators and their fuel supply are capable of maintaining core cooling, spent fuel cooling, and containment indefinitely. Also, the licensee was requested to identify the electrical power requirements for implementing Phase 3 of the mitigating strategies and provide the capacity of the power sources.

Updated information provided by the licensee as part of the audit process stated restoration of 480 VAC to the essential safety system buses will provide power to critical loads such as battery chargers, instrument panels and remote operated valves, all of which support maintaining core cooling, spent fuel cooling and containment. The Phase 3 strategy is essentially a continuance of the Phase 2 strategy, indefinitely. The necessary power requirements and the capacity of the power sources has not been determined for Phase 2 equipment yet, but will be determined as FLEX design specifics are completed. Therefore there are no additional power requirements for Phase 3.

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

## 4.0 OPEN AND CONFIRMATORY ITEMS

### 4.1 OPEN ITEMS

| Item Number | Description | Notes |
|---|---|---|
| 3.2.3.A. | Generic concern related to adoption of Revision 3 to the | SIGNIFICANT |

| | | |
|---|---|---|
| | BWROG EPG/SAG [Emergency Procedure Guidelines/ Severe Accident Guidelines] relating to potential detrimental effects on containment response. | |
| 3.2.4.6.A. | Licensee asserts 120 degree F used for habitability in SBO is adequate for FLEX. Habitability of the control room should consider 110 degree F temperature limits of NUMARC 87-00 and MIL-STD-1472C. | |
| 3.3.2.A. | Control of equipment and connections for unavailability needs to be addressed. | |
| 3.4.B. | Details not provided to demonstrate the minimum capabilities for offsite resources will be met per NEI 12-06 Section 12.2. | |

## 4.2 CONFIRMATORY ITEMS

| Item Number | Description | Notes |
|---|---|---|
| 3.1.1.2.A. | Studies for liquefaction and the effects on haul paths and storage location(s) are not complete. | |
| 3.1.1.2.B. | A postulated downstream dam failure from a seismic event still being evaluated. | |
| 3.1.1.2.C. | Need to confirm implementation of strategy for power to move or deploy FLEX equipment and opening of doors. | |
| 3.1.1.3.A. | Plans for strategies have insufficient information to demonstrate alternate sources of instrument readings and adequate tolerances/accuracies if there is seismic impact to primary sources. Also, need identification of installed instrumentation location and power source. | |
| 3.1.1.3.B. | Need identification of instrumentation used to monitor FLEX electrical power equipment including measurement tolerance/accuracy. | |
| 3.1.2.2.A. | A detailed fuel supply plan is to be provided in a future 6 month status update including what is needed, what is available, and how it will be transported. | |
| 3.1.3.2.A. | Completion of development of administrative program to ensure pathways remain clear or compensatory actions will be implemented to ensure all strategies can be deployed during all modes of operation. Procedures and programs are to be developed. | |
| 3.1.3.2.B. | Completion of assessment on the adequacy of the debris removal equipment and the effect on the timeline to assure the critical times are capable of being met. This will be tracked as an open item in the 6 month update. | |
| 3.2.1.1.A. | Need benchmarks to demonstrate MAAP4 is the appropriate code for simulation of ELAP. | |
| 3.2.1.1.B. | The collapsed level must remain above Top of Active Fuel (TAF) and the cool down rate must be within technical specification limits. | |
| 3.2.1.1.C. | MAAP4 must be used in accordance with Sections 4.1, 4.2, 4.3, 4.4, and 4.5 of the June 2013 position paper. | |

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| 3.2.1.1.D. | In using MAAP4, the licensee must identify and justify the subset of key modeling parameters cited from Tables 4-1 through 4-6 of the "MAAP4 Application Guidance, Desktop Reference for Using MAAP4 Software, Revision 2" (Electric Power Research Institute Report 1020236). | |
| 3.2.1.1.E. | The specific MAAP4 analysis case that was used to validate the timing of mitigating strategies in the integrated plan must be identified and should be available on the e-Portal for NRC staff to view. Alternately, a comparable level of information may be included in the supplemental response. | |
| 3.2.1.2.A. | Questions remain unanswered regarding seal leakage rates. Aspects such as pressure dependence, leakage phase assumptions (single phase liquid, steam, mixed) are not discussed. | |
| 3.2.1.3.A. | Need GAP analysis between results of the licensee's analysis results and those of BWROG document NEDC-33771P. Results are presented in 6 month update; however there is no analysis of the relevance of differences. | |
| 3.2.1.3.B. | Licensee plans further review and analysis to ensure Suppression Pool temperature will support RCIC operation. | |
| 3.2.1.3.C. | Need identification of minimum voltage and the basis of determination. | |
| 3.2.1.4.A. | Water quality issue and guidance on priority of water source usage need to be addressed. | |
| 3.2.1.4.B. | Need completion of current evaluation of FLEX generator sizing calculation. | |
| 3.2.1.4.C. | Design and working pressure of hoses and fittings. | |
| 3.2.1.6.A. | Licensee identified protection of equipment for Hardened Vent is to Order EA-13-109. Not clear if this is equivalent to Order EA-12-049. | |
| 3.2.2.A. | The licensee identified modifications and procedures for SFP cooling are in development. | |
| 3.2.4.2.A. | Modifications to restore RCIC room cooling are being developed by the licensee. | |
| 3.2.4.2.B. | Modifications to restore ventilation to the Battery room via use of the portable FLEX generators to address hydrogen and cold weather are being developed by the licensee. | |
| 3.2.4.4.A. | Procedures for emergency lighting is are to be developed for deployment of hands free flashlights. | |
| 3.2.4.4.B. | Confirm upgrades to communication system that resulted from the licensee communications assessment. Reference assessment correspondence ADAMS Accession Nos. ML 12306A199 and ML13056A135. | |
| 3.2.4.5.A. | Completion of drafted procedures for protected and internal locked area access. | |
| 3.2.4.6.B. | Site industrial procedures and identification of protective clothing, ice vests/packs, bottled water, etc. is needed. | |
| 3.2.4.6.C. | Need to address the use of appropriate human performance aids (e.g., component marking, connection schematics, installation sketches, photographs, etc.) shall be included in the FLEX | |

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|---|---|---|
| | guidance implementing the FLEX strategies. | |
| 3.2.4.8.A. | The licensee did not provide any information regarding loading/sizing calculations of portable diesel generators(s) and strategy for electrical isolation for FLEX electrical generators from installed plant equipment. | |
| 3.2.4.9.A. | Need detailed fuel plan including fuel storage tank, truck, and day tank volumes and how fuel quality is maintained in the day tanks and in portable FLEX equipment. | |
| 3.2.4.10.A. | Need detailed load profile for all mitigating strategies and a detailed discussion of loads that will be shed, how they will be shed, and what are the effects of the shed. | |
| 3.4.A. | Procedures for interface with the RRC need to be developed. | |