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

Revision 1

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Virginia Electric and Power Company
North Anna Power Station, Units 1 & 2
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1.0 BACKGROUND

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

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

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

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

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

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

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

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

2.0 EVALUATION PROCESS

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

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

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

- Spent Fuel Pool Cooling Strategies
- Containment Function Strategies
- Programmatic Controls
  - Equipment Protection, Storage, and Deployment
  - Equipment Quality

The technical evaluation (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 stated that they will generate a procedure to implement a specific mitigation strategy, assuming that the procedure would otherwise support the licensee's plan, this evaluation accepts that a proper procedure will be prepared. This philosophy for this evaluation and the ISE does not imply that there are any limits in this area to future NRC inspection activities.

3.0 TECHNICAL EVALUATION

By letter dated February 28, 2013, (ADAMS Accession No. ML13063A182), and as supplemented by the first six-month status report in letter dated August 28, 2013 (ADAMS Accession No. ML1324A012), Virginia Electric and Power Company (the licensee or Dominion) provided the North Anna Power Station Units 1 & 2 (North Anna) Integrated Plan for compliance with Order EA-12-049. The Integrated Plan describes the strategies and guidance under development for implementation by North Anna for the maintenance or restoration of core cooling, containment, and SFP cooling capabilities following a BDBEE, including modifications necessary to support this implementation, pursuant to Order EA-12-049. By letter dated August 28, 2013 (ADAMS Accession No. ML13234A503), the NRC staff notified all licensees and construction permit holders that the NRC staff is conducting audits of their responses to Order EA-12-049. That letter described the process used by the NRC staff in its review, leading to the issuance of an interim staff evaluation and audit report. The purpose of the staff's audit is to determine the extent to which the licensees are proceeding on a path towards successful implementation of the actions needed to achieve full compliance with the Order.

3.1 EVALUATION OF EXTERNAL HAZARDS

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

3.1.1 Seismic Events.

NEI 12-06, Section 5.2 states:

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

The licensee's screening for seismic hazards, as presented in their Integrated Plan, has screened in this external hazard. The licensee confirmed on page 1 of the Integrated Plan that a site-specific assessment for North Anna provides the development of strategies, equipment lists, storage requirements, and deployment procedures for the conditions and consequences of seismic events. The licensee also stated that the seismic re-evaluation pursuant to the 10 CFR 50.54(f) letter of March 12, 2012 had not been completed and therefore was not assumed in their Integrated Plan.

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

3.1.1.1 Protection of FLEX Equipment – Seismic Hazard

NEI 12-06, Section 5.3.1 states:

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

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

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

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

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

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

On page 17 of the Integrated Plan the licensee stated that a study is in progress to determine the design features, site location(s), and number of equipment storage facilities. The final design for BDB equipment storage will be based on the guidance contained in NEI 12-06, Section 11.3, Equipment Storage. The licensee completed the BDB equipment storage study as documented in the completed Open Item #6 of its six-month status report. Staff review of the results of this study is identified as Confirmatory Item 3.1.1.1.A in Section 4.2 below.

The licensee's commitment to meet the storage structure considerations of NEI 12-06, Section 11.3 will conform to the storage structure considerations of Section 5.3.1 for the seismic hazard.

On page 29, 56, and 64 of the Integrated Plan the licensee stated that the BDB pumps, necessary hoses and fittings are protected from seismic events while stored in the BDB Storage Building(s) or in protected areas of the plant.

On page 64 of the Integrated Plan the licensee stated that the BDB portable diesel generators, necessary cables and connectors will be protected from seismic events while stored in either the BDB Storage Building(s) or in seismic protected areas of the plant.

The licensee's plan did not address the securing of large portable equipment to protect them during a seismic event or to ensure unsecured and/or non-seismic components do not damage the equipment during a seismic event as specified by NEI-12-06, Section 5.3.1 considerations 2 and 3. During the audit process, the licensee stated that the storage building will be equipped with tie-downs to ensure FLEX equipment is protected from seismic events. Fire protection and HVAC within the storage building is being seismically installed. Lighting, conduits, and fire detection is not considered a threat to damage the FLEX equipment.

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

3.1.1.2 Deployment of FLEX Equipment - Seismic Hazard

NEI 12-06, Section 5.3.2 states:

> 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.

On page 100 of the Integrated Plan, the licensee stated that preferred travel pathways for FLEX equipment movement will be determined using the guidance contained in NEI 12-06. The pathways will attempt to avoid areas with trees, power lines, and other potential obstructions and will consider the potential for soil liquefaction. However, debris can still interfere with these preferred travel paths. Debris removal equipment will be kept in the BDB Storage Building(s) so that it is protected from the severe storm, earthquake and flood hazards. Therefore, the debris removal equipment remains functional and deployable to clear obstructions from the travel pathways to the BDB equipment's deployed location(s). The stored BDB equipment includes tow vehicles (small tractors) equipped with front-end buckets and rear tow connections in order to move or remove debris from the needed travel paths. A front-end loader will also be available to deal with more significant debris conditions.

On pages 30, 31, 35, 44, 45, 46, 57, 58, 65, 66, 68, 74, and 76 of the Integrated Plan, in the sections describing protection of connections, the licensee details information as to how at least one connection point for FLEX equipment will only require access through seismically robust structures.

On page 26 of the Integrated Plan the licensee stated that an indefinite supply of water can be provided from Lake Anna or the Service Water Reservoir. Lake Anna will remain available for any of the external hazards applicable to North Anna. The service water reservoir is a safety-related, seismic category I earthen structure and will also remain available for any of the external hazards applicable to North Anna.

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

3.1.1.3 Procedural Interfaces – Seismic Hazard

NEI 12-06, Section 5.3.3 states:

> There are four procedural interface considerations 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.

In the Integrated Plan the licensee does not provide any information on the availability of a reference source for obtaining instrument readings using a portable instrument to support coping strategy implementation. In response to the audit, the licensee stated that a FLEX support guideline (FSG) is currently under development to provide operators with direction on how to establish alternate monitoring and control capabilities. This is identified as Confirmatory Item 3.1.1.3.A in Section 4.2 below.

In the Integrated Plan, the licensee does not provide any information on non-robust internal flooding sources that do not require ac power or the use of ac power to mitigate ground water in critical locations. In response to the audit, the licensee stated that fire protection water piping and other water system piping within the plant was evaluated during the Individual Plant Examination for External Events (IPEEE) as potential seismic event induced flooding sources. The results of this evaluation concluded that seismic-induced leakage from these systems would not result in flooding that adversely affected safe-shutdown equipment. In addition, the licensee stated that no subsurface dewatering pumps are required.

As described in Section 3.1.1.2 of this evaluation, the licensee's plan does not rely on water source that is not seismically robust.

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 seismic procedural interfaces considerations, if these requirements are implemented as described.

3.1.1.4 Considerations in Using Offsite Resources – Seismic Hazard

NEI 12-06, Section 5.3.4 states:

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

On page 21 of the Integrated Plan, the licensee stated that the industry will establish two Regional Response Centers (RRCs) to support utilities during BDB events. Dominion has established contracts with the Pooled Equipment Inventory Company (PEICo) to participate in the process for support of the RRCs as required. Each RRC will hold five sets of equipment, four of which will be able to be fully deployed when requested, the fifth set will have equipment in a maintenance cycle. In addition, on-site BDB equipment hose and cable end fittings are standardized with the equipment supplied from the RRC. Equipment will be moved from an RRC to a local Assembly Area, established by the Strategic Alliance for FLEX Emergency Response (SAFER) team and the utility. Communications will be established between the affected nuclear site and the SAFER team and required equipment 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. Confirmation of the RRC local staging area, evaluation of access routes, and method of transportation to the site is identified as Confirmatory Item 3.1.1.4.A in Section 4.2 below.

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

3.1.2 Flooding.

NEI 12-06, Section 6.2 states:

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

NEI 12-06, Section 6.2.1 states 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 stated that a site-specific assessment for North Anna provides the development of strategies, equipment lists, storage requirements, and deployment procedures for the conditions and consequences of external flooding. The licensee stated that the flood 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.

On page 2 of the Integrated Plan, the licensee provides information regarding the effects of external flooding on the plant but did not provide a definitive statement as to whether the site is determined to be a “dry site” or “wet site”. In response to the audit, the licensee stated that North Anna is a “wet” site because the site is kept “dry” by a permanently installed dike. The licensee stated that the design basis flood level is based on the maximum potential lake level of 267.3’ MSL resulting from a probable maximum precipitation (PMP) event over the Lake Anna watershed causing a significant rise in lake level. Although the majority of the site grade is above the design base flood level, the western portion of the Unit 2 turbine building is protected by a dike to prevent flooding during the design basis flood. There is no deployment of FLEX equipment in the area west of the Unit 2 turbine building; therefore there are no deployment limitations due to flooding from the design basis flood.

On page 3 of the Integrated Plan, the licensee stated that the current flood analysis for Unit 3 is applicable according to NEI 12-06. During the audit, the licensee was requested to clarify whether all of the information regarding external flooding in the Integrated Plan is derived from the most recent flood analysis (i.e., Unit 3 flood analysis). In response, the licensee stated that the information in the Integrated Plan, Section A.1 regarding external flooding was based on the current North Anna Units 1 and 2 UFSAR, not the North Anna Unit 3 COLA. However, since a seiche event had not been addressed in the North Anna Units 1 and 2 UFSAR, a reference to the North Anna Unit 3 COLA evaluation was used for completeness.

Since the submittal of the Integrated Plan, Dominion has completed and submitted the Flood Hazard Reevaluation Report (FHRR) (ADAMS Accession No. ML13318A090) for North Anna requested by the 10 CFR 50.54(f) letter dated March 12, 2012. NRC review of this report is not yet complete, but the licensee characterizes the results as follows. The reevaluation represents the most current flooding analysis for North Anna Units 1 and 2. The reevaluation results were mostly bounded by the original North Anna UFSAR site flooding vulnerabilities and characteristics, in that the non-events such as seiche and dam failures continued to be non-events. The maximum flood level due to elevated lake levels resulting from a PMP event over the Lake Anna watershed exceeded the UFSAR value by 0.1 foot. This difference is insignificant since the plant grade is nearly 4 feet above this flood level. The only significant difference identified from the UFSAR was a local intense precipitation (LIP) event. Using conservative drainage assumptions and current PMP rates, some areas of the site were subject to short term flooding which required minimal protective actions. Details of the LIP event can be obtained from Section 2.1 of the FHRR. Therefore, the most current analysis for flooding is the FHRR for North Anna and is neither the current North Anna Units 1 and 2 UFSAR nor the North Anna Unit 3 COLA.

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

3.1.2.1 Protection of FLEX Equipment – Flooding Hazard

NEI 12-06, Section 6.2.3.1 states:

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

On page 17 of the Integrated Plan, the licensee stated that a study is in progress to determine the design features, site location(s), and number of equipment storage facilities. The final design for BDB equipment storage will be based on the guidance contained in NEI 12-06, Section 11.3, Equipment Storage. Meeting the storage structure considerations of NEI 12-06, Section 11.3 will conform to the storage structure considerations of Section 6.2.3.1 for the flooding hazard. The licensee completed the BDB equipment storage study as documented in the completed Open Item #6 of its six-month status report. Staff review of the results of this study is included with Confirmatory Item 3.1.1.1.A in Section 4.2 below.

On page 29, and 56 of the Integrated Plan the licensee stated that the BDB pumps, necessary hoses and fittings are protected from flooding while stored in the BDB Storage Building(s) or in protected areas of the plant.

On page 64 of the Integrated Plan the licensee stated that the BDB portable diesel generators, necessary cables and connectors will be protected from flooding while stored in either the BDB Storage Building(s) or in flood protected areas of the plant.

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

3.1.2.2 Deployment of FLEX Equipment – Flooding Hazard

NEI 12-06, Section 6.2.3.2 states:

> There are a number of considerations which apply to the deployment of FLEX equipment for external flood hazards:
>
> 1. For external floods with warning time, the plant may not be at power. In fact, the plant may have been shut down for a considerable time and the plant configuration could be established to optimize deployment. For example, the portable pump could be connected, tested, and readied for use prior to the arrival of the critical flood level. Further, protective actions can be taken to reduce the potential for flooding impacts, including cooldown, borating the RCS, isolating accumulators, isolating RCP [reactor coolant pump] seal leak off, obtaining dewatering pumps, creating temporary flood barriers, etc. These factors can be credited in considering how the baseline capability is deployed.
>
> 2. The ability to move equipment and restock supplies may be hampered during a flood, especially a flood with long persistence. Accommodations along these lines may be necessary to support successful long-term FLEX deployment.
>
> 3. Depending on plant layout, the ultimate heat sink may be one of the first functions affected by a flooding condition. Consequently, the deployment of the FLEX equipment should address the effects of LUHS, as well as ELAP.

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

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

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

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

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

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

On page 100 of the Integrated Plan, the licensee stated that stored BDB equipment includes tow vehicles (small tractors) equipped with front-end buckets and rear tow connections in order to move or remove debris from the needed travel paths and to deploy equipment.

On page 7 of the Integrated Plan, the licensee stated that normal access to the ultimate heat sink is lost, but the water inventory in the ultimate heat sink (UHS) remains available and robust piping connecting the UHS to plant systems remains intact. The motive force for UHS flow, i.e., pumps, is assumed to be lost with no prospect for recovery.

On page 73 of the Integrated Plan the licensee stated that the BDB fuel carts, pumps, necessary hoses, fittings, and containers will be protected from flooding events while stored in the BDB Storage Building(s) or in protected areas of the plant. On page 72, the licensee details how the fuel would be accessed from the underground diesel fuel oil storage tanks that are protected from the flood hazard.

On pages 30, 31, 32, 35, 44, 45, 46, 57, 58, 66, 68, 74, and 76 of the Integrated Plan, the licensee describes how each connection point is accessed and protected to ensure at least one connection point will be available for strategy deployment.

North Anna is not limited by storm-driven flooding, such as Probable Maximum Surge or Probable Maximum Hurricane (PMH). NEI 12-06, Section 6.2.3.2, Consideration 6 is not applicable.

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

3.1.2.3 Procedural Interfaces – Flooding Hazard

NEI 12-06, Section 6.2.3.3 states:

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

On page 17 of the Integrated Plan, the licensee stated that FSGs will be developed in accordance with the Pressurized Water Reactor Owners Group (PWROG) guidelines. Interface with ECA-0.0, "Loss of All AC Power", will be revised to the extent necessary to include appropriate reference to FSGs. Interface with Abnormal Procedures O-AP-41, Severe Weather Conditions, will be revised to the extent necessary to include appropriate reference to FSGs.

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

3.1.2.4 Considerations in Using Offsite Resources – Flooding Hazard

NEI 12-06, Section 6.2.3.4 states:

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

On page 21 of the Integrated Plan, the licensee stated that the industry will establish two RRCs to support utilities during BDB events. Dominion has established contracts with the Pooled Equipment Inventory Company (PEICo) to participate in the process for support of the RRCs as required. Each RRC will hold five sets of equipment, four of which will be able to be fully deployed when requested, the fifth set will have equipment in a maintenance cycle. In addition, on-site BDB equipment hose and cable end fittings are standardized with the equipment supplied from the RRC. 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. Confirmation of the RRC local staging area, evaluation of access routes, and method of transportation to the site is combined with Confirmatory Item 3.1.1.4.A in Section 4.2 below.

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

3.1.3 High Winds

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

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

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

On page 1 of the Integrated Plan, the licensee stated that a site-specific assessment of North Anna provides for the development of strategies, equipment lists, storage requirements, and deployment procedures for the conditions and consequences of storms such as hurricanes, high winds, and tornados.

On page 3 of the Integrated Plan, the licensee stated that the plant design bases address the storm hazards of hurricanes, high winds and tornadoes. With the site being approximately 100 miles from the Atlantic Ocean, hurricanes and tropical storms tend to weaken before reaching the site. For extreme straight winds, the extreme 1-mile wind speed is defined as the 1-mile passage of wind with the highest speed for the day. The extreme 1-mile wind speed at 30 feet above the ground, which is predicted to occur once in 100 years, is 80 mph. The tornado model used for design purposes has a 300 mph rotational velocity and a 60 mph translational velocity.

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 severe storms with high winds, if these requirements are implemented as described.

3.1.3.1 Protection of FLEX Equipment - High Winds Hazard

NEI 12-06, Section 7.3.1 states:

> These considerations apply to the protection of FLEX equipment from high wind hazards:
>
> 1. For plants exposed to high wind hazards, FLEX equipment should be stored in one of the following configurations:
>
>   a. In a structure that meets the plant's design basis for high wind hazards (e.g., existing safety-related structure).
>
>   b. In storage locations designed to or evaluated equivalent to ASCE 7-10, *Minimum Design Loads for Buildings and Other Structures* given the limiting tornado wind speeds from Regulatory Guide 1.76 or design basis hurricane wind speeds for the site.
>
>   - Given the FLEX basis limiting tornado or hurricane wind speeds, building loads would be computed in accordance with requirements of ASCE 7-10. Acceptance criteria would be based on building serviceability requirements not strict compliance with stress or capacity limits. This would allow for some minor plastic deformation, yet assure that the building would remain functional.
>
>   - Tornado missiles and hurricane missiles will be accounted for in that the FLEX equipment will be stored in diverse locations to provide reasonable assurance that N sets of FLEX equipment will remain deployable following the high wind event. This will consider locations adjacent to existing robust structures or in lower sections of buildings that minimizes the probability that missiles will damage all mitigation equipment required from a single event by protection from adjacent buildings and limiting pathways for missiles to damage equipment.
>
>   - The axis of separation should consider the predominant path of tornados in the geographical location. In general, tornadoes travel from the West or West Southwesterly direction, diverse locations should be aligned in the North-South arrangement, where possible. Additionally, in selecting diverse FLEX storage locations, consideration should be given to the location of the diesel generators and switchyard such that the path of a single tornado would not impact all locations.
>
>   - Stored mitigation equipment exposed to the wind should be adequately tied down. Loose equipment should be in protective boxes that are adequately tied down to foundations or slabs to prevent protected equipment from being damaged or becoming airborne. (During a tornado, high winds may blow away metal siding and metal

deck roof, subjecting the equipment to high wind forces.)

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

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

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

On page 17 of the Integrated Plan, the licensee stated that a study is in progress to determine the design features, site location(s), and number of equipment storage facilities. The final design for BDB equipment storage will be based on the guidance contained in NEI 12-06, Section 11.3, Equipment Storage. A future submittal will be provided with the results of the equipment storage study. The licensee's plans to follow the storage structure considerations of NEI 12-06, Section 11.3, will conform to the storage structure considerations of Section 7.3.1 for the high wind hazard. The licensee completed the BDB equipment storage study as documented in the completed Open Item #6 of its six-month status report. Staff review of the results of this study is included with Confirmatory Item 3.1.1.1.A in Section 4.2 below.

On page 29, and 57 of the Integrated Plan the licensee stated that the BDB pumps, necessary hoses and fittings are protected from severe storms with high winds while stored in the BDB Storage Building(s) or in protected areas of the plant.

On page 65 of the Integrated Plan the licensee stated that the BDB portable diesel generators, necessary cables and connectors will be protected from severe storms with high winds while stored in either the BDB Storage Building(s) or in wind/missile protected areas of the plant.

The Integrated Plan stated that the BDB pumps, necessary hoses and fittings, BDB portable diesel generators, and necessary cables and connectors are protected from severe storms with high winds while stored in the BDB Storage Building(s) or in protected areas of the plant.

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

3.1.3.2 Deployment of FLEX Equipment - High Winds Hazard

NEI 12-06, Section 7.3.2 states:

> There are a number of considerations which apply to the deployment of FLEX equipment for high wind hazards:
>
> 1. For hurricane plants, the plant may not be at power prior to the simultaneous ELAP and LUHS condition. In fact, the plant may have been shut down and

> the plant configuration could be established to optimize FLEX deployment. For example, the portable pumps could be connected, tested, and readied for use prior to the arrival of the hurricane. Further, protective actions can be taken to reduce the potential for wind impacts. These factors can be credited in considering how the baseline capability is deployed.
>
> 2. The ultimate heat sink may be one of the first functions affected by a hurricane due to debris and storm surge considerations. Consequently, the evaluation should address the effects of ELAP/LUHS, along with any other equipment that would be damaged by the postulated storm.
>
> 3. Deployment of FLEX following a hurricane or tornado may involve the need to remove debris. Consequently, the capability to remove debris caused by these extreme wind storms should be included.
>
> 4. A means to move FLEX equipment should be provided that is also reasonably protected from the event.
>
> 5. The ability to move equipment and restock supplies may be hampered during a hurricane and should be considered in plans for deployment of FLEX equipment.

On page 100 of the Integrated Plan, the licensee stated that preferred travel pathways will be determined using the guidance contained in NEI 12-06. The pathways will attempt to avoid areas with trees, power lines, and other potential obstructions. Debris removal equipment will be kept in the BDB Storage Building(s) so that it is protected from the severe storm. The stored BDB equipment includes tow vehicles (small tractors) equipped with front-end buckets and rear tow connections in order to move or remove debris from the needed travel paths. A front-end loader will also be available to deal with more significant debris 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 provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to deployment of FLEX equipment in a high wind hazard, if these requirements are implemented as described.

3.1.3.3 Procedural Interfaces - High Winds Hazard

NEI 12-06, Section 7.3.3, states:

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

On page 17 of the Integrated Plan, the licensee stated that FSGs will be developed in accordance with PWROG guidelines. Interface with ECA-0.0, will be revised to the extent necessary to include appropriate reference to FSGs. Interface with Abnormal Procedures O-AP-41, Severe Weather Conditions, will be revised to the extent necessary to include appropriate reference to FSGs.

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

3.1.3.4 Considerations in Using Offsite Resources – High Winds Hazard

NEI 12-06, Section 7.3.4 states:

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

On page 21 of the Integrated Plan, the licensee stated that the industry will establish two RRCs to support utilities during BDB events. Dominion has established contracts with the Pooled Equipment Inventory Company (PEICo) to participate in the process for support of the RRCs as required. Each RRC will hold five sets of equipment, four of which will be able to be fully deployed when requested, the fifth set will have equipment in a maintenance cycle. In addition, on-site BDB equipment hose and cable end fittings are standardized with the equipment supplied from the RRC. 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. Confirmation of the RRC local staging area, evaluation of access routes, and method of transportation to the site is combined with Confirmatory Item 3.1.1.4.A in Section 4.2 below.

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

3.1.4 Snow, Ice and Extreme Cold

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

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

On page 1 of the Integrated Plan, the licensee stated that a site-specific assessment for North Anna provides for the development of strategies, equipment lists, storage requirements, and deployment procedures for the conditions and consequences of snow and ice storms, and cold.

On page 4 of the Integrated Plan, the licensee stated that snowfalls of 4 inches or more occur, on average, once a year, and snow usually only remains on the ground from 1 to 4 days at a time. Richmond averages about 14.6 inches of snow a year. The North Anna UFSAR stated that an examination of the period between 1977 and 1987 indicates that there were only six documented cases of ice storms in Louisa County and the immediately surrounding counties. Of these, two were reported to have caused serious damage (including damage to power lines and trees).

The licensee further stated that temperatures in the site region rarely fall below 10 degrees F. The lowest temperature recorded in Richmond was minus 12 degrees F in January 1940 and the lowest recorded in Charlottesville was minus 9 degrees F in January 1985. Such low temperatures could adversely affect access to and the flow path from Lake Anna or the Service Water Reservoir. Ice could form on the surface of Lake Anna or the Service Water Reservoir and impact the FLEX strategy. However, the licensee stated that capabilities are available to break through the ice, if needed, to provide access and a flow path.

During the audit, the licensee was asked to provide a discussion on the applicability of the data used to determine the applicable snow, ice, and extreme cold hazards, in relation to the protection and deployment of FLEX equipment, given the time period of the data. In response, the licensee stated that the high and low temperature data stated in the OIP have been confirmed to be accurate based on published data for the southeast region of the Unite States through 2012.

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

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

NEI 12-06, Section 8.3.1 states:

> These considerations apply to the protection of FLEX equipment from snow, ice, and extreme cold hazards:
>
> 1. For sites subject to significant snowfall and ice storms, portable FLEX equipment should be stored in one of the two configurations.
>
>   a. In a structure that meets the plant’s design basis for the snow, ice and cold conditions (e.g., existing safety-related structure).
>
>   b. In a structure designed to or evaluated equivalent to ASCE 7-10, *Minimum Design Loads for Buildings and Other Structures* for the snow, ice, and cold conditions from the site’s design basis.
>
>   c. Provided the N sets of equipment are located as described in a. or b. above, the N+1 equipment may be stored in an evaluated storage

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

On page 17 of the Integrated Plan, the licensee stated that a study is in progress to determine the design features, site location(s), and number of equipment storage facilities. The final design for BDB equipment storage will be based on the guidance contained in NEI 12-06, Section 11.3, Equipment Storage. The storage structure considerations of NEI 12-06, Section 11.3 conform to the storage structure considerations of Section 8.3.1 for the snow, ice and extreme cold hazard. The licensee completed the BDB equipment storage study as documented in the completed Open Item #6 of its six-month status report. Staff review of the results of this study is included with Confirmatory Item 3.1.1.1.A in Section 4.2 below.

On pages 29 and 57 of the Integrated Plan, the licensee stated that the BDB pumps, necessary hoses and fittings, are protected from snow, ice, and extreme cold while stored in the BDB Storage Building or in protected areas of the plant to ensure equipment readiness at extreme temperatures when called upon.

On page 65 of the Integrated Plan, the licensee stated that the BDB portable diesel generators, necessary cables and connectors will be protected from snow, ice and extreme cold events while stored in either the BDB Storage Building(s) or in weather protected areas of the plant to ensure equipment readiness at extreme temperatures when called upon.

On page 92 of the Integrated Plan, the licensee stated that the FLEX strategies for maintenance and/or support of safety functions involve several elements. One element is to ensure that heating is adequate to maintain acceptable environmental conditions for equipment operation. The licensee stated that details of the ventilation strategy are under development and will conform to the guidance given in NEI 12-06.

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

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

NEI 12-06, Section 8.3.2 states:

> There are a number of considerations that apply to the deployment of FLEX equipment for snow, ice, and extreme cold hazards:
>
> 1. The FLEX equipment should be procured to function in the extreme conditions applicable to the site. Normal safety-related design limits for outside conditions may be used, but consideration should also be made for any manual operations required by plant personnel in such conditions.

2. For sites exposed to extreme snowfall and ice storms, provisions should be made for snow/ice removal, as needed to obtain and transport 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 pages 16 and 17 of the Integrated Plan, the licensee stated that design requirements and supporting analysis will be developed for portable equipment that directly performs a FLEX mitigation strategy for core cooling, RCS inventory, containment function, and SFP cooling. The design requirements and supporting analysis provide the inputs, assumptions, and documented analysis that the mitigation strategy and support equipment will perform as intended. Manufacturer's information is used in establishing the basis for the equipment use. The specified portable equipment capacities ensure that the strategy can be effective over a range of plant and environmental conditions. This design documentation will be auditable, consistent with generally accepted engineering principles and practices, and controlled within Dominion's document management system. The basis for designed flow requirements considers the following factors: Potential clogging of strainers, pumps, valves or hoses from debris or ice when using Lake Anna, the service water reservoir, or the discharge canal as a water supply; and environmental conditions (e.g., extreme high and low temperature range) in which the equipment would be expected to operate.

On page 101 of the Integrated Plan, the licensee stated that the BDB equipment for removing debris (tractors and front-end loader) will be protected from snow, ice and extreme cold events while stored in BDB Storage Building(s) to ensure equipment readiness at extreme temperatures when called upon.

On page 4 of the Integrated Plan, the licensee stated that, low temperatures could adversely affect access to and the flow path from Lake Anna or the service water reservoir. Ice could form on the surface of Lake Anna or the service water reservoir and impact the FLEX strategy. The licensee stated that capabilities are available to break through the ice, if needed, to provide access and a flow path.

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

3.1.4.3 Procedural Interfaces - Snow, Ice and Extreme Cold Hazard

NEI 12-06, Section 8.3.3 states:

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

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

On page 17 of the Integrated Plan, the licensee stated that FSGs will be developed in accordance with PWROG guidelines. Interface with ECA-0.0 will be revised to the extent necessary to include appropriate reference to FSGs. Interface with Abnormal Procedures O-AP-41, Severe Weather Conditions, will be revised to the extent necessary to include appropriate reference to FSGs.

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

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

NEI 12-06, Section 8.3.4, states:

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

On page 21 of the Integrated Plan, the licensee stated that the industry will establish two RRCs to support utilities during BDB events. Dominion has established contracts with the Pooled Equipment Inventory Company (PEICo) to participate in the process for support of the RRCs as required. Each RRC will hold five sets of equipment, four of which will be able to be fully deployed when requested, the fifth set will have equipment in a maintenance cycle. In addition, on-site BDB equipment hose and cable end fittings are standardized with the equipment supplied from the RRC. 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. Confirmation of the RRC local staging area, evaluation of access routes, and method of transportation to the site is combined with Confirmatory Item 3.1.1.4.A in Section 4.2 below.

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

3.1.5 High Temperatures

NEI 12-06, Section 9.2 states:

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

of the FLEX equipment.

On page 1 of the Integrated Plan, the licensee stated that that a site-specific assessment for North Anna provides for the development of strategies, equipment lists, storage requirements, and deployment procedures for the conditions and consequences of extreme heat.

On page 4 of the Integrated Plan, the licensee stated that temperatures in the site region rarely exceed 95 degrees F (UFSAR Section 2.3.1). The peak temperature recorded in Richmond was 105 degrees F in July 1977 and the peak temperature recorded in Charlottesville was 107 degrees F in September 1954 (UFSAR Table 2.3-2).

During the audit, the licensee was asked to provide a discussion on the applicability of the data used to determine the applicable high temperature hazard, in relation to the protection and deployment of FLEX equipment, given the time period of the data. In response, the licensee stated that the high temperature data stated in the Integrated Plan has been confirmed to be accurate based on published data for the southeast region of the Unite States through 2012. However the licensee did not state whether they intend to use 107 degrees F or the values recommended in NEI 12-06 Section 9.2 as the basis for protection and deployment strategies of FLEX equipment. This is identified as Confirmatory Item 3.1.5 in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to screening for 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 29 and 57 of the Integrated Plan, the licensee stated that the BDB pumps, necessary hoses and fittings, are protected from high temperature events while stored in the BDB Storage Building or in protected areas of the plant to ensure equipment readiness at extreme temperatures when called upon.

On page 65 of the Integrated Plan, the licensee stated that the BDB portable diesel generators, necessary cables and connectors will be protected from high temperature events while stored in either the BDB Storage Building(s) or in weather protected areas of the plant to ensure equipment readiness at extreme temperatures when called upon.

On page 92 of the Integrated Plan, the licensee stated that the FLEX strategies for maintenance and/or support of safety functions involve several elements. One element is to ensure that cooling is adequate to maintain acceptable environmental conditions for equipment operation. The licensee stated that the details of the ventilation strategy are under development and will conform to the guidance given in NEI 12-06.

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

3.1.5.2 Deployment of 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 pages 16 and 17 of the Integrated Plan, the licensee stated that design requirements and supporting analysis will be developed for portable equipment that directly performs a FLEX mitigation strategy for core cooling, RCS inventory, containment function, and SFP cooling. The design requirements and supporting analysis provide the inputs, assumptions, and documented analysis that the mitigation strategy and support equipment will perform as intended. Manufacturer's information is used in establishing the basis for the equipment use. The specified portable equipment capacities ensure that the strategy can be effective over a range of plant and environmental conditions. This design documentation will be auditable, consistent with generally accepted engineering principles and practices, and controlled within Dominion's document management system. The basis for designed flow requirements considers environmental conditions (e.g., extreme high and low temperature range) in which the equipment would be expected to operate.

In the Integrated Plan, the licensee did not address considerations for any manual actions required by plant personnel in high temperature conditions. This has been identified as Confirmatory Item 3.1.5.2.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 deployment of FLEX equipment in a high temperature hazard, if these requirements are implemented as described.

3.1.5.3 Procedural Interfaces – High Temperature Hazard

NEI 12-06, Section 9.3.3 states:

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

The licensee’s approach to addressing the effects of high temperatures on the FLEX equipment is discussed in 3.1.5.2 of this evaluation. Staff review of inclusion of any manual actions from above or other procedural enhancements will be included with Confirmatory Action 3.1.5.2.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 provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to the procedural interfaces – high temperature hazard, if these requirements are implemented as described.

3.2 PHASED APPROACH

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

To meet these EA-12-049 requirements, licensees will establish a baseline coping capability to prevent fuel damage in the reactor core or SFP and to maintain containment capabilities in the context of a BDBEE that results in the loss of all ac power, with the exception of buses supplied by safety-related batteries through inverters, and loss of normal access to the UHS.

As discussed in NEI 12-06, Section 1.3, plant specific analysis will determine the duration of each phase.

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

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

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

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

During the audit, the licensee was requested to specify which analysis performed in WCAP-17601 is being applied to North Anna. Additionally, the licensee was requested to justify the use of that analysis by identifying and evaluating the important parameters and assumptions demonstrating that they are representative of North Anna and appropriate for simulating the ELAP transient.

In response to the audit, the licensee stated that the analysis applicable to North Anna is presented in Section 5.2.1 of WCAP-17601. The applicability of this reference case to North Anna is evaluated in detail in ETE-NAF-2012-0150, Section 6.3. The staff's assessment of the licensee's computer codes and analysis is presented in the following section.

3.2.1.1 Computer Code Used for the ELAP Analysis

NEI 12-06, Section 1.3 states:

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

The licensee provided a Sequence of Events (SOE) in its integrated plan, which included the time constraints and the technical basis for the site. To support the mitigating strategy in its integrated plan, the licensee has elected to reference generic ELAP analysis performed with the NOTRUMP computer code. Although NOTRUMP has been reviewed and approved for performing small-break loss of coolant accident (LOCA) analysis for PWRs, the NRC staff had not previously examined its technical adequacy for simulating an ELAP event. In particular, the ELAP scenario is differentiated from typical design-basis small-break LOCA scenarios in several key respects, including the absence of normal emergency core cooling system (ECCS) injection and the substantially reduced leakage rate, which places significantly greater emphasis on the accurate prediction of primary-to-secondary heat transfer, natural circulation, and two-phase flow within the RCS. As a result of these differences, concern arose associated with the use of the NOTRUMP code for ELAP analysis for modeling of two-phase flow within the RCS and heat transfer across the steam generator tubes as single-phase natural circulation transitions to two-phase flow and the reflux condensation cooling mode.

During the audit, the licensee clarified that the SOE was based specifically on the generic NOTRUMP analysis in Section 5.2.1 of WCAP-17601-P that considers a four-loop Westinghouse plant with standard reactor coolant pump seals. The analysis assumes 21 gpm leakage per reactor coolant pump plus 1 gpm unidentified leakage. Two hours following event initiation, the plant is assumed to be cooled down symmetrically at a rate of approximately 70 °F per hour to a final steam generator pressure of 300 psia.

During the audit, the licensee was requested to clarify whether the 33-hour timeframe discussed in the submittal as the timeframe for providing RCS makeup is based on the first or the last RCS loop in the generic NOTRUMP analysis in Section 5.2.1 of WCAP-17601-P entering reflux cooling. If the 33-hour timeframe were based on the last loop entering reflux cooling, the licensee was further requested to identify the times at which the other RCS loops entered reflux cooling and justify that they would not have accumulated unacceptable quantities of condensed, deborated water in the loop seals.

In response to this audit question, the licensee stated that the onset of reflux cooling occurs at approximately the same time in all loops in the NOTRUMP calculation. The licensee stated that the PWROG is developing a revision to the criterion for determining the entry into reflux cooling. The revised criterion will be documented in WCAP-17792, which is scheduled to be issued by the end of 2013. The licensee stated that, if the timeframe for entering reflux cooling documented in WCAP-17792 is changed from 33 hours, an update will be provided in the February 2014 six-month update submittal.

Section 5.3.1 of WCAP-17601-P discusses the extension of the generic four-loop analysis in Section 5.2.1 to Westinghouse plants of other designs, including the three-loop NSSS design applicable to the reactors at North Anna. Section 5.3.1 of WCAP-17601-P concludes that the results are applicable or bounding relative to the entire Westinghouse fleet. However, the staff noted that this conclusion is based upon using the timing of core uncovery as a figure of merit; whereas, due to issues discussed above regarding the modeling of reflux condensation cooling, the staff's current position is that primary makeup should be provided prior to entering the reflux condensation cooling mode. The licensee's integrated plan submittal had used a time constraint of 33 hours for providing makeup to the RCS. This time was based on the time of entry into reflux cooling as defined by the authors of WCAP-17601-P for the analysis in Section 5.2.1. The definitions and rationale underlying the selection of 33 hours as the time of entry into the reflux condensation cooling mode have not been adequately justified to the staff. In an attempt to provide margin to the 33-hour time constraint derived from WCAP-17601-P, the licensee's six-month update stated that reactor coolant system makeup will actually be provided by 16 hours instead of by 33 hours. However, at the current time, adequate basis has not been presented to justify that 16 hours is an appropriate time constraint for preventing entry into the reflux cooling mode. Because the PWROG (and hence the licensee) has not finalized the criterion for determining the entry into reflux condensation cooling, a final determination cannot be made at this time as to (1) whether the generic analysis in Section 5.2.1 of WCAP-17601-P is bounding relative to North Anna with respect to the time of predicted entry into reflux cooling and (2) whether providing makeup by 16 hours is sufficient to avoid entry into the reflux condensation cooling mode.

Although North Anna's integrated plan is based on an analysis that considers leakage from standard RCP seals, the licensee stated that Flowserve N-9000 low-leakage RCP seals with the Abeyance feature will eventually be installed at North Anna on all RCPs. However, only two of three RCPs at each unit will have the seals installed by the FLEX implementation date. The licensee stated that with essentially zero leakage from the two Flowserve N-9000 seals with the Abeyance feature, the duration of natural circulation within the RCS would be significantly extended, allowing additional time for deployment of the BDB RCS injection pump. The staff expects the installation of the Flowserve N-9000 seals with the Abeyance feature will provide North Anna significant margin relative to the analysis in Section 5.2.1 of WCAP-17601-P; however, the low-leakage performance of these seals with the Abeyance feature under extended station blackout conditions has not yet been adequately demonstrated to the NRC staff.

Therefore, in light of the above discussion regarding codes and analysis, the staff has designated the following Confirmatory Items:

> Reliance on the NOTRUMP code for the ELAP analysis of Westinghouse plants is limited to the flow conditions before reflux condensation initiates. This includes specifying an acceptable definition for reflux condensation cooling. This is identified as

> Confirmatory Item 3.2.1.1.A in Section 4.2 below.
>
> Confirmation that the generic analysis in Section 5.2.1 of WCAP-17601-P is applicable or bounding with respect to North Anna for an appropriate figure of merit for defining entry into the reflux condensation cooling mode. This is identified as Confirmatory Item 3.2.1.1.B in Section 4.2 below.

The analysis in WCAP-17601-P that the licensee has relied upon, as further elaborated in the PWROG's accompanying core cooling position paper, attempts to prevent intrusion of nitrogen gas from the cold leg accumulators into the reactor coolant system by terminating the RCS depressurization at a SG pressure that is sufficient to preclude gas injection. During the audit the licensee was requested to discuss the analytical methodology and key assumptions for assessing the potential for nitrogen injection from accumulators during an ELAP event. The licensee was further requested to identify any instrumentation operators would rely upon to ensure that nitrogen injection will not occur.

In response to the audit question, the licensee stated that the North Anna ELAP response is consistent with the PWROG's core cooling position paper with respect to the methodology for preventing nitrogen injection from accumulators during an ELAP event.

The licensee stated that SG pressure is the indication monitored to ensure nitrogen injection does not occur during the ELAP. The licensee stated that current setpoints in ECA-0.0, which is the emergency contingency action procedure for a loss of all alternating current power, are sufficient to preclude nitrogen injection. Specifically, the licensee stated that the setpoint used in ECA-0.0 for minimum SG pressure was revised in March 2008, to reflect a revision to the assumed expansion of the nitrogen gas in the accumulators from an adiabatic process to an isothermal process. The licensee indicated that, if the nitrogen temperature remains constant during the expansion, as with an uninsulated accumulator during a slow-moving event such as an ELAP, the process can be considered isothermal. On the other hand, rapid expansion of accumulator nitrogen during a large-break LOCA may be better approximated as adiabatic. The licensee stated that, in order to ensure that injection of nitrogen into the RCS does not adversely affect natural circulation heat removal for core cooling, it is appropriate to base the setpoint for minimum SG pressure on an isothermal gas expansion. The staff considers this choice to be the appropriate one for determining nitrogen injection into the RCS in light of the physical behavior expected during an ELAP event. The licensee stated that, to provide an allowance for operator response and overshoot, containment heatup, SG instrument uncertainty, and variation in primary-to-secondary differential pressure, a 100 psi margin was added to the calculated minimum SG pressure setpoint. The licensee added that a cooldown and depressurization beyond the current setpoints would require either (1) additional evaluations to demonstrate that nitrogen injection cannot occur for these conditions, (2) venting of the nitrogen cover gas from each cold leg accumulator, or (3) isolation of the cold leg accumulators from the RCS.

Based upon the staff's review of the example calculation in Attachment 1 to the PWROG's core cooling position paper, it appeared possible that the imposition of a 100-psi margin could result in the need for terminating the plant cooldown at a pressure that exceeds the pressure assumed in the baseline analysis referenced by North Anna in Section 5.2.1 of WCAP-17601-P. A discrepancy of this sort would be of concern, since its reconciliation implies either a reduced margin to nitrogen injection from the accumulators or an increased final system pressure with increased leakage from the reactor coolant system relative to the analysis in Section 5.2.1 of WCAP-17601-P. However, the parameters in the example calculation in Attachment 1 to the core cooling position paper were not fully representative of North Anna. Considering parameters expected to be more applicable to North Anna, an approximate hand calculation performed by the staff suggests that the inclusion of a 100-psi margin into the calculation for preventing nitrogen injection for North Anna may be consistent with the depressurization terminus assumed in WCAP-17601-P. Ultimately, however, this determination is the licensee's responsibility, and sufficient basis was not provided in the licensee's response to confirm the consistency of the margin imposed to prevent accumulator nitrogen injection with the cooldown terminus assumed in WCAP-17601-P. This is identified as Confirmatory Item 3.2.1.1.C in Section 4.2 below.

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

3.2.1.2 Reactor Coolant Pump Seal Leakage Rates

NEI 12-06, Section 1.3 states:

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

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

The licensee provided an SOE in its Integrated Plan, which included the time constraints and the technical basis for its site. The SOE is based on an analysis in Section 5.2.1 of WCAP-17601-P that assumes a RCP seal leakage rate of 21 gpm per pump. WCAP-17601-P considers this seal leakage rate applicable to Westinghouse plants with a standard Westinghouse RCP seal design. However, as noted above, the licensee indicated that all seals on the Westinghouse Model 93A RCPs at North Anna will eventually be modified to use Flowserve N-9000 seals with the Abeyance feature. The modified seal design is expected to result in significantly reduced leakage relative to the standard seal design for events involving an extended loss of seal cooling. However, adequate justification has not yet been presented to the NRC staff to justify the low-leakage performance of the Flowserve N-9000 seals with the Abeyance feature.

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

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

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

After reviewing these submittals, the NRC staff placed certain limitations on Westinghouse designed plants. Those limitations and their applicability are discussed below in light of design-specific information pertaining to the reactors at North Anna:

1. For the plants using Westinghouse RCPs and seals that are not the SHIELD shutdown seals, the RCP seal initial maximum leakage rate should be greater than or equal to the upper bound expectation for the seal leakage rate for the ELAP event (21 gpm/seal) discussed in the PWROG white paper addressing the RCP seal leakage for Westinghouse plants. If the RCP seal leakage rates used in the plant-specific ELAP analyses are less than the upper bound expectation for the seal leakage rate discussed in the whitepaper, justification should be provided. If the seals are changed to non-Westinghouse seals, the acceptability of the use of non-Westinghouse seals should be addressed, and the RCP seal leakage rates for use in the ELAP analysis should be provided with acceptable justification. The licensee has assumed a seal leakage rate of 21 gpm per reactor coolant pump seal for North Anna. Furthermore, an open item is identified below relative to the need to provide a basis for the leakage rate associated with the Flowserve N-9000 seals with the Abeyance feature. Therefore, the staff considers this item associated with leakage rates less than 21 gpm to be addressed for North Anna.

2. In some plant designs, such as those with 1200 to 1300 psia SG design pressures and no accumulator backing of the main steam system power-operated relief valve (PORV) actuators, the cold legs could experience temperatures as high as 580 ^{0}F before cooldown commences. This is beyond the qualification temperature (550 ^{0}F) of the O-rings used in the RCP seals. For those Westinghouse designs, a discussion of the information (including the applicable analysis and relevant seal leakage testing data) should be provided to justify that (1) the integrity of the associated O-rings will be maintained at the temperature conditions experienced during the ELAP event, and (2) the seal leakage rate of 21 gpm/seal used in the ELAP is adequate and acceptable. Based upon information provided by the licensee during the audit, the SG power-operated relief valves’ nominal opening setpoint is 1035 psig. This implies a steam generator temperature of approximately 550 °F, and hence a slightly higher cold leg temperature during single-phase natural circulation, but one which is also roughly 550 °F. Furthermore, as addressed via an open item below, specific qualification testing for the Flowserve N-9000 seals with the Abeyance feature will be reviewed by the staff to ensure that the performance of these seals has been qualified for the conditions applicable to North Anna. As such, the staff considers this item associated with O-ring

qualification for plants with elevated SG design pressures to be addressed for North Anna.

3. Some Westinghouse plants have installed or will install the SHIELD shutdown seals, or other types of low leakage seals, and have credited or will credit a low seal leakage rate (e.g., 1 gpm/seal) in the ELAP analyses for the RCS response. For those plants, information should be provided to address the impacts of the Westinghouse 10 CFR Part 21 report, "Notification of the Potential Existence of Defects Pursuant to 10 CFR Part 21," dated July 26, 2013 (ADAMS No. ML13211A168) on the use of the low seal leakage rate in the ELAP analysis. The licensee's Integrated Plan does not currently credit low leakage seals in the ELAP analyses. Therefore this item is currently not applicable for North Anna.

4. If the seals are changed to the newly designed Generation 3 SHIELD seals, or non-Westinghouse seals, the acceptability of the use of the newly designed Generation 3 SHIELD seals, or non-Westinghouse seals should be addressed, and the RCP seal leakages rates for use in the ELAP analysis should be provided with acceptable justification. The PWROG is working on these issues and will submit to the NRC position papers that will contain test data regarding the maximum seal leakage rates of Generation 3 SHIELD seals and Flowserve N-9000 seals. The NRC staff will review these position papers upon their receipt. Resolution of the generic concern associated with the acceptability of the Flowserve N-9000 seals with the Abeyance feature and the determination of an appropriate leak rate is identified as Open Item 3.2.1.2.B for North Anna in Section 4.2 below.

The NRC staff also requested during the audit that the licensee address issues concerning the response of the pump seal to a restoration of seal cooling and the potential for increased stress and degradation of the seal during a cooldown of the reactor coolant system. The licensee stated that event response procedures for an ELAP will be the same as currently used for the station blackout event; however, the staff's review identified that this response lacked the following information: (1) the basis for concluding that the station blackout analysis had acceptably addressed the issues of concern to the staff, (2) the significant difference in time duration between the station blackout and ELAP events, and (3) the proposed reactor coolant pump seal design modification. Therefore, the staff designated Confirmatory Item 3.2.1.2.C in Section 4.2, below, for the licensee to:

(1) Confirm that stresses resulting from a cooldown of the RCS will not result in the failure of seal materials.
(2) As applicable, confirm that reestablishing cooling to the seals will not result in increased leakage due to thermal shock.

The staff further noted that the licensee's depressurization terminus for North Anna is 290 psig in the steam generators, which is slightly in excess of the 300 psia value that was assumed in the analysis in Section 5.2.1 of WCAP-17601-P. The staff considered the effect of this slight pressure difference on the seal leakage rate to be insignificant relative to the expected conservatism of assuming a 21-gpm seal leakage rate in light of the planned installation of low-leakage seals.

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 and Open Items, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to RCP seal leakage rates, if these requirements are implemented as described.

3.2.1.3 Decay Heat

NEI Section 3.2.1.2 states in part:

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

Engineering Technical Evaluation, ETE-NAF-2012- 0150, Revision 0, “Evaluation of Core Cooling Coping for Extended Loss of AC Power (ELAP) and Proposed Input for Dominion’s Response to NRC Order EA-12-049 for Dominion Fleet,” documents the technical basis for the core cooling coping time for North Anna. The design inputs and assumptions for this document include the initial plant condition that the reactor has been operating at 100 percent rated thermal power for at least 100 days prior to the event or has just been shut down from such a power history as required by plant procedures in advance of the impending event.

The NRC staff further understands that the generic analysis in Section 5.2.1 of WCAP-17601-P that is being referenced by the licensee for North Anna computed decay heat based on the ANS 5.1-1979 decay heat model with a two-sigma adder. This model includes fission product decay heat resulting from the fission of U-235, U-238, and Pu-239, as well as actinide decay heat from U-239 and Np-239.

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 decay heat, if these requirements are implemented as described.

3.2.1.4 Initial Values for Key Plant Parameters and Assumptions

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

On pages 6 and 7 of the Integrated Plan, in regards to the boundary conditions and initial plant conditions and assumptions established to support development of FLEX strategies, the licensee included all of the relevant baseline assumptions contained in NEI 12-06.

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

3.2.1.5 Monitoring Instrumentation and Controls

NEI 12-06, Section 3.2.1.10 states in part:

> The parameters selected must be able to demonstrate the success of the strategies at maintaining the key safety functions as well as indicate imminent or actual core damage to facilitate a decision to manage the response to the event within the Emergency Operating Procedures and FLEX Support Guidelines or within the SAMGs. Typically, these parameters would include the following:
>
> - SG Level
> - SG Pressure
> - RCS Pressure
> - RCS Temperature
> - Containment Pressure
> - SFP Level
>
> The plant-specific evaluation may identify additional parameters that are needed in order to support key actions identified in the plant procedures/guidance or to indicate imminent or actual core damage.

On pages 24 and 25 of the Integrated Plan, the licensee listed the installed instrumentation credited for maintaining core cooling and heat removal during Phase 1 of an ELAP. Phase 2 and 3 strategies rely on the same key instrumentation. Available measured parameters include AFW flowrate, SG level, SG pressure, RCS hot and cold leg temperatures, core exit thermocouple temperature, and ECST level.

On pages 37 and 38 of the Integrated Plan, the licensee listed the installed instrumentation credited to maintain RCS inventory control during Phase 1 of an ELAP. Phase 2 and 3 strategies rely on the same key instrumentation. Available measured parameters and instruments include SG pressure, RCS hot leg and cold leg temperatures, pressurizer level, reactor vessel level indication, and excore nuclear instruments.

On pages 47 and 48 of the Integrated Plan, the licensee listed the containment pressure and containment wide range temperature as measured parameters that would be available through all phases of the ELAP.

On page 53 of the Integrated Plan, the licensee listed SFP level as a measured parameter that would be available through all phases of the ELAP event.

On page 61 of the Integrated Plan, the licensee stated that the Phase 1 strategy involves extending the available electrical power from the installed Class 1E 125 VDC batteries through reduction of DC bus loading soon after the occurrence of an ELAP/LUHS by stripping non-essential loads from the 125 VDC and the battery-backed 120 VAC vital buses. Essential instrumentation necessary for key parameter monitoring is powered by the 120 VAC vital bus circuits, which will be maintained energized by 125 VDC battery bus through the Class 1E inverters following an ELAP.

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

3.2.1.6 Sequence of Events

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

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

The SOE is discussed in the integrated plan on pages 8 through 13 and in Attachment 1A on pages 110 and 111.

On page 8 of the Integrated Plan, the licensee stated that the sequence of events timeline is provided in Attachment 1A and provided the following explanation:

> Preliminary estimates of response times have been developed based on plant simulator runs and table-top walkthroughs of planned actions. A 2-hour duration is assumed for deployment of equipment from the BDB Storage Building(s) based on a "sunny day" validation for implementation of CFR 50.54(hh)(2) time sensitive actions. The validation included deploying a portable high capacity pump from its storage location to a location near the Service Water Reservoir (staging location) and routing hoses to provide flow to the spent fuel pool. Time to clear debris to allow equipment deployment is assumed to be 2 hours, and will depend on the location of the BDB Storage Building(s). This time is considered to be reasonable based on site reviews and proposed locations of the BDB Storage Building(s). Debris removal equipment will be stored in the BDB Storage Building(s). Validation of assumed response times included in Attachment 1A will be completed once FSGs have been developed and will include a staffing analysis.

Validation of the response times is identified as Confirmatory Item 3.2.1.6.A in Section 4.2 below.

On pages 9 through 13 of the Integrated Plan, as modified by the six-month update dated August 23, 2013, and the supplement to the OIP dated April 30, 2013, the licensee detailed strategies that had a time constraint and provided the basis that the strategies could reasonably be met.

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 sequence of events, if these requirements are implemented as described.

3.2.1.7 Cold Shutdown and Refueling

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

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

The generic concern related to shutdown and refueling requirements is applicable to North Anna. This generic concern has been resolved through the NRC endorsement of NEI position paper entitled “Shutdown/Refueling Modes” (ADAMS Accession No. ML13273A514); and has been endorsed by the NRC in a letter dated September 30, 2013 (ADAMS Accession No. ML13267A382).

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

The licensee informed the NRC staff of its intent to abide by the 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 Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to cold shutdown and refueling, if these requirements are implemented as described.

3.2.1.8 Core Sub-Criticality

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

> All plants provide means to provide borated RCS makeup.

On page 36 of the Integrated Plan, the licensee stated

> In general, the FLEX strategy for RCS inventory control / reactivity management relies on RCP seal leakage being sufficiently low for initial control of RCS inventory, isolation of the RCS as directed by the emergency procedure, and cooldown limitations to limit reactivity addition. With these controls in place, no RCS makeup or boration is required for the first 33 hours of an ELAP / LUHS event. …
>
> Reactivity:
> The emergency procedure for the loss of all AC power, ECA-0.0, provides direction for the Operator to initiate an RCS cooldown using the SG PORVs to a steam generator pressure of approximately 290 psig which equates to an RCS core inlet temperature of approximately 419 degrees F. At this RCS temperature, analysis indicates that at the most limiting core condition, additional RCS boration is not needed to ensure adequate Shutdown Margin (SDM), e.g., reactivity <0.99, is maintained for the first 37 hours without boration. The most limiting core condition is the highest core burnup, which occurs at end of EOC.

In the 6-month update to the Integrated Plan, the licensee stated:

> Changes to the timing of the RCS injection strategy have been made. The strategy for RCS injection for inventory and reactivity control has been moved from a Phase 3 activity to a Phase 2 activity. The details and descriptions provided in Section C.3 of the Integrated Plan for RCS injection for the Phase 3 activity continue to be the same for the Phase 2 strategy for RCS injection,

> including the time at which natural circulation capability is lost, i.e., approximately 33 hours based on WCAP-17601 and ETE-NAF-2012-0150. For conservatism and margin to account for uncertainty within the calculations and unanticipated deployment issues, a time of 16 hours has been chosen, which provides significant margin (by a factor of 2) prior to loss of natural circulation and the start of reflux boiling.

As noted previously, the time constraint of 33 hours for providing makeup to the reactor coolant system was an industry-determined value from analysis performed in WCAP-17601-P. The definitions and rationale underlying the selection of 33 hours as the time of entry into the reflux condensation cooling mode, which is regarded as the triggering point for providing makeup to the reactor coolant system, have not been adequately justified to the staff. Likewise, as reflected above in Confirmatory Item 3.2.1.1.A, at the present time, the provision of makeup at 16 hours has not been demonstrated to be sufficient to avoid entry into the reflux condensation cooling mode. Furthermore, based upon the licensee's planned installation of low-leakage seals, the planned timing of makeup appears reasonable; however, the performance of the N-9000 seals with the Abeyance feature is currently Open Item 3.2.1.2.B.

Review of the Integrated Plan revealed that a generic concern associated with the modeling of the timing and uniformity of the mixing of a liquid boric acid solution injected into the RCS under natural circulation conditions potentially involving two-phase flow was applicable to the licensee. The PWROG submitted to the NRC a position paper, dated August 15, 2013 (withheld from public disclosure for proprietary reasons), which provides test data regarding boric acid mixing under single-phase natural circulation conditions and outlines applicability conditions intended to ensure that boric acid addition and mixing would occur under conditions similar to those for which boric acid mixing data is available. However at the time of the licensee's audit responses to support this review, the NRC staff had not endorsed the August 15, 2013 PWROG position paper.

In response to a question concerning the boric acid mixing model raised by the NRC staff during the audit, the licensee stated that:

> The uniform mixing model is used for the North Anna ELAP analysis. This analysis is consistent with the method in the PWROG white paper related to the boron mixing model. The North Anna analysis shows that no boron addition is required to offset the cooldown of the core to the inlet temperature corresponding to a secondary pressure of 290 psig. Boration is not required until approximately 37 hours into the transient to account for Xenon decay. The inventory control strategy will deploy the BDB RCS Injection pump for RCS make-up with borated water approximately 16 hours into the event. Mass addition via the BDB RCS Injection pump will forestall natural circulation flow breakdown and the transition to reflux cooling and restore levels into the pressurizer. Therefore, boron injected into the RCS will mix via turbulent natural circulation flow and would be expected to provide an essentially uniform boron concentration in the reactor coolant system well before any boron concentration increase is needed for reactivity control. Per Calculation CAL-MISC-11788, the total amount of RWST water that is required to offset the complete decay of Xenon (which occurs at a time greater than 100 hours) is 5,200 gallons. At 40 gpm, the time necessary to inject this amount of borated water (at the RWST concentration or 2600 ppm) is less than 2.25 hours.

The licensee's approach for modeling boric acid mixing, as described above, is based upon a method described in the PWROG position paper that the NRC staff had not yet endorsed at the time of the audit discussions with the licensee. Since this time, the NRC endorsed the PWROG position paper but with several clarifications (ADAMS Accession No. ML13276A183). Therefore, the staff considers the modeling of boric acid mixing to be Open Item 3.2.1.8.A for North Anna for the licensee to address the clarifications and alignment with the NRC endorsement letter dated January 8, 2014.

In response to a question concerning the reactivity analysis for North Anna that was raised by the NRC staff during the audit, the licensee stated that

> CAL-MISC-11788 is the North Anna reactivity analysis which verified the reactor remains sub-critical for the limiting conditions of the ELAP. As noted in the assumptions of the calculation, no accumulator injection was credited which represents the no leakage case. The information in this response will be provided in the February 2014 Six-Month Status Update.

As described above, the licensee has not completed reactivity calculations for North Anna for a case with no reactor coolant system leakage. Furthermore, as reflected by the fact that the staff did not endorse the PWROG position paper on boron mixing, the staff has not concluded that the no-leakage case is limiting with respect to ensuring adequate shutdown margin. Therefore, completion of calculations demonstrating adequate shutdown margin for North Anna in ELAP scenarios with and without seal leakage is identified as Confirmatory Item 3.2.1.8.B in Section 4.2.

Shutdown margin calculations typically rely on boration curves that are cycle specific. In such cases, cycle-specific verification of shutdown margin calculations is necessary because the negative reactivity insertion requirements are a function of the core design, which generally varies from operating cycle to operating cycle. Based upon a review of the licensee's relevant calculations, it appears that the shutdown margin calculations for North Anna are based on a specific core design, and that the licensee has recognized the need to validate whether adjustments are required for future cores. However, it is not clear that an adequate method of verification has been developed and whether, in fact, the licensee will confirm that shutdown margin calculations remain bounding for each future operating cycle. This is identified as Confirmatory Item 3.2.1.8.C in Section 4.2.

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

3.2.1.9 Use of Portable Pumps

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

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

> require cooldown and depressurization of the SGs in advance of using the portable pump connections. Guidance should address both the proactive transition from installed equipment to portable and reactive transitions in the event installed equipment degrades or fails. Preparations for reactive use of portable equipment should not distract site resources from establishing the primary coping strategy. In some cases, in order to meet the time-sensitive required actions of the site-specific strategies, the FLEX equipment may need to be stored in its deployed position.
>
> The fuel necessary to operate the FLEX equipment needs to be assessed in the plant specific analysis to ensure sufficient quantities are available as well as to address delivery capabilities.

NEI 12-06 Section 11.2 states in part:

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

On page 26 of the Integrated Plan, the licensee stated that the Phase 2 strategy for reactor core cooling and heat removal provides an indefinite supply of water for feeding SGs and a portable, diesel-driven backup AFW pump for use in the event that the fire protection system water make-up source and/or the TDAFW pump becomes unavailable.

In the six-month update to the Integrated Plan, the licensee stated that changes to the timing of the RCS injection strategy have been made. The strategy for RCS injection for inventory and reactivity control has been moved from a Phase 3 activity to a Phase 2 activity. North Anna will purchase and store two BDB RCS Injection Pumps for use in the Phase 2 RCS Inventory strategy. However, the licensee did not clarify how the two BDB RCS injection pumps conform to NEI 12-06, paragraph following Section 3.2.2, Guideline 15 which states in part: “In order to ensure 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., N+1 capability, where N is the number of units on-site.” This is identified as Confirmatory Item 3.2.1.9.A in Section 4.1 below.

During the audit, the licensee was requested to clarify whether a single FLEX pump will be used to provide cooling flow to multiple destinations (e.g., the reactor core, SGs, and the SFP). If so, the licensee was requested to confirm that the FLEX pump can supply adequate flow and clarify whether the pumped flow will be split and simultaneously supplied to all destinations or whether the flow will be alternated between them. If simultaneous flow will be used, the licensee was requested to clarify how the flow splits will be measured and controlled (i.e., whether control exists for the total flow on a common line or on lines to individual destinations) to ensure that adequate flow (i.e., sufficient but not excessive) reaches each destination.

In response, the licensee stated that:

> The BDB high capacity pump is capable of providing makeup to both the Unit 1 and Unit 2 AFW systems for SG injection, as well as makeup water to the dual unit SFP, to accomplish the associated FLEX strategies. The BDB high capacity

pump has the ability to draw water from the circulating water discharge canal, Lake Anna, or the Service Water reservoir. A single BDB high capacity makeup pump has a minimum capacity of 1200 gpm at 100 psi. Preliminary hydraulic analysis of the BDB high capacity pump and the associated hoses and installed piping systems confirm that the BDB high capacity pump capabilities exceed the FLEX strategy requirements for AFW supply and SPF makeup given below:

Unit 1 BDB AFW Requirement--------------300 gpm
Unit 2 BDB AFW Requirement--------------300 gpm
Spent Fuel Pool Makeup Requirement----500 gpm

The BDB high capacity pump discharge hydraulic hose network designed for splitting the flow to the three loads listed above is shown in Figure 2 of ETE-CPR-2012-0012, Appendix B. Flow may be controlled in both the common supply hose, i.e., the discharge hose from the BDB high capacity pump, and in each individual branch line into which the flow splits off. Flow is controlled in the pump discharge hose by controlling the speed of the BDB high capacity pump and/or opening the discharge recirculation line to send a portion of the discharge overboard. Flow splits in the branches are controlled and monitored by various means as follows:

Flow is controlled in the branch line to the SFP by throttling the branch line gated wye discharge valve and/or in-line shutoff valve. Flow to the SPF is monitored by observing SPF level and throttling the branch line flow to reach equilibrium with the SFP boiloff after returning the SFP level to normal level. Alternately, flow to the SFP may be periodically batched to maintain SFP in an acceptable level range, as the limiting SFP boil off rate is calculated to be only 101 gpm (Calculation MISC-11792).

Flow is controlled in the branch line to fill each unit’s ECST by throttling the branch line gated wye discharge valve, and/or the AFW distribution manifold discharge valve, and/or the two isolation (ball) valves in the mechanical connection to the ESCT. Flow to the ECST is monitored by observing ECST level indication and throttling the branch line flow to reach equilibrium with the flow demand of the TD AFW pump that is taking suction from the ECST and delivering AFW to the steam generators for core cooling and decay heat removal. Alternately, flow to the ECST may be periodically batched to maintain ECST level in a desired range, especially when the TD AFW pump flow demands are low due to decreasing decay heat removal requirements. TD AFW pump flow demand is monitored directly by AFW flow indication in the MCR and indirectly by steam generator level indication in the MCR.

Flow is controlled in the branch line to supply each unit’s BDB AFW pump by throttling the branch supply line gated wye discharge valve, and/or the branch supply line AFW distribution manifold discharge valve, and/or the AFW system boundary isolation (globe) valve in the mechanical connection to the AFW pump discharge header. BDB AFW pump flow is monitored directly by flow indication in the discharge header of the BDB AFW pump on the pump trailer, directly by AFW flow indication in the MCR, and indirectly by steam generator level indication in the MCR.

> Phase 2 and Phase 3 FLEX strategy for RCS inventory and core reactivity control is that the borated water from the RWST is injected into the RCS from the BDB RCS Injection pump. The BDB RCS injection pump is a positive displacement pump with a nominal capacity of 45 gpm. RCS injection flow is monitored by pump flow indication on the BDB RCS Injection pump trailer and controlled by varying the speed diesel engine/pump and/or recirculating a portion of the pump flow back to the suction via the recirculation line.
>
> The BDB RCS Injection pump hose network (see Figure 2 of ETE-CPR-2012-0012, Appendix B) is a different hose network than that for providing for SFP makeup and AFW supply described above. If the RWST is depleted or unavailable, the BDB RCS Injection pump may be supplied by an alternate borated water source or take suction from the portable boron mixing tank. The portable boron mixing tank is filled by a clean water source, or from the discharge of the BDB High Capacity pump, and bags of boric acid are manually added to and mixed in the tank. Filling the portable boron mixing tank is a manual batching operation that requires no flow indication. If the BDB High Capacity pump is used to fill the portable boron mixing tank, it has sufficient excess capacity from the margin above its SFP makeup and AFW supply requirements to supply water to the portable boron mixing tank for one or both units.
>
> Calculations documenting the AFW supply, SFP makeup, and RCS inventory hydraulic analysis, originally scheduled to be completed by September 2013 (OIP OI # 5), will be completed later this year and available on the Dominion ePortal at that time. The change in the calculation completion date does not impact the Order implementation date.

The licensee's response regarding flow splitting appears to be a reasonable plan; however, the staff noted that completion of the hydraulic analysis is outstanding. Completion of the hydraulic analysis is designated as Confirmatory Item 3.2.1.9.B in Section 4.2 below.

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

3.2.2 Spent Fuel Pool Cooling Strategies

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

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

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

On page 53 of the Integrated Plan, the licensee stated that evaluations estimate that with no operator action following a loss of SFP cooling at the maximum design heat load, the SFP will reach 212 degrees F in approximately 9 hours and boil off to a level 10 feet above the top of fuel in 43 hours from initiation of the event. Therefore, the Phase 1 coping strategy for spent fuel pool cooling is to monitor spent fuel pool level using instrumentation to be installed as required by NRC Order EA-12-051. No additional modifications are required other than installation of the BDB Spent Fuel Pool level monitoring instruments as required by NRC Order EA-12-051.

On page 55 of the Integrated Plan, the licensee stated that the primary FLEX strategy for SFP cooling is to continuously monitor SFP level. Within the first 24 hours of the BDB event, the BDB high capacity pump will be staged and connected to the external SFP makeup connection installed outside the Fuel Building to provide SFP makeup capabilities up to 500 gpm, which exceeds the boil-off rate of 101 gpm. The alternate FLEX strategy utilizes the diesel driven fire pump to pressurize the fire main, which provides makeup to the SFP via the 6" emergency makeup line. This makeup strategy does not require entry into the Fuel Building. An existing spray strategy provides a means to spray water to the SFP at a rate of 500 gpm. The strategy provides makeup flow through either fire hose run over the side of the SFP or spray monitors set up on the SFP deck fed by the fire main or the BDB High Capacity pump. When deployed, two spray monitors are connected via a wye that splits the pump supply into two (2) 3-inch hoses. The two 3-inch spray monitor hoses will be routed from the New Fuel storage area to the SFP. The two oscillating spray monitors will be set up 30 feet apart and 16 feet back from the SFP to spray water into the SFP to maintain water level. The suction sources for the BDB High Capacity pump are the SW Reservoir or Lake Anna.

On page 55 of the Integrated Plan, the licensee stated that following a BDB event, a vent pathway would be required in the event of SFP bulk boiling and can be established by opening the Fuel Building roll-up doors for inlet and outlet air flow. However the licensee does not provide a technical justification that confirms opening of the roll-up doors would provide an adequate ventilation path for the SFP area. This is 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 3-2 and Appendix D provide some examples of acceptable approaches for demonstrating the baseline capability of the containment strategies to effectively maintain containment functions during all phases of an ELAP. One of these acceptable approaches is by analysis.

The North Anna units are both dry, sub-atmospheric-type containments, and the licensee performed calculations to demonstrate that no actions would be required to remove heat and protect the containment functions in the first seven days following an ELAP event.

On page 47 of the Integrated Plan, the licensee stated that the Phase 1 coping strategy for containment involves verifying containment isolation per ECA-0.0, Loss of All AC Power, and continuing to monitoring containment pressure using installed instrumentation. Evaluations have concluded that containment temperature and pressure will remain below design limits and key parameter instruments subject to the containment environment will remain functional for at least 7 days. Calculation MISC-11793, "Evaluation of Long Term Containment Pressure and Temperature Profiles Following Loss of Extended AC Power (ELAP)" was referenced in the Integrated Plan to support the above conclusion. This calculation utilized Gothic version 7.2a to perform the calculation. Assumptions included in the calculation were standard Westinghouse RCP seal leakage of 21 gpm per pump, plus 1 gpm unidentified leakage, for a total leakage of 64 gpm.

On page 50 of the Integrated Plan, the licensee stated that further analysis is required to determine the strategy and time requirements, if any, for actions to reduce containment pressure and temperature beyond seven days. As such, the Phase 3 coping strategy to maintain containment integrity is under development. Methods to monitor and evaluate containment conditions and depressurize/cool containment, if necessary, will be provided in a future update. This is identified as Confirmatory Item 3.2.3.A in Section 4.2 below.

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

3.2.4 Support Functions

3.2.4.1 Equipment Cooling – Cooling Water

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

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

> or provide a technical justification for continued functionality without the support system.

In the Integrated Plan, the licensee did not discuss the need for additional strategies to provide cooling functions for equipment to assure that coping strategy functionality could be maintained. During the audit process, the licensee stated that permanently installed plant equipment to support FLEX strategies do not require cooling support systems to perform their required functions.

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

3.2.4.2 Ventilation – Equipment Cooling

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

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

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

On page 92 of the Integrated Plan, the licensee stated that the FLEX strategies for maintenance and/or support of safety functions involve several elements. One element is to ensure that ventilation, heating, and cooling is adequate to maintain acceptable environmental conditions for equipment operation and personnel habitability. In the six-month update (Item #13) and during the audit process, the licensee stated that the finalized details of the ventilation strategy are still under development and will conform to the guidance given in NEI 12-06. The details of this strategy will be provided at a later date. This is identified as Confirmatory Item 3.2.4.2.A in Section 4.2 below.

During the audit, the licensee was requested to provide information on the adequacy of the ventilation provided in the battery room to protect the batteries from the effects of extreme high and low temperatures.

In response, the licensee stated:

> In the case of an ELAP event, the Class 1E battery buses will be load stripped within 1.5 hours after initiation of the event in order to provide for an extended Phase 1 battery life of 8 hours. During battery discharge in Phase 1 of the ELAP scenario, heat addition internal to the battery rooms is negligible. The four battery rooms (per unit) are rooms with concrete walls partitioned out of the Control Room (CR) envelope. Two battery rooms are in the Emergency Switchgear Room (ESGR) and two are in the Cable Spreading Room above the CR. The ventilation for the battery rooms in the ESGR flows from the ESGR into the room, and then outside through the normal exhaust fan. For the Battery rooms above the CR, air is drawn from the CR and exhausted back to the CR. While the battery rooms are not modeled in the loss of ventilation transient analysis model, Calculation ME-0972, Rev. 0 shows that the expected loss of ventilation transient temperatures in the ESGR and in the CR are expected to remain below 120 F during Phase 1 of an ELAP event (approximately 8 hours). Therefore, the temperatures in the battery rooms above and below the CR are expected to be approximately the same as the temperatures of the ESGR and the CR, respectively, during Phase 1.
>
> The FSG procedures for Phase 2 require the battery room exhaust flow path and exhaust fans to be aligned and flow confirmed prior to starting the battery chargers, which are powered by the 480 VAC portable diesel generators. The exhaust fans and exhaust flow paths are the same components used in normal plant operation and design basis events. As previously stated, the two battery rooms located above the CR take suction from the CR and the two battery rooms located below the CR take suction from the ESGR. Calculation ME-0972, Rev. 0 shows that the expected loss of ventilation transient temperatures in the sources of suction for the battery room ventilation systems (i.e., the ESGR and CR) are expected to remain below 120 F indefinitely.

> Although the Phase 2 conditions in the battery rooms are acceptable indefinitely, the current strategy for Phase 3 is to repower a CR chiller for each unit and thus re-establish normal HVAC cooling capacity for the CR envelope. The completed ventilation strategy (OIP Open Item #13) will be provided in the February 2014 Six-Month Status Update.
>
> The impact of extreme low temperatures is not expected to be significant due to the continuous connection with the CR and ESGR spaces and the heat storage capacity of the battery room concrete walls/floors/ceilings. However, if decreasing battery room temperatures become a concern, the FSG procedures provide for the use of portable heating equipment.

Since battery rooms are not modeled in the loss of ventilation transient analysis model, it appears that there is no analysis or calculation to demonstrate the adequacy of the battery room ventilation. This is identified as Confirmatory Item 3.2.4.2.B in Section 4.2.

During audit, the licensee was requested to provide a detailed summary of the analysis and/or technical evaluation performed to demonstrate the adequacy of the ventilation provided in the TDAFW pump room to support equipment operation throughout all phases of an ELAP.

In response, the licensee stated:

> Calculation 01040.4410-USB-268, Rev 0, “SBO Loss of Ventilation Temperature Transients,” was reviewed and indicates that after 8 hours the TDAFW pump room temperature remains below approximately 129 F. The SBO calculations are conservative, since they do not credit all the heat sink areas, or opening doors and dampers. The calculations also do not credit diurnal swings in outside air temperatures. All of these factors would tend to reduce the temperature inside the TDAFW pump room. Since the TDAFW pump is expected to operate during Phase 1, Phase 2 and Phase 3 of an ELAP event and the potential exists for temperatures to slowly rise beyond the value evaluated at 8 hours, FSG procedures will direct the opening of the exterior access door and/or blocking open the wall dampers to maintain the room at or below the maximum calculated transient temperature (129 F) determined by the SBO Loss of Ventilation calculation 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 Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to ventilation equipment cooling, if these requirements are implemented as described.

3.2.4.3 Heat Tracing

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

> *Plant procedures/guidance should consider loss of heat tracing effects for equipment required to cope with an ELAP. Alternate steps, if needed, should be identified to supplement planned action.*

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

In the Integrated Plan, the licensee did not address the loss of heat tracing. The licensee screened in for extreme cold, ice and snow and therefore the licensee should address loss of heat tracing effects on FLEX strategies.

During the audit, the licensee was requested to provide a discussion on the effects of the loss of heat tracing in regards to the effects for equipment required to cope with an ELAP, including alternate steps, if needed, to supplement planned actions.

In response to the audit, the licensee stated that heat trace is used to provide two protection functions:

1. Heat trace is used to maintain highly concentrated soluble boron solutions above the temperature where the soluble boron will precipitate out of solution.

2. Heat trace is also used to protect piping systems and components from freezing in extreme cold weather conditions.

The licensee stated that the FLEX strategies developed do not depend on highly concentrated soluble boron solutions and the FLEX strategies developed will use borated water sources with boron concentrations below 4000 PPM. The licensee stated that at these levels boron precipitation is not expected to occur. The licensee further stated that in addition, FLEX strategies for the mixing of borated water in portable FLEX tanks includes equipment such as an agitator and a tank heater to facilitate complete dissolution of the boric acid crystals. The licensee stated that the FLEX strategies will provide guidance for mixing to maintain concentrations below the solubility limit corresponding to freezing temperatures, which will ensure that boron precipitation at low ambient temperatures is not challenged.

The licensee stated that FLEX strategies have been developed to protect piping systems and components from freezing. The licensee stated that commercially available heat tape and insulation rolls have been identified and will be procured and maintained in the FLEX Storage Building for use on piping systems and components that will be used during an ELAP event where freezing is a concern in extreme cold weather conditions. The licensee stated that major components being procured for FLEX strategies will be provided with cold weather packages and small electrical generators to power the heat tape circuits as well as protect the equipment from damage due to extreme cold weather and help assure equipment reliability. In addition, the licensee stated that the CST level instrument tubing credited for BDB and subject to freezing conditions in an ELAP, will be protected with the use of heat lamps which can be powered from small generators that have been procured for FLEX strategies or from the small generators that will be included as part of the large BDB pump skids being purchased.

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

3.2.4.4 Accessibility – Lighting and Communications

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

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

On page 78 of the Integrated Plan, the licensee stated that the FLEX strategies for Phase 1 for maintenance and/or support of safety functions involve several elements. One necessary element is maintaining sufficient lighting in areas needed to successfully implement the planned FLEX strategies. North Anna Power Station initially relies on emergency lighting installed for Fire Protection/Appendix R to perform Phase 1 coping strategy activities. However, Appendix R lighting is powered by battery packs at each light and is rated for only 8 hours. This lighting also does not provide a100% coverage of areas involving FLEX strategy activities including ingress and egress from task areas. In these areas and areas poorly lit, portable lighting and headlamps are available for use. Portable lighting is currently staged throughout the site, mainly for use by the Fire Brigade or Appendix R fire response.

On page 80 of the Integrated Plan, the licensee stated that the FLEX strategies for Phase 2 involves three methods of providing light in areas needed to successfully implement FLEX strategies. The first method is the continued use of the Appendix R lighting discussed above. However, as previously stated this lighting is limited to approximately 8 hours. The second method is the use of supplemental lights that will be available as stored BDB equipment. This includes additional small portable sources (e.g., flashlights and head lamps) for personal uses, as well as larger portable equipment (e.g., self-powered light plants). The larger lighting equipment would be typically deployed in outside areas to support deployment of BDB pumps and generators. In some cases, BDB equipment will be equipped with their independent lighting sources. The third method is the restoration of power to various lighting panels in the electrical distribution system. A lighting study will be performed to validate the adequacy of supplemental lighting and the adequacy and practicality of using portable lighting to perform FLEX strategy actions. This is being tracked by licensee Open Item 17. This is identified as Confirmatory Item 3.2.4.4.A in Section 4.2 below.

During audit, the licensee was requested to clarify the means of communication between the control room and local equipment operators for the SG makeup pumps (i.e., TDAFW or FLEX pumps) and ADVs to affect a symmetric cooldown of the RCS. The licensee was further requested to clarify whether environmental factors such as elevated temperatures or ambient noise of exiting steam have been considered in the evaluation to determine that the necessary coordination is feasible.

In response, the licensee stated:

> There are multiple communication strategies available to the operating staff. During the first couple of hours of an ELAP event the station's Public Address (PA) system (powered from the station vital 120 VAC Bus) is expected to remain available. Following load stripping actions the PA system would become unavailable and the staff would then rely on BDB hand-held analog radios or on the site sound-powered phone circuits. Neither of these options relies on electrical power, however the hand-held radios are powered by rechargeable batteries. Spare batteries will be available and the FLEX strategy includes provisions to provide portable generators to power the various battery chargers. Should the analog radios experience difficulty with reception signal strength the staff would rely on the sound- powered phones circuits that are permanently installed throughout the plant.
>
> In high noise areas, the sound-powered phone circuits will provide the preferred communication strategies since the head sets on these phones provide significant noise dampening attributes. Multiple phone circuits are available in the BDB response areas and the ability to cross-tie the phone circuits provides additional flexibility. BDB dedicated sound-powered headsets are being purchased as part of the FLEX strategies.
>
> Temperatures in the Main Steam Valve House (MSVH) where the atmospheric dump valves (SG PORVs) would be locally manually operated have been evaluated and determined to remain in the normal operating range. Normal plant practices for accessing this area during full power operation would be employed in the event of an ELAP.
>
> Therefore, local temperatures and high noise have been considered and communications with operators is expected to be effective and coordination of activities feasible.

The NRC staff has reviewed the licensee communications assessment (ML12307A028 and ML13064A012) in response to the March 12, 2012 50.54(f) request for information letter for North Anna and, as documented in the staff analysis (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 is identified as Confirmatory Item 3.2.4.4.B in Section 4.2 below.

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

3.2.4.5 Protected and Internal Locked Area Access

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

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

On page 98 of the Integrated Plan, the licensee stated:

> The FLEX strategies for maintenance and/or support of safety functions involve several elements. One element is the ability to access site areas required for successful implementation of the planned FLEX strategy.
>
> The potential impairments to required access are doors and gates. The coping strategy to maintain site accessibility through doors and gates is applicable to all phases of the FLEX coping strategies, but is immediately required as part of Phase 1. Doors and gates serve a variety of barrier functions on the site. One primary function is security and is discussed below. However, other barrier functions include fire, flood, radiation, ventilation, tornado, and high energy line break (HELB). As barriers, these doors and gates are typically administratively controlled to maintain their function as barriers during normal operations. Following an ELAP event, FLEX coping strategies require the routing of hoses and cables to be run through various barriers in order to connect BDB equipment to station fluid and electric systems. For this reason, certain barriers (gates and doors) will be opened and remain open under administrative control.
>
> The security doors and gates of concern are those barriers that rely on electric power to operate opening and/or locking mechanisms. The ability to open doors for ingress and egress, ventilation, or temporary cables/hoses routing is necessary to implement the FLEX coping strategies. The Security force will initiate an access contingency upon loss of the Security Diesel and all AC/DC power as part of the Security Plan. Access to the Owner Controlled Area, site Protected Area, and areas within the plant structures will be controlled under this access contingency.
>
> Vehicle access to the Protected Area is via the double gated sally-port at the Security Building. As part of the Security access contingency, the sally-port gates will be manually controlled to allow delivery of BDB equipment (e.g., generators, pumps) and other vehicles such as debris removal equipment into the Protected 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 protected and internal locked area access, if these requirements are implemented as described.

3.2.4.6 Personnel Habitability – Elevated Temperature

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

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

Section 9.2 of NEI 12-06 states,

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

On page 91 of the Integrated Plan, the licensee stated that the FLEX strategies for maintenance and/or support of safety functions involve several elements. One element is to ensure that ventilation, heating, and cooling is adequate to maintain acceptable environmental conditions for equipment operation and personnel habitability. In the six-month update (Item #13) and during the audit process, the licensee stated that the finalized details of the ventilation strategy are still under development and will conform to the guidance given in NEI 12-06. The details of this strategy will be provided at a later date. This is included as part of Confirmatory Item 3.2.4.2.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 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/UHS 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 23 of the Integrated Plan, the licensee stated that initially, AFW water supply will be provided by the installed emergency condensate storage tank (ECST). The tank has a minimum usable capacity of 96,649 gallons and will provide a suction source to the TDAFW pump for a minimum of 3.8 hours of RCS decay heat removal assuming a concurrent RCS cooldown at 100°F/hr to a minimum SG pressure of 290 psig. After depletion of the inventory in the ECST, the TDAFW pump suction will be aligned to the fire protection (FP) system. The FP system will be pressurized by the diesel driven fire pump (DDFP), which provides water from the Service Water Reservoir at sufficient flowrate and pressure to support TDAFW pump operation. The Service Water Reservoir provides an approximately 22.5 million gallon useable water volume to the FP system since the service water system would not be functional due to the ELAP/LUHS.. Potential debris at the suction screening of the DDFP would not prevent an adequate flow to the DDFP. The trash screens on the SW reservoir intake bay are designed to pass the full design flow of a SW pump and the FP pump. The SW pumps will not be operating due to the ELAP/LUHS. Since the 600 gpm required by the DDFP to provide a suction source for the TDAFW pump is a small fraction of the design flow rate of the trash screen, the calculated unblocked trash screen area required for passing the required flow rate is justifiable.

On page 26 of the Integrated Plan, the licensee stated that a back-up indefinite supply of water, as make-up to the ECST or directly to the suction of the portable diesel driven BDB AFW pump, can be provided from Lake Anna or the Service Water Reservoir. Lake Anna and the Service Water Reservoir will remain available for any of the external hazards applicable to North Anna. The portable, diesel driven BDB High Capacity pump will be transported from the BDB Storage Building(s) to a location near the selected water source. A flexible hose will be routed from the pump suction to the water source where water will be drawn through a strainer sized to limit solid debris size to prevent damage to the TDAFW or the BDB AFW pump. A flexible hose will be routed from the BDB High Capacity Pump discharge to the BDB ECST refill connection or to the suction of the portable BDB AFW pump.

In the 6-month update to the Integrated Plan, dated April 30, 2013, the licensee stated that changes to the timing of the RCS injection strategy have been made. The strategy for RCS injection for inventory and reactivity control has been moved from a Phase 3 activity to a Phase 2 activity. North Anna will purchase and store BDB RCS Injection Pumps for use in the Phase 2 RCS Inventory strategy. The RCS injection strategy supplies make-up water to the RCS from either units RWST or from a portable borax acid mixing tank, which would be filled using the BDB B AFW pump or the BDB high capacity pump taking suction from Lake Anna.

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

3.2.4.8 Electrical Power Sources/Isolations and Interactions.

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

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

On page 63 of the Integrated Plan, the licensee stated that prior to depletion of the Class IE 125 V DC batteries, vital 120 VAC circuits will be re-powered to continue to provide key parameter monitoring instrumentation using portable diesel generators (DGs) stored on-site. In addition, selected plant lighting will be re-energized.

During the audit, the licensee was requested to provide single-line diagrams showing the proposed connections of Phase 2 and 3 electrical equipment on the e-Portal, to include protection information (breaker, relay, etc.) and rating of the equipment on the Single Line Diagrams. In response, the licensee stated that Figure 7 in the Integrated Plan provides a Single Line Diagram for North Anna showing the proposed connections for the Phase 2 and 3 diesel generators. (A revised Figure 7 was provided in the August 2013 six-month status update.) Additional details regarding protection information for the North Anna emergency buses is available in the North Anna Drawings for Unit 1 & Unit 2 (11715/12050 –FE-1BA), "Protective Device Coordination Electrical One Line Diagram."

During the audit, the licensee was requested to provide a summary of the sizing calculation for the FLEX generators to show that they can supply the loads assumed in phases 2 and 3.

In response, the licensee stated that for Unit 1, Calculation EE-0863, "Calculation for North Anna Power Station Beyond Design Basis – FLEX Electrical 480VAC and 120VAC System Loading Analysis for NAPS BDB FLEX DC NA-13-01017" provides the basis for the sizing of the North Anna Phase 2 portable BDB diesel generators. For Unit 1, the total loads for the 120 VAC and 480 VAC DGs are 12.4 kW and 189 kW, respectively. The calculation for Unit 2 is Calculation EE-0865, "Calculation for North Anna Power Station Beyond Design Basis – FLEX Electrical 480VAC and 120VAC System Loading Analysis for NAPS BDB FLEX DC NA-13-01018." Additional details for the individual 120 VAC and 480 VAC loads for Unit 2 are provided in Attachment 13.1 of the Calculation EE-0865. The sizes of the 120 VAC and 480 VAC BDB diesel generators are 35.5 kW and 350 kW, respectively.

The licensee further stated that the Phase 3 4160 VAC BDB diesel generator loading analysis has not been completed. It is estimated that the total loads for either unit will be approximately 1.7 MW. The portable diesel generators available from the RRC will be 2 MW generators.

The licensee further stated that as provided in the North Anna six-month status update, dated August 23, 2013, the scheduled completion date for the calculations documenting the load/sizing analyses was extended to December 2013. Calculations EE-0863 and EE-0865 discussed above for the 120 VAC and 480 VAC loads for Units 1 and 2, respectively, have been completed. The 4160 VAC load/sizing calculation will be completed in December 2013. This is identified as Confirmatory Item 3.2.4.8.A in Section 4.2 below.

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

In response, the licensee stated that for permanently installed BDB equipment connections, the connection hardware is either procured/installed to the requirements of safety related equipment or is isolated from the class IE buses in accordance with the approved license basis for each unit. The FSGs provide guidance for energizing a Class 1E bus using portable generators consistent with NEI 12-06, Section 3.2.2. The BDB portable diesel generators will be used only when the Class 1E Diesel Generators have been isolated. Each of the BDB portable diesel generators will be provided with output electrical protection (breakers, fuses, relays, etc.) that will provide protection for the output cables and the connection buses. Existing load circuit protection will be used for the bus loads. Class 1E equipment is protected by existing protection relaying. FLEX strategy does not change any existing equipment protection scheme.

Electrical isolation to prevent simultaneously supplying power to the same bus from different sources will be administratively controlled. The FSGs will be written to ensure the breakers from other potential supply sources are racked out and tagged before power is supplied to the bus by use of a BDB portable diesel generator which will be connected directly to the emergency bus for the 4160 VAC tie-in and to permanently installed receptacles for the 480 VAC tie-in.

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

3.2.4.9 Portable Equipment Fuel.

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

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

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

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

remains available.

On page 70 of the Integrated Plan, the licensee stated that the general coping strategy for supplying fuel oil to diesel driven portable equipment used to cope with an ELAP / LUHS, is to draw fuel oil out of any available existing diesel fuel oil tanks on the North Anna site. During Phase 1, the only fuel requirements would be to re-fuel the diesel driven fire pumps which has an 8 hour fuel oil supply at the beginning of the ELAP event. However, no fuel is required for stored or staged BDB equipment for any of the Phase 1 coping strategies.

On Page 72 of the Integrated Plan, the licensee stated that, for Phase 2 and Phase 3 the primary source of fuel oil for portable equipment will be the EDG Fuel Oil Day Tanks. These four diesel tanks contain 800 gallons of diesel fuel each (a total of 3200 gallons) and are seismically mounted and housed in the tornado protected EDG rooms. The licensee stated that, fuel can be obtained using the tank drain valve and a flexible hose; fuel can be gravity fed to suitable fuel containers for transport to BDB equipment so no pumps are necessary.

The licensee stated that a secondary source for fuel oil will be the two EDG Underground Diesel Fuel Oil Storage Tanks. Each tank has a 45,000 gallon capacity. These tanks are protected from high winds, tornado missiles, seismic events, and floods. The licensee stated that fuel can be obtained using a cart mounted 12 VDC fuel pump and attaching the pump suction to any of the eight (8) EDG fuel transfer pump suction strainer drain valves and pumping the fuel oil to suitable fuel containers for transport. The licensee stated that fuel transfer carts and pumps are stored in the BDB Storage Building(s).

The licensee stated that an evaluation of all BDB equipment fuel consumption and required re-fill strategies will be developed including any gasoline required for small miscellaneous equipment. The licensee stated that site-specific procedural guidance governing re-fueling strategies will be developed using industry guidance, and will address the monitoring of fuel supplies and consumption in order to initiate refueling activities prior to FLEX equipment shutdown (including the diesel-driven fire pump at the SW reservoir. The licensee does not discuss how the quality fuel oil and gasoline supplies will be controlled in order to ensure proper diesel or gasoline-powered FLEX equipment operation. In addition the licensee did not discuss available sources of gasoline and how those sources will be protected to ensure availability following a BDB event. This is identified as Confirmatory Item 3.2.4.9.A in Section 4.2 below

On page 76 of the Integrated Plan, the licensee stated that, for Phase 3, the coping strategy for supplying fuel oil to diesel driven portable equipment is the same as described for Phase 2. The licensee stated that the fuel strategy will evaluate the need for additional fuel required from the RRC or other offsite sources. However, the licensee does not describe how the onsite fuel capacity provides an indefinite supply of fuel or if the RRC is capable of providing an indefinite, ongoing supply of fuel. This is included with Confirmatory Item 3.2.4.9.A in Section 4.2 below.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and, subject to the successful closure of issues related to the Confirmatory Item, 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 10 of the Integrated Plan, the licensee stated that plant specific analysis for extension of Class 1E DC battery life included an initial condition that load stripping would be completed in 90 minutes from an ELAP event. The licensee stated that, with completion of load stripping in 90 minutes, the battery life was calculated as 8 hours for Unit 1 and 8 hours for Unit 2. Within 60 minutes of the initiating event, an ELAP condition would be diagnosed and load stripping of the vital buses would be initiated. Load stripping starts at 60 minutes from the initiating event and is completed within 30 minutes. The vital 120 VAC panels and 125 VDC panels required to be accessed by the operator to perform load stripping are located either in the Main Control Room (MCR) or directly below in the Emergency Switchgear Room (ESGR). The licensee stated that because the panels are readily accessible (close proximity to the normal duty station for the operator assigned this action) and load stripping is an uncomplicated task, completing the load stripping action within 30 minutes is reasonable. Therefore the 90 minute time constraint can be met.

During the audit, the licensee was requested to provide the dc load profile with the required loads for the mitigating strategies to maintain core cooling, containment, and spent fuel pool cooling.

In response, the licensee stated that Calculation EE-0009, Rev. 1, Addendum J, "125V DC System Analysis," Attachment 15.5, Pages 1 thru 8, provides the dc load profile with the required loads for the North Anna FLEX mitigating strategies.

During the audit, the licensee was requested to provide a detailed discussion on the loads that will be shed from the dc bus, the equipment location (or location where the required action needs to be taken), and the required operator actions needed to be performed and the time to complete each action.

In response, the licensee stated that there are four (4) 125 VDC buses at North Anna. The four dc bus distribution panels are located in the ESGR at elevation 254', directly below the MCR at elevation 274'. The ESGR has multiple access points including the stairwell behind the MCR, two access points from elevation 254' in the turbine building, and the control rod drive room. The ESGR is a part of the MCR pressure envelope and is in a Category 1 turbine-missile and flood protected room. Multiple access points provide reasonable assurance that the 125 VDC panels will remain accessible during any BDB ELAP scenario.

The licensee stated that, upon declaration of an ELAP, an operator will be dispatched from the MCR to perform dc bus load stripping per the guidance in FSG-4, “ELAP DC Bus Load Shed and Management." Within 60 minutes after an ELAP event, the guidance instructs the operator to secure the dc-powered seal oil pump and dc-powered turbine oil pump, after ensuring the hydrogen gas has been vented from the main generators. The licensee stated that once the pumps have been secured, the operator will then strip the remaining dc loads from the dc buses and the ac loads from the vital buses within the following 30 minutes; all load stripping will be completed within 90 minutes following initiation of the event.

The licensee stated that the four dc buses each provide power to their respective vital bus inverters, which convert 125 VDC to 120 VAC. The loads are stripped from the dc busses with the exception of these vital bus inverters. Load stripping in FSG-4 also includes the guidance to strip selected 120 VAC vital bus loads to preserve the emergency batteries. The required actions to strip the 120 VAC loads from the AC buses are performed in the Hathaway and Computer Rooms, which are an extension of the MCR, elevation 274’ Tables provided in FSG-4 give the operators a detailed description of the vital bus ac and the dc loads that will be required to be stripped and the basis for stripping the load. The operator guide tables are provided for Unit 1 and are typical for Unit 2.

The licensee stated that, Per NEI 12-06, Section 3.2.1.3(9), FLEX strategies do not need to assume additional failures beyond those attributed to the BDB External Event directly, and as such instrumentation redundancy is not a requirement for the key parameter indications, which remain available after load-stripping has been performed. However, as a defense in depth approach, the licensee stated that alternate indication is available from an independent source (e.g. a local pressure gauge, level versus flow indication, etc.) for many of the North Anna key parameters identified in the Integrated Plan.

During the audit, the licensee was requested to provide the basis for the minimum dc bus voltage that is required to ensure proper operation of all required electrical equipment.

In response, the licensee stated that the basis for the final 1E battery terminal voltage is the design minimum voltage per cell given in North Anna stationary battery specification NAS-2050. Section 2.1.3, of NAS-2050, “General Technical Requirements” states that the minimum voltage per cell for a Class 1E battery is 1.75 VDC per cell. Since North Anna utilizes a 60 cell battery, the final Class 1E battery terminal voltage is 105 VDC (60 x 1.75VDC).

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 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, following item (15) states:

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

NEI 12-06, Section 11.5 states:

> 1. FLEX mitigation equipment should be initially tested or other reasonable means used to verify performance conforms to the limiting FLEX requirements. Validation of source manufacturer quality is not required.
>
> 2. Portable equipment that directly performs a FLEX mitigation strategy for the core, containment, or SFP should be subject to maintenance and testing[1] guidance provided in INPO AP 913, Equipment Reliability Process, to verify proper function. The maintenance program should ensure that the FLEX equipment reliability is being achieved. Standard industry templates (e.g., EPRI) and associated bases will be developed to define specific maintenance and testing including the following:
>
>   a. Periodic testing and frequency should be determined based on equipment type and expected use. Testing should be done to verify design requirements and/or basis. The basis should be documented and deviations from vendor recommendations and applicable standards should be justified.
>
>   b. Preventive maintenance should be determined based on equipment type and expected use. The basis should be documented and deviations from vendor recommendations and applicable standards should be justified.
>
>   c. Existing work control processes may be used to control maintenance and testing. (e.g., PM Program, Surveillance Program, Vendor Contracts, and work orders).

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[1] Testing includes surveillances, inspections, etc.

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

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

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

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

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

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

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

The generic concern involving clarification of how licensees would maintain FLEX equipment such that it would be readily available for use is applicable to North Anna. 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.

During the audit, the licensee stated that the EPRI Templates will be used for most equipment. However, in the event that EPRI templates are not available, Preventative Maintenance (PM) actions will be developed based on manufacturer provided information/recommendations. Additionally, EPRI Templates will be adopted for new pieces of FLEX equipment as they are purchased/received on site.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01 and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to 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 19 of the Integrated Plan, the licensee stated that the FLEX strategies and their bases will be maintained in an overall program document. The program document will address the key safety functions to provide reactor core cooling and heat removal, provide RCS inventory and reactivity control, ensure containment integrity, provide spent fuel pool cooling, provide indication of key parameters, and provide reactor core cooling (Modes 5 and 6).

The licensee stated that support functions for the implementation of the FLEX strategies include providing load stripping of 125 VDC and 120 VAC vital buses to extend battery life, re-powering AC and DC electrical buses, providing ventilation for equipment cooling and area habitability, providing lighting, providing communications capability, providing for fueling of portable equipment, and providing plant and area access. The licensee stated that the program document will contain a historical record of previous strategies and their bases. In addition, the program document will include the bases for ongoing maintenance and testing activities for the BDB equipment.

The licensee stated that existing design 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. Changes for the FLEX strategies will be reviewed with respect to operations critical documents to ensure no adverse effect. The licensee stated that, future changes to the FLEX strategies may be made without prior NRC approval provided that the revised FLEX strategies meet the requirements of NEI 12-06. The licensee stated that an engineering basis will be documented that ensures that the change in FLEX strategies continues to ensure the key safety functions (core and SFP cooling, containment integrity) are met.

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 20 of the Integrated Plan, the licensee stated that Dominion's Nuclear Training Program will be revised to assure personnel proficiency in the mitigation of BDB events is developed and maintained. These programs and controls will be developed and implemented in accordance with the Systematic Approach to Training (SAT).

The licensee stated that initial and periodic training will be provided to site emergency response leaders on BDB emergency response strategies and implementing guidelines. Personnel

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[2] The Systematic Approach to Training (SAT) is recommended.

[3] Emergency response leaders are those utility emergency response personnel assigned leadership roles, as defined by the Emergency Plan, for managing emergency response to design basis and beyond-design-basis plant emergencies.

assigned to direct the execution of mitigation strategies for BDB events will receive necessary training to ensure familiarity with the associated tasks, considering available job aids, instructions, and mitigation strategy time constraints.

The licensee stated that operator training for BDB event accident mitigation will not be given undue weight in comparison with other training requirements. The testing/evaluation of Operator knowledge and skills in this area will be similarly weighted. Operator training will include use of equipment from the Regional Response Center.

The licensee stated that "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 BDB 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.

The licensee stated that where appropriate, integrated FLEX drills will 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 required to connect/operate permanently installed equipment during these drills.

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

3.4 OFFSITE RESOURCES

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

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

10) Provision to ensure that reasonable supplies of spare parts for the off-site equipment are readily available if needed. The intent of this provision is to reduce the likelihood of extended equipment maintenance (requiring in excess of 90 days for returning the equipment to operational status).

On page 21 of the Integrated Plan, the licensee stated that the industry will establish two RRCs to support utilities during BDB events. Dominion has established contracts with the PEICo to participate in the process for support of the RRCs as required. Each RRC will hold five sets of equipment, four of which will be able to be fully deployed when requested, the fifth set will have equipment in a maintenance cycle. In addition, on-site BDB equipment hose and cable end fittings are standardized with the equipment supplied from the RRC. 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.

The implementation of Guidelines 2 through 10 above is identified as Confirmatory Item 3.4.A, in Section 4.2

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

4.0 OPEN AND CONFIRMATORY ITEMS

4.1 OPEN ITEMS

Item Number	Description	Notes
3.2.1.2.B	Demonstration of the acceptability of the use the Flowserve N-9000 seals with the Abeyance feature and validation of an acceptable leakage rate for these seals.	
3.2.1.8.A	The PWROG submitted to NRC a position paper, dated August 15, 2013, which provides test data regarding boric acid mixing under single-phase natural circulation conditions and outlined applicability conditions intended to ensure that boric acid addition and mixing would occur under conditions similar to those for which boric acid mixing data is available. During the audit process, the licensee informed the NRC staff that its boric acid mixing model is based on the PWROG method. Since the audit discussions, the NRC endorsed the PWROG guidance with several clarifications in the letter dated January 8, 2014. The licensee should address the clarifications alignment with the NRC endorsement letter for the development of an adequate model for determining the mixing of boric acid in the reactor coolant system during natural circulation with the potential for two-phase flow conditions.	

4.2 CONFIRMATORY ITEMS

Item Number	Description	Notes
3.1.1.1.A	Storage & Protection of FLEX equipment – Confirm final design of FLEX storage structure conforms to NEI 12-06, Sections 5.3.1, 6.2.3.1, 7.3.1, and 8.3.1 for storage considerations for the hazards applicable to North Anna.	
3.1.1.3.A	Procedural Interface Considerations (Seismic) – Confirm FLEX support guideline to provide operators with direction on how to establish alternate monitoring and control capabilities.	
3.1.1.4.A	Off-Site Resources – Confirm RRC local staging area, evaluation of access routes, and method of transportation to the site.	
3.1.5	Clarify whether the site intends to use 107 degrees F or the values recommended in NEI 12-06 Section 9.2 as the basis for protection and deployment strategies of FLEX equipment.	
3.1.5.2.A	In the Integrated Plan, the licensee did not address considerations for any manual actions required by plant personnel is high temperature conditions as recommended in NEI 12-06, Section 9.3.2. Discuss effects of high temperatures on any manual action performed by plant	

	personnel and any applicable contingencies and any related procedural changes or enhancements.	
3.2.1.1.A	Reliance on the NOTRUMP code for the ELAP analysis of Westinghouse plants is limited to the flow conditions before reflux condensation initiates. Specify an acceptable definition for reflux condensation cooling.	
3.2.1.1.B	Confirmation that the generic analysis in Section 5.2.1 of WCAP-17601-P is applicable or bounding with respect to North Anna for an appropriate figure of merit for defining entry into the reflux condensation cooling mode.	
3.2.1.1.C	Confirm the consistency of the margin imposed to prevent accumulator nitrogen injection with the cooldown terminus assumed in WCAP-17601-P	
3.2.1.2.C	**(1)** Confirm that stresses resulting from a cooldown of the RCS will not result in the failure of seal materials. **(2)** As applicable, confirm that reestablishing cooling to the seals will not result in increased leakage due to thermal shock.	
3.2.1.6.A	Sequence of Events – Confirm that the final timeline has been time validated after detailed designs are completed and procedures are developed. The results will be provided in a future 6-month update.	
3.2.1.8.B	Completion of calculations demonstrating adequate shutdown margin for North Anna in ELAP scenarios with and without seal leakage.	
3.2.1.8.C	Confirm that shutdown margin calculations will be verified to remain bounding for future operating cycles and clarify the method that will be used to make this determination.	
3.2.1.9.A	North Anna will purchase and store two BDB RCS Injection Pumps for use in the Phase 2 RCS Inventory strategy. However, the licensee did not clarify how the two BDB RCS injection pumps conform to NEI 12-06, paragraph following Section 3.2.2, Guideline 15 which states in part: “In order to ensure 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., N+1 capability, where N is the number of units on-site.”	
3.2.1.9.B	Confirm completion of calculations documenting the AFW supply, SFP makeup, and RCS inventory hydraulic analysis.	
3.2.2.A	SFP venting – Provide a technical justification that confirms opening of the roll-up doors would provide an adequate ventilation path for the SFP area.	
3.2.3.A	Containment – Confirm containment analysis to determine any containment temperature and pressure actions beyond 7 days.	
3.2.4.2.A	Ventilation – Equipment Cooling – Confirm development of the ventilation strategy.	

3.2.4.2.B	Battery rooms are not modeled in the loss of ventilation transient analysis model. Therefore, it appears that there is no analysis or calculation to demonstrate the adequacy of the battery room ventilation.	
3.2.4.4.A	Verify the lighting study validates the adequacy of supplemental lighting and the adequacy and practicality of using portable lighting to perform FLEX strategy actions. The lighting study is being tracked by licensee Open Item 17	
3.2.4.4.B	Communications - Review the licensee's proposed enhancements and interim measures to the site's communications systems and that they have been completed.	
3.2.4.8.A	Electrical Power Sources – Confirm load calculations for the phase 2 and 3 FLEX generators will support supplied loads.	
3.2.4.9.A	Fuel Supplies – Confirm the adequacy of the fuel consumption evaluation. Confirm that the procedural guidance governing re-fueling strategies addresses: (a) how the quality of the fuel oil and gasoline supplies will be controlled in order to ensure proper diesel or gasoline-powered FLEX equipment operation, (b) available sources of gasoline and how those sources will be protected to ensure availability following a BDB event, and (c) if the onsite fuel capacity provides an indefinite supply of fuel or if the RRC is capable of providing an indefinite, ongoing supply of fuel (both diesel and gasoline).	
3.4.A	NEI 12-06, Section 12.2 lists minimum capabilities for offsite resources for which each licensee should establish the availability. The licensee did not discuss implementation of consideration 2 through 10 in NEI 12-06, Section 12.2.	