Mega-Tech Services, LLC

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

Revision 2

February 12, 2014

Virginia Electric And Power Company
Surry Power Station, Units 1 & 2
Docket Nos. 50-280 and 50-281

Prepared for:

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

Contract NRC-HQ-13-C-03-0039
Task Order No. NRC-HQ-13-T-03-0001
Job Code: J4672
TAC Nos. MF1002 and MF1003

Prepared by:

Mega-Tech Services, LLC
11118 Manor View Drive
Mechanicsville, Virginia 23116

1.0 BACKGROUND

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

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

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

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

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

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

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

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

2.0 EVALUATION PROCESS

In accordance with the provisions of Contract NRC-HQ-13-C-03-0039, Task Order No. NRC-HQ-13-T-03-0001, Mega-Tech Services, LLC (MTS) performed an evaluation of each licensee's Integrated Plan. As part of the evaluation, MTS, in parallel with the NRC staff, reviewed the original Integrated Plan and the first 6-month status update, and conducted an audit of the licensee documents. The staff and MTS also reviewed the licensee's answers to the NRC staff's and MTS's questions as part of the audit. 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 was provided to all licensees in a letter dated August 28, 2013 from Jack R. Davis, Director, Mitigating Strategies Directorate (ADAMS Accession No. ML13234A503).

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

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

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

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

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

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

3.0 TECHNICAL EVALUATION

By letter dated February 28, 2013 (ADAMS Accession No. ML13063A181), and as supplemented by the first six month status report in letter dated August 23, 2013 (ADAMS Accession No. ML13242A013), Virginia Electric and Power Company (the licensee or Dominion) provided Surry Power Station, Unit 1 and 2's (Surry) Integrated Plan for Compliance with Order EA-12-049. The Integrated Plan describes the strategies and guidance under development for implementation by Surry for the maintenance or restoration of core cooling, containment, and SFP cooling capabilities following a BDBEE, including modifications necessary to support this implementation, pursuant to Order EA-12-049. By letter dated August 28, 2013 (ADAMS Accession No. ML13234A503), the NRC notified all licensees and construction permit holders that the NRC staff is conducting audits of their responses to Order EA-12-049. That letter described the process used by the 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 Surry 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 the Integrated Plan.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and 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 5 of the six-month status report, the licensee stated that a single 10,000 sq. ft. Type 1 building will be constructed at Surry for storage of BDB equipment. The building will be designed to meet the plant's design basis for the SSE, high wind hazards, snow, ice and cold conditions, and will be located above the flood elevation from the most recent site flooding analysis.

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. In response to the NRC audit, 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 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.

With regards to deployment of FLEX equipment (consideration 1), and protection of the means to move FLEX equipment (consideration 5), on page 103 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 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 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 page 109 of the Integrated Plan, in the section of its integrated plan listing the portable equipment for phase 2, the licensee listed two front-end loaders, two tow vehicles, two hose trailers or utility vehicles, and two sets of miscellaneous debris removal equipment.

With regards to access to connection points (consideration 2), in various sections of the Integrated Plan the licensee details information as to how each connection point is accessed and protected to ensure at least one connection point will be available for strategy deployment. However, on page 54 of the Integrated Plan, in regards to protection of connections for maintaining containment during the final phase, the licensee stated that protection of connections for future Phase 3 strategies to assess containment conditions and deploy equipment to depressurize/cool containment will be identified later and is being tracked as part of the licensee’s open items. This is identified as Confirmatory Item 3.1.1.2.A in Section 4.2 below.

With regards to accessibility of a water source (consideration 3), on page 28 of the Integrated Plan the licensee stated that an indefinite supply of water, as make-up to the emergency condensate storage tank (ECST) or directly to the suction of the portable diesel driven BDB auxiliary feedwater (AFW) pump, can be provided from the station circulating water discharge canal. The discharge canal communicates directly with the James River and will remain available for any of the external hazards applicable to Surry. Failure of a downstream dam is not applicable to Surry (refer to Section 3.1.1.3 consideration 4)

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory Item, 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.

The vital ac and dc distribution system and associated equipment are seismically-designed and installed in protected areas of the plant and are expected to remain available following an ELAP/LUHS. However, regarding consideration 1, on page 65 of the Integrated Plan, the licensee stated that in the unlikely event of vital ac and dc infrastructure damage due a seismic event or other hazard, key parameter monitoring capability can be provided using methods, such as repowering instruments locally, that are currently addressed by existing site procedures previously developed to respond to extreme events. However, the licensee's plan did not contain any information in regards to any plans for conforming to the following parts of consideration 1 above: a) The development of procedure/guidelines on critical actions to perform until alternate indications can be connected; and b) The development of procedures/guidelines on how to control critical equipment without control power. During the NRC audit, the licensee was requested to provide information on their plans to conform to these parts of consideration 1. In response, the licensee stated that for item a) a FLEX Support Guideline (FSG) is being developed to enable plant personnel to obtain instrument readings locally in the event that instrument power is disabled. The guideline will indicate the location where readings can be obtained and include conditions required to access the areas needed to get the readings, special tools and equipment needed, etc. Portable meters will be used to display an electrical output, which will be compared to a conversion chart included in the guideline to determine the converted parametric value of the readout. Key instrumentation required to implement the FLEX strategies can be accessed using this method. For item b) critical plant equipment credited for implementation of FLEX strategies do not rely on control power for operation. The licensee response did not address critical actions to perform until alternate indication can be connected, such as the control of the turbine driven auxiliary feedwater (TDAFW) pump if SG level indication is lost. Confirmation that the FSG being developed for obtaining local instrument readings addresses critical actions to perform until alternate indications can be connected is identified as Confirmatory Item 3.1.1.3.A in Section 4.2 below.

The licensee's Integrated Plan did not provide any information on non-robust internal flooding sources that do not require ac power (consideration 2) or the use of ac power to mitigate ground water in critical locations (consideration 3). During the NRC audit, the licensee was requested to provide information to address considerations 2 and 3 and how the proposed mitigation strategy will cope with a worse case turbine building flooding event during an ELAP. In response, the licensee stated that regarding consideration 2, fire protection water piping and other water system piping within the plant, including flooding sources that are not seismically robust and do not require ac power, were 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. Additionally, in response to a 2004 NRC inspection finding and unresolved issue, Dominion performed a detailed evaluation of a turbine building (TB)/emergency switchgear room (ESR) internal flooding scenario caused by a seismic event. The evaluation considered an earthquake magnitude sufficient to result in seismic loadings equivalent to twice the design basis earthquake. Flooding from circulating water (CW) and service water (SW) system sources were evaluated due to the potential for gravity flow in the event of piping or component failures in these systems. The evaluation determined that the risk of internal flooding due to failure of the SW/CW system components under this scenario was acceptably small. NRC Inspection Report 2005-002 documented the resolution of this finding and closed the unresolved item. In addition, the high confidence of low probability of failure values calculated for the evaluated structures and components indicate that the definition of a "robust design" in NEI 12-06 is met such that these components would not be assumed to fail for an ELAP/LUHS. Therefore, mitigation strategies to cope with TB internal flooding resulting from non-seismically robust components during an ELAP are not required.

In accordance with the current licensing basis, the licensee contends that the equipment in the turbine building is sufficiently robust for demonstrating compliance with Order EA-12-049. However, the adequacy of protection against turbine building flooding will be subject to further re-evaluation pursuant to Section 402 of Public Law 112-074, "Consolidated Appropriations Act," which requires that the NRC to require licensees to reevaluate the seismic, tsunami, flooding, and other external hazards at their sites against current applicable Commission requirements and guidance for such licenses as expeditiously as possible, and thereafter when appropriate. The reviewer notes that the initial re-evaluation of the seismic hazard is being accomplished in response to the 10 CFR 50.54(f) letter of March 12, 2012, discussed above.

Regarding consideration 3; the licensee stated that as described in UFSAR Section 15.5.1.3, non-safety-related pumps are installed to remove subsurface seepage water collected from beneath the containment structure preventing water levels from reaching the containment base mat and exerting hydrostatic pressure on the top of the mat liner. In the event that groundwater would rise to the site finished ground grade level at Elevation 26'-6" mean sea level (MSL), flotation of the containment is not credible. Therefore, Surry does not rely on ac power to mitigate ground water in critical locations.

With regards to consideration 4, although not specifically addressed in the Integrated Plan, the failure of a non-seismically robust downstream dam is not applicable to Surry as there are no downstream dams between the plant site and the Chesapeake Bay.

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 22 of the Integrated Plan, the licensee stated that the industry will establish two Regional Response Centers (RRCs) to support utilities during 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.

The licensee confirmed on page 1 of the Integrated Plan that a site-specific assessment for Surry provides the development of strategies, equipment lists, storage requirements, and deployment procedures for the conditions and consequences of external flooding. The licensee also stated that the flood re-evaluations pursuant to the 10 CFR 50.54(f) letter of March 12, 2012 had not been completed and therefore were not assumed in the Integrated Plan.

Review of the licensee's Integrated Plan with respect to screening for flooding hazard identified Probable Maximum Hurricane (PMH) as the most severe meteorological event at the site and results in the most limiting flood level elevations at both the site and the intake structure. The licensee stated that during a PMH, the James River still water level is 22.7 feet MSL at the site. Accounting for maximum wave run-up, the flood level of a PMH at the east end of the site (i.e., the intake structure) is approximately 28.6 feet MSL. The east face of the intake structure is protected against this wave action. The intake structure is located more than a mile from the main site (power block) structures and has no role in the FLEX strategies for Surry. Maximum run-up due to storm surges at the west side of the main site is 24 feet MSL. Critical equipment in this area is protected against flooding to elevation 26.5 feet MSL, which is the typical site grade.

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 5 of the six-month status report, the licensee stated that a single 10,000 sq. ft. Type 1 building will be constructed at Surry for storage of BDB equipment. The building will be designed to meet the plant's design basis for the SSE, high wind hazards, snow, ice and cold conditions, and will be located above the flood elevation from the most recent site flooding analysis.

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

With regards to consideration 2 on the ability to move equipment and restock supplies, and consideration 9 for a means to move FLEX equipment and protection of the means, on page 103 of the Integrated Plan regarding safety function support (accessibility), the licensee stated that 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.

With regards to consideration 4 for providing fuel for FLEX equipment, on page 74 and 75 of the Integrated Plan, the licensee stated that the general coping strategy for supplying fuel oil to diesel driven portable equipment, i.e., pumps and generators, is to draw fuel oil out of any available existing diesel fuel oil tanks on site. A secondary source for fuel oil will be the two emergency diesel generator (EDG) underground diesel fuel oil storage tanks. Each tank has a 17,500 gallon capacity and is protected from high wind tornado missiles by virtue of the underground location and is also protected from seismic and flooding events. Fuel can be obtained using a cart mounted 12 Vdc fuel pump and attaching the pump suction to any of the six (6) EDG fuel transfer pump suction strainer drain valves and pumping the fuel oil to suitable fuel containers for transport. Fuel transfer carts and pumps are stored in the BDB storage buildings.

With regards to consideration 5 for access to connection points, in various sections of the Integrated Plan the licensee details information as to how each connection point is accessed to ensure at least one connection point will be available for strategy deployment. However, on page 54 of the Integrated Plan, in regards to access of connections for maintaining containment during the final phase, the licensee stated that connections for future Phase 3 strategies to assess containment conditions and deploy equipment to depressurize/cool containment will be identified later and is being tracked as part of the licensee's open items. This is has been included with Confirmatory Item 3.1.1.2.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 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 18 of the Integrated Plan in the section discussing programmatic controls, the licensee indicated that FSGs will be developed in accordance with Pressurized Water Reactor Owners Group (PWROG) guidance; will interface with emergency operating procedures (EOPs); and abnormal procedures such as "Abnormal Environmental Conditions" will be revised as necessary to implement the FSGs.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, 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 22 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 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. This 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 regarding the determination of applicable extreme external hazards, site-specific assessment of Surry 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. The characterization of hurricanes includes the fact that significant notice will be available in the event that a severe hurricane will impact the site. For tornadoes and tornado missiles, the Surry UFSAR, Section 2.2.2, indicates that the tornado model used for design purposes has a 300 mph rotational velocity, a 60 mph translational velocity, and a pressure drop of 3 psi in 3 seconds. Wind generated missiles include a utility pole and a 1 ton vehicle traveling at 150 mph. The characterization of tornadoes is such that little warning is available, and pre-deployment of equipment is not practical, nor is it likely to be effective. On April 16, 2011, a tornado struck the Surry switchyard. Damage to equipment in the switchyard resulted in a loss of offsite power and automatic shutdown of the Unit 1 and 2 reactors.

The reviewer performed a cross check to confirm that the hurricane and tornado wind speeds used for design purposes, meet or exceed the wind speeds of NEI 12-06, Figures 7-1 and 7-2 for the site location.

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 5 of the six-month status report, the licensee stated that a single 10,000 sq. ft. Type 1 building will be constructed at Surry for storage of BDB equipment. The building will be designed to meet the plant's design basis for the SSE, high wind hazards, snow, ice and cold conditions, and will be located above the flood elevation from the most recent site flooding analysis.

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

With regards to consideration 1, on page 18 of the Integrated Plan, the licensee stated that abnormal procedures such as 0-AP-37.01, "Abnormal Environmental Conditions" will be revised to implement the FSGs to include actions to optimize FLEX deployment, as well as provide protective actions to reduce the potential for wind impacts, prior to the arrival of a hurricane.

With regards to the affects of a hurricane on the UHS (consideration 2), the water inventory in the UHS (intake canal) is unavailable, due to the plant design for gravity flow through the main condenser waterboxes and service water flowpaths, since power is lost to close the motor-operated isolation valves. As discussed on page 28 of the Integrated Plan, Surry relies on the station circulating water discharge canal as the indefinite supply of water, which is protected against the hazards of hurricane winds. Pumps taking suction from the discharge canal will use a strainer sized to limit solid debris to prevent damage to the pumps.

With regards to deployment of FLEX equipment (consideration 3), protection of the means to move FLEX equipment (consideration 4), and the ability to move equipment and restock supplies, on page 103 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 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 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 page 109 of the Integrated Plan, in the section of its integrated plan listing the portable equipment for phase 2, the licensee listed two front-end loaders, two tow vehicles, two hose trailer or utility vehicle, and two sets of miscellaneous debris removal equipment.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to 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 18 of the Integrated Plan in the section discussing programmatic controls, the licensee indicated that FSGs will be developed in accordance with PWROG guidance; will interface with EOPs; and abnormal procedures such as "Abnormal Environmental Conditions" will be revised as necessary to implement the FSGs.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, 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 22 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 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. This 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.

The licensee confirmed on page 1 of the Integrated Plan that a site-specific assessment for Surry provides 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 3 and 4 of the Integrated Plan, in the section regarding the determination of applicable extreme external hazards, the licensee stated that the climatic characteristics of the region are influenced by the Atlantic Ocean, the Chesapeake Bay, and the Appalachian Mountains. The Atlantic Ocean has a moderating effect on the temperature for the region, whereas the Appalachians act as a barrier to deflect Midwest winter storms to the northeast of the region. Snow is not common during winter in the Tidewater area of Virginia. A snowfall of 10 inches or more in a month in the Tidewater area is expected to occur once every 4 years. In general, the total accumulated snow for the Tidewater region is approximately 10 inches each year. Precipitation occurs mostly as rain in the site area. The maximum monthly snowfall in Norfolk was 18.9 inches occurring in February 1980 and the maximum monthly snowfall for Richmond was 28.5 inches occurring in January 1940. The lowest temperature recorded in Norfolk was minus 37°F in January 1985, and in Richmond it was minus 12°F in January 1940.

Although not stated in the Integrated Plan, the site is located at approximately 37.165° N, with is north of the 35th parallel.

.

The licensee's screening for hazards due to snow, ice and extreme cold does not discuss the hazards of ice in the determination of extreme external hazards. During the NRC audit, the licensee was requested to provide a discussion of the external hazards of ice in the appropriate screening section of the Integrated Plan. In response, the licensee stated that the Surry UFSAR does not provide historical data on ice storms in the site characterization and, therefore, was not included in Section A.1 of the Integrated Plan. The licensee further stated that Ice storms can occur at Surry and may cause hazardous travel and downed trees, which may block the site access road and possibly deployment haul paths. The station maintains a supply of ice melting chemicals and the equipment to deploy the chemicals as a matter of routine site safety. If an ice storm causes access route issues due to downed trees and icy conditions, two tractors and a front-end loader will be available to help clear debris and ice from roadways. The BDB storage building is located adjacent to the site but is outside of the site protected area. Therefore, the distances for hauling equipment to the designated deployment locations are relatively short and the assumed 2 hour duration for the clearing of haul paths remains reasonable.

The reviewer compared the site location to NEI 12-06, Figure 8-2 and determined that the site was a Level 4 site, subject to severe damage to power lines and/or existence of large amounts of ice.

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

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

NEI 12-06, Section 8.3.1 states:

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

called upon. For example, by storage in a heated enclosure or by direct heating (e.g., jacket water, battery, engine block heater, etc.).

On page 5 of the six-month status report, the licensee stated that a single 10,000 sq. ft. Type 1 building will be constructed at Surry for storage of BDB equipment. The building will be designed to meet the plant's design basis for the SSE, high wind hazards, snow, ice and cold conditions, and will be located above the flood elevation from the most recent site flooding analysis.

On page 4 of the Integrated Plan, the licensee stated that the BDB equipment will be stored in a BDB storage building that will be maintained at a temperature range to ensure equipment readiness at extreme temperature when called upon.

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

In regards to consideration 1 and 3, on page 17 and 18 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 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 potential clogging of strainers, pumps, valves or hoses from debris or ice when using 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.

With regard to consideration 2, on page 109 and110 of the Integrated Plan, in the section regarding portable equipment for phase 2, the licensee listed two front-end loaders and 2 sets of miscellaneous debris removal equipment. On page 104 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. Additionally, the station maintains a supply of ice melting chemicals and the equipment to deploy the chemicals as a matter of routine site safety.

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 18 of the Integrated Plan in the section discussing programmatic controls, the licensee indicated that FSGs will be developed in accordance with PWROG guidance; will interface with EOPs; and abnormal procedures such as "Abnormal Environmental Conditions" will be revised as necessary to implement the FSGs.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to procedural interfaces in a 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 22 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 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. This 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.

The licensee confirmed on page 1 of the Integrated Plan that a site-specific assessment for Surry provides the development of strategies, equipment lists, storage requirements, and deployment procedures for the conditions and consequences of extreme heat.

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

3.1.5.1 Protection of FLEX Equipment - High Temperature Hazard

NEI 12-06, Section 9.3.1, states:

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

On page 1 of the Integrated Plan, the licensee stated that the BDB equipment will be stored in a BDB storage building that will be maintained at a temperature range to ensure equipment readiness at extreme temperature when called upon.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to 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 page 17 and 18 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 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.

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

3.1.5.3 Procedural Interfaces – High Temperature Hazard

NEI 12-06, Section 9.3.3 states:

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

The design requirements of the portable equipment is discussed in Section 3.1.5.2 above, and includes the effects of extreme high temperatures in which the equipment would be expected to operate.

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 SFP cooling capabilities.

The phases consist of an initial phase using installed equipment and resources, followed by a transition phase using portable onsite equipment and consumables and a final phase using offsite resources.

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

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

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

NEI 12-06, Table 3-2 and Appendix D summarize one acceptable approach for reactor core cooling & heat removal, and RCS inventory control strategies. This approach uses the installed auxiliary feedwater (AFW)/emergency feedwater (EFW) system to provide steam generator (SG) makeup sufficient to maintain or restore SG level in order to continue to provide core cooling for the initial phase. This approach relies on depressurization of the SGs for makeup with a portable injection source in order to provide core cooling for the transition and final phases. This approach accomplishes RCS inventory control and maintenance of long term subcriticality through the use of low leak RCP 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 BDB event, the analysis used to provide the technical basis for time constraints for the mitigation strategies may use nominal initial values (without uncertainties) for plant parameters, and best-estimate physics data. All equipment used for consequence mitigation may be assumed to operate at nominal setpoints and capacities. NEI 12-06, Section 3.2.1.2 describes the initial plant conditions for the at-power mode of operation; Section 3.2.1.3 describes the initial conditions; and Section 3.2.1.4 describes boundary conditions for the reactor transient.

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

During the NRC audit, the licensee was requested to specify which analysis performed in WCAP-17601-P is being applied to Surry. 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 Surry and appropriate for simulating the ELAP transient. The licensee has provided information in response to these requests. The NRC staff will review this information to ensure that it sufficiently justifies the analysis being applied. Additional information may be needed to confirm the appropriate use of the analysis. This has been identified as Confirmatory Item 3.2.1.A in Section 4.2 below.

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 performed Engineering Technical Evaluation, ETE-NAF-2012-0150,"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," Revision 1. This ETE provides a technical basis for the core cooling coping time for Surry. As discussed in this ETE, WCAP 17601 provides the reference case for Westinghouse Nuclear Steam Supply System (NSSS) designed plants and assumes standard RCP seal packages to determine the minimum adequate core cooling time with respect to RCS inventory control (i.e., core uncovery). The reference case models a Westinghouse 4 loop plant, which showed adequate core cooling for 55 hours. Hand calculations were performed for other Westinghouse plant types considering RCS volume, number of loops and RCP model differences. All the cases assume 21 gpm seal leakage per pump at normal operating pressure and temperature. In some cases, NOTRUMP was executed as an informal check of the results.

The licensee has provided a Sequence of Events (SOE) in their Integrated Plan, which included the time constraints and the technical basis for the site. That SOE is based on an analysis using the industry-developed NOTRUMP computer code. NOTRUMP was written to simulate the response of pressurized water reactors (PWRs) to small-break loss of coolant accident (LOCA) transients for licensing basis safety analysis.

The licensee has decided to use the NOTRUMP computer code for simulating the ELAP event. Although NOTRUMP has been reviewed and approved for performing small break LOCA analysis for PWRs, the NRC staff had not previously examined its technical adequacy for simulating an ELAP event. In particular, the ELAP scenario is differentiated from typical design-basis small-break LOCA scenarios in several key respects, including the absence of normal 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 SG tubes as single-phase natural circulation transitions to two-phase flow and the reflux condensation cooling mode. This concern resulted in the following Confirmatory Item:

> Reliance on the NOTRUMP code for the ELAP analysis of Westinghouse plants is limited to the flow conditions prior to reflux condensation initiation. 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.

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 computer codes used to perform ELAP analysis if these requirements are implemented as planned.

3.2.1.2 RCP Seal Leakage Rates

NEI 12-06, Section 1.3 states:

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

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

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

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

- A position paper dated August 16, 2013, entitled "Westinghouse Response to NRC Generic Request for Additional Information (RAI) on Reactor Coolant Pump (RCP) Seal Leakage in Support of the Pressurized Water Reactor Owners Group (PWROG)" (ADAMS Accession No. ML13235A151 (Non-Publicly Available)).

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

1. For the plants using Westinghouse RCPs and seals that are not the SHIELD shutdown seals, the RCP seal initial maximum leakage rate should be greater than or equal to the upper bound expectation for the seal leakage rate for the ELAP event (21 gpm/seal) discussed in the PWROG white paper addressing the RCP seal leakage for Westinghouse plants. If the RCP seal leakage rates used in the plant-specific ELAP

analyses are less than the upper bound expectation for the seal leakage rate discussed in the whitepaper, justification should be provided. If the seals are changed to non-Westinghouse seals, the acceptability of the use of non-Westinghouse seals should be addressed, and the RCP seal leakage rates for use in the ELAP analysis should be provided with acceptable justification. The Surry RCP seals have been replaced with FlowServe N-9000 three-stage seals with abeyance feature on all 6 RCPs. For the purposes of this analysis, the licensee continued to use the standard Westinghouse RCP seal leakage rate of 21 gpm for timing the RCS injection strategy. The licensee's analysis states that based on the above, natural circulation will be lost at approximately 33 hours, but the RCS injection SOE action time was chosen at 16 hours for a factor of two margin. Confirmation of the acceptability of the non-Westinghouse seals is identified as Confirmatory Item 3.2.1.2.A in Section 4.2 below.

2. In some plant designs, such as those with 1200 to 1300 psia SG design pressures and no accumulator backing of the main steam (MS) 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.

   During the NRC audit, the licensee was requested to address the applicability of the above statements to the ELAP analysis, and justify that the integrity of the associated O-rings will remain for a specified time period. In response, the licensee stated that there is no compressed air accumulator backing up the normal instrument air system for extended operation of the SG PORVs, therefore the SG pressure may increase to the main steam safety valve (MSSV) setpoint for a period of time following the ELAP. The lowest MSSV setpoint is 1085 psig, which corresponds to a cold leg temperature of approximately 556 ^{0}F. The Surry RCP seals have been replaced with FlowServe N-9000 three-stage seals on all 6 RCPs. The qualification of the N-9000 seal performance at high temperatures will be addressed in the forthcoming FlowServe White Paper. It is expected that FlowServe will show qualified performance for temperatures well in excess of the cold leg temperature associated with MSSV lift setpoints. This is identified as Confirmatory Item 3.2.1.2.B in Section 4.2 below.

3. Some Westinghouse plants have installed or will install the SHIELD shutdown seals, or other types of low leakage seals, and have credited or will credit a low seal leakage rate (e.g., 1 gpm/seal) in the ELAP analyses for the RCS response. For those plants, information should be provided to address the impacts of the Westinghouse 10 CFR Part 21 report, “Notification of the Potential Existence of Defects Pursuant to 10 CFR Part 21,” dated July 26, 2013 (ADAMS No. ML13211A168) on the use of the low seal leakage rate in the ELAP analysis. This is not applicable to Surry at this time as they are crediting a seal leakage rate of 21 gpm/seal in their analysis.

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. During the NRC audit, the licensee was requested to provide the value of

the maximum leak-off for each RCP seal in gpm assumed in the ELAP analysis.

In response, the licensee stated that the reference ELAP analysis is presented in WCAP-17601, Section 5.2 for a 4-loop plant. The applicability of these results to Surry is evaluated in detail in Dominion ETE-NAF-2012-150, Section 6.4. The assumed leakage in the reference analysis is 21 gpm per seal. Dominion has replaced the original Westinghouse designed RCP seals with the FlowServe N-9000 three stage seal design for all RCPs. FlowServe is providing an evaluation of the performance of the Surry N-9000 seals under ELAP conditions (i.e. the FlowServe White Paper). The results are expected to show that the assumptions in WCAP-17601 Section 5.2 conservatively bound the FlowServe seal performance throughout the ELAP event. The FlowServe White Paper will be provided for NRC review when available. This is included in Confirmatory Item 3.2.1.2.A in Section 4.2 below.

During the NRC audit, the licensee was requested to provide the following information pertaining to the RCP seals that will be installed:

a. Provide the manufacturer's name and model number for the RCPs and the RCP seals.

In response, the licensee stated that the RCPs are Westinghouse Model 93A with FlowServe N-9000 three-stage seals.

b. Confirm that the primary ELAP strategy is to perform a symmetric cooldown using all RCS loops.

In response, the licensee stated that for an ELAP/LUHS event initiating during power operation mode, Surry's primary ELAP strategy will use all three SG PORV's to perform a symmetric cooldown and depressurization to the target steam pressure of 300 psig. During the limited time period when the plant is between 350F RCS temperature and hot shutdown condition, the auxiliary feedwater supply lines to one SG are required to be isolated for motor-driven AFW pump runout concerns. If the event initiates under this initial condition, since the fail-as-is motor-operated AFW isolation valves are located inside containment and inaccessible following an ELAP, AFW flow to one SG will be unavailable and asymmetric plant cooldown will be performed using the remaining two available SGs.

c. Confirm that load shed activities will not interfere with required valve positioning or operator action capability that may be credited in establishing ELAP response strategies, including specifically those actions related to isolating RCS leakage paths.

In response, the licensee stated that the generic loss of all ac procedure step sequence is such that RCS isolation is performed/confirmed prior to initiation of dc load shed actions. This order will be retained for the Surry specific procedures, which incorporate the FLEX strategies for response to an ELAP event.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and subject to the successful closure of issues related to the Confirmatory 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.

On page 6 of the Integrated Plan, in regards to the boundary conditions established to support development of FLEX strategies, the licensee stated that both reactors are initially operating at power, unless there are procedural requirements to shut down due to the impending event. The assumed power history is that the reactors have been operating at 100% power for the past 100 days.

The licensee's integrated plan references Engineering Technical Evaluation, ETE-NAF-2012-0150. This evaluation was a site-specific assessment of the generic WCAP-17601-P evaluation. The design inputs and assumptions for this document includes the initial plant condition that 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.

NEI 12-06, Section 1.3, Flex Objectives and Guiding Principles, states in part: Plant-specific analyses will determine the duration of each phase; and, to the extent practical, generic thermal hydraulic analyses will be developed to support plant-specific decision-making. Westinghouse completed generic analyses for Westinghouse Plants as documented in WCAP-17601-P. NEI 12-06, Table D-1, Summary of Performance Attributes for PWR Core Cooling Functions states in part: SG makeup rate should exceed decay heat levels at time of planned deployment in order to support restoring SG water level, e.g., 200 gpm. Assumption 4 on page 4-13 of WCAP-17601-P states that decay heat is per ANS 5.1-1979 + 2 sigma, or equivalent.

During the NRC audit the licensee was requested to address the applicability of assumption 4 to Surry. If the ANS 5.1-1979 + 2 sigma model is used in the Surry ELAP analysis, address the adequacy of the use of the decay heat model in terms of the plant-specific values of the following key parameters: (1) initial power level, (2) fuel enrichment, (3) fuel burnup, (4) effective full power operating days per fuel cycle, (5) number of fuel cycles, if hybrid fuels are used in the core, and (6) fuel characteristics (addressing whether they are based on the beginning of the cycle, middle of the cycle, or end of the cycle). If a different decay heat model is used, describe the specific model and address the adequacy of the model and the analytical results.

In response, the licensee stated that Westinghouse Letter LTR-LIS-13-515, Rev. 0-A, Attachment 1, page 4 of 4, addresses this question and concludes that the values used for the requested parameters in the Westinghouse calculations that were performed using the ANS 5.1 1979 +2 sigma decay heat model bound initial condition 3.2.1.2(1) of NEI 12-06, Section 3.2.1.2. The decay heat curve used in the core cooling/condensate consumption calculation is provided in the Design Inputs Section 7.E of calculation CALC-MISC-11787. This curve is also based on ANS-5.1-1979+2-sigma and is consistent with the Dominion approved LOCA mass and energy release models used for design basis containment analyses.

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 page 6 and 7 the Integrated Plan the licensee listed the boundary conditions established to support development of FLEX strategies, and initial conditions and assumptions established for the purpose of defining FLEX strategies. The reviewer compared the listed boundary condition and the initial values for key plant parameters and assumptions to those listed in NEI 12-06 and determined that the licensee had included all of the relevant boundary conditions and key initial conditions and assumptions.

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 26, 27, 39, 40, 50, and 55 of the Integrated Plan, the licensee listed the installed instrumentation credited for FLEX coping strategies to include:

> <u>AFW Flowrate</u> - AFW flowrate indication is available in the main control room (MCR), and will initially be available for SG 'A', 'B', and 'C'. Following electrical load stripping, AFW flowrate indication will only be available to SG 'B'. Indication of SG 'A' wide range

(WR) and narrow range (NR) and ‘C’ NR water level would remain available. Following re-power of vital AC circuits, AFW flowrate indication will be restored for SG ‘A’ and ‘C’ throughout the event.

SG Water Level - SG WR and NR water level indication is available from the MCR for all SGs. SG NR level indication will always be available. SG WR level indication will be available only for SG 'A' following electrical load stripping. After re-power of vital AC circuits, SG 'B' and 'C' WR level indication will be restored.

SG Pressure - SG pressure indication is available from the MCR. SG pressure indication is available for SG ‘A’, ‘B’, and ‘C’ throughout the event.

RCS Temperature - RCS hot-leg and cold-leg temperature indication and core exit thermocouple indication is available from the MCR. Following electrical load stripping, RCS hot-leg and cold-leg temperature indication will only be available for ‘B’ loop. Following re-power of vital ac circuits, RCS hot-leg and cold-leg temperature indication will be restored for RC loop ’A’ and ‘C’.

ECST Level - ECST water level indication is available from the MCR prior to electrical load stripping. Following load stripping, level indication will be available locally at the tank via a float level gauge and local pressure gauge to be installed on the tank fill line.

Pressurizer Water Level - Pressurizer level indication is available from the MCR. Pressurizer level indication is available throughout the event.

Reactor Vessel Level Indication System - Reactor Vessel Level Indication System (RVLIS) indication is available from the MCR. RVLIS indication is available throughout the event.

Reactor Power Level – Excore nuclear instruments indication is available from the MCR throughout the event.

Containment Pressure Containment pressure indication is available in the MCR throughout the event.

SFP Water Level – SFP water level indication will be provided in accordance with the requirements of NRC Order EA-12-051. SFP water level indication will be available throughout the event.

During the review it was noted that SG level indications and AFW flow indication will not be available to all three SGs following load shed activities. During the NRC audit, the licensee was requested to describe the method for controlling RCS heat removal, AFW flow, SG level control, and include any configuration changes to TDAFW pump steam supply.

In response, the licensee stated that the FLEX strategy for reactor core cooling and decay heat removal will be accomplished by providing for steam release from, and the addition of a corresponding amount of feed water to, the SGs via the MS and AFW systems. The SG PORVs are used for SG steam release. The AFW system includes the ECST and the emergency condensate make-up tank (ECMT) for the water source. The TDAFW pump, which does not require electrical power for motive force or control, will be available and will be manually controlled for injection of feed water into the SGs.

The licensee's response continued stating that the TDAFW pump does not rely on ac or dc power, or on compressed air pressure, to function. The TDAFW pump turbine is supplied with motive steam through two parallel, normally closed air-operated valves. The valves fail open upon loss of dc power and fail as-is upon loss of compressed air pressure. DC power will be available at the initiation of the ELAP and these valves are expected to open as a result of the TDAFW pump start signal. The valves will remain open following ELAP DC load stripping and will not be cycled open/closed to control the TDAFW pump. During an ELAP, the TDAFW pump turbine steam flow will be controlled automatically by the governor valve or manually with the overspeed trip/throttle valve. Neither the TDAFW pump turbine governor valve nor the overspeed trip/throttle valve requires electrical power or compressed air to function.

The safety-related station batteries and inverters will initially provide power to vital bus ac for indication of RCS temperature, AFW flowrate, SG level and SG pressure in the MCR for directing core cooling. Indication of AFW flow rate, SG level and SG pressure will provide the necessary information for manually controlling AFW flowrate, including manual throttling of the AFW discharge header isolation valves, for proper AFW delivery to the SGs, and manually controlling steam flow using the SG PORVs to support RCS cool down.

The licensee further stated that load stripping will be directed by procedure to extend available battery life. The load stripping will commence approximately 45 minutes after start of ELAP and be completed approximately 30 minutes later. After load stripping, SG narrow range level indication will be available for all SGs and wide range level indication will be available for "A" SG. AFW flowrate indication will only be available to the 'B' SG. However, indirect indication of AFW flowrate will be available via the SG narrow range level indication for 'A', 'B' and 'C' SGs and SG wide range level indication for 'A' SG, which will allow operators to control AFW flowrate to maintain SG levels in the normal range. Following implementation of the strategy for re-powering of vital 120 VAC buses, the 'A' and 'C' AFW flowrate indication will be restored. Thus, for the duration of the dc battery life after load stripping (Phase 1), and during Phases 2 and 3 when the key instrumentation is repowered, operators would have adequate indication available for manual operation of the AFW system and the SG PORVs to provide core cooling and heat removal. The FLEX strategies do not include any configuration changes to the TDAFW pump steam supply.

Although not mentioned in the licensee's response above, based on information contained in the Integrated Plan, repowering of key instrumentation during Phase 2 would restore SG "B" and SG "C" WR level indication, further aiding the operators in controlling SG level.

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

3.2.1.6 Sequence of Events

NEI 12-06 discusses an event timeline and time constraints in several sections of the document, for example Section 1.3, Section 3.2.1.7 principle (4) and (6), Section 3.2.2 Guideline (1) and Section 12.1.

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

Each site should establish the minimum coping capabilities consistent with unit-specific evaluation of the potential impacts and responses to an ELAP and LUHS. In general, this coping can be thought of as occurring in three phases:

- Phase 1: Cope relying on installed plant equipment.

- Phase 2: Transition from installed plant equipment to on-site FLEX equipment.

- Phase 3: Obtain additional capability and redundancy from off-site equipment until power, water, and coolant injection systems are restored or commissioned.

The SOE is discussed on pages 8 through 14 and in Attachment 1A of the Integrated Plan. In the section for providing a sequence of events and time constraint required for success, including the technical basis for the time constraint, the licensee stated that preliminary estimates of response times have been developed based on plant simulator runs and table-top walkthroughs of planned actions. A two-hour duration is assumed for deployment of equipment from the BDB storage building based on a "sunny day" validation for implementation of 10 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 station discharge canal (staging location) and routing hoses to provide flow to the SFP. Time to clear debris to allow equipment deployment is assumed to be two hours. Debris removal equipment will be stored in the BDB storage building. Validation of estimated response times included in Attachment IA will be completed once FSGs have been developed and will include a staffing analysis. This is identified as Confirmatory Item 3.2.1.6.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 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 NRC staff reviewed the licensee's Integrated Plan and determined that the generic concern related to shutdown and refueling requirements is applicable to the plant. This generic concern has been resolved generically through the NRC endorsement of NEI position paper entitled "Shutdown/Refueling Modes" (ADAMS Accession No. ML13273A514); and has been endorsed by the NRC in a letter dated September 30, 2013 (ADAMS Accession No. ML13267A382).

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

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

3.2.1.8 Core Sub-Criticality

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

> All plants provide means to provide borated RCS makeup.

On page 38 of the Integrated Plan, the licensee stated that calculation MISC-11789, which documents a site-specific analysis of core reactivity following an ELAP/LUHS, concluded that for an RCS cooldown to conditions corresponding to the emergency procedure minimum SG pressure of 300 psig, no boration is required for the first 72 hours to maintain adequate shutdown margin (Keff < 0.99).

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

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

PWROG submitted a position paper, dated August 15, 2013 (withheld from public disclosure due to proprietary content), which provides test data regarding boric acid mixing under single-phase natural circulation conditions and outlined applicability conditions intended to ensure that boric acid addition and mixing would occur under conditions similar to those for which boric acid mixing data is available. In an endorsement letter dated January 8, 2014 (ADAMS Accession No. ML13276A183), the NRC staff concluded that the August 15, 2013, position paper constitutes an acceptable approach for addressing boric acid mixing under natural circulation during an ELAP event, provided that the following additional conditions are satisfied:

(1) The required timing for providing borated makeup to the primary system should consider conditions with no reactor coolant system leakage and with the highest applicable leakage rate for the reactor coolant pump seals and unidentified reactor coolant system leakage.

(2) For the condition associated with the highest applicable reactor coolant system leakage rate, two approaches have been identified, either of which is acceptable to the staff:

a. Adequate borated makeup should be provided such that the loop flow rate in two-phase natural circulation does not decrease below the loop flow rate corresponding to single-phase natural circulation.

b. If loop flow during two-phase natural circulation has decreased below the single-phase natural circulation flow rate, then the mixing of any borated primary makeup added to the reactor coolant system is not to be credited until one hour after the flow in all loops has been restored to a flow rate that is greater than or equal to the single-phase natural circulation flow rate.

(3) In all cases, credit for increases in the reactor coolant system boron concentration should be delayed to account for the mixing of the borated primary makeup with the reactor coolant system inventory. Provided that the flow in all loops is greater than or equal to the corresponding single-phase natural circulation flow rate, the staff considers a mixing delay period of one hour following the addition of the targeted quantity of boric acid to the reactor coolant system to be appropriate.

During the audit, the licensee informed the NRC staff of its intended actions and intent to abide by the generic approach discussed above prior to NRC endorsement with clarification. As such, the generic concern associated with modeling the timing and uniformity of boric acid mixing within the RCS under natural circulation conditions potentially involving two-phase flow requires resolution in terms of whether the licensee (1) commits to abide by the generic approach discussed above, including the additional conditions specified in the NRC's endorsement letter, or (2) identifies an acceptable alternate approach for justifying the boric acid mixing assumptions in the analyses supporting its mitigating strategy. As such, resolution of this concern is identified as Open Item 3.2.1.8.A in Section 4.1.

On page 25 of the Integrated Plan the licensee stated that minimum SG pressure is established to prevent safety injection accumulator nitrogen gas from entering the RCS. During the NRC audit, the licensee was requested to identify and discuss what controls will be utilized to accomplish this.

In response, the licensee stated that the ELAP response is consistent with the PWROG Core Cooling Management Interim Position Paper with respect to the methodology for preventing nitrogen injection from accumulators during an ELAP event. From the position paper:

> The current Westinghouse NSSS SBO EOPs use SG pressure as a parameter to prevent CLA nitrogen injection into the RCS. The Westinghouse methodology used to develop the target SG pressure contains uncertainties to provide margin against nitrogen injection from the CLAs. These uncertainties include maximum initial CLA pressure, minimum initial CLA water level, operating margin, and the effects of containment heat-up as discussed in ERG DW 06-014.

Specifically, the EOP setpoint used in ECA-0.0, Loss of All AC Power, was revised in March 2008 to implement the guidance in ERG DW 06-014. SG pressure is the indication monitored to ensure nitrogen injection does not occur during the 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 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.

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 28 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 TDAFW pump is unavailable.

On pages 3 and 4 of the Six-Month Status 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. 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. Two BDB RCS injection pumps for use in the RCS injection strategy will be stored in the BDB storage building.

As described above, the licensee will only provide two RCS injection pumps for implementing the Phase 2 RCS injection strategy. During the NRC audit, the licensee was requested to explain how they meet the N+1 guidance provided in NEI 12-06, paragraph following Section 3.2.2(15), for FLEX equipment reliability and availability with only two RCS injection pumps.

In response, the licensee stated that regarding the number of BDB RCS Injection pumps, if one of the two pumps stored in the on-site BDB storage building is inoperable, the operable pump may be used to supply RCS inventory makeup to both units by alternating RCS injection between the units. RCS injection would begin with the BDB RCS Injection pump supplying makeup to the unit with the indicated leakage for approximately 1 hour. Then the pump would be used to supply makeup to the opposite unit for 1 hour. The alternating RCS injection process would be repeated until RCS level was indicated in the pressurizer(s), or until approximately 28 hours at which time a replacement RCS Injection pump could be received from the RRC and deployed for RCS makeup for one of the two units.

In order for the licensee approach to be considered in conformance with the N+1 guidance of NEI 12-06, there would need to be supporting analysis to show that intermittent RCS injection by alternating between units is adequate using only one RCS injection pump. This is identified as Confirmatory Item 3.2 1.9.A in Section 4.2 below.

During the NRC audit, the licensee was requested to provide a summary of the calculations that determined the BDB high capacity pump can provide sufficient flow to provide 300 gpm of AFW to each unit and 500 gpm to SFP simultaneously. The licensee was requested to include a discussion of pump line losses to primary and secondary injection points and the affects of changing the RCS injection strategy to provide RCS makeup during phase 2.

In response, the licensee stated that as described in the Integrated Plan Section B.2, the BDB high capacity pump will be sized to deliver flow to the SFP makeup connection and to the suctions of both units' BDB AFW pumps simultaneously. Preliminary hydraulic analyses of the BDB high capacity pump / BDB AFW pump / SFP makeup connection and the associated hoses and installed piping systems indicate that the BDB high capacity pump capabilities exceed the FLEX strategy requirements for AFW supply (300 gpm to each unit) and SFP makeup (500 gpm to the dual unit SFP) simultaneously, flowing to either the primary or alternate (secondary) injection points. The BDB high capacity pump / BDB AFW pump / SFP makeup hose network is shown on Figures 1 (BDB Mechanical Equipment and Hose Layout) and 2 (BDB FLEX Strategy Primary Mechanical Connections) of the Integrated Plan. The final calculation for the hydraulic analysis of the BDB high capacity pump / BDB AFW pump / SFP makeup connection and the associated hoses and installed piping systems will be made available for NRC review when completed. The BDB high capacity pump does not supply flow to support the RCS inventory makeup strategy, therefore there is no change to the BDB high capacity pump discharge flowpath due to the changing strategy to provide RCS makeup during phase 2. Review of the final hydraulic analysis is identified 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 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 SFP cooling piping or other alternate location capable of exceeding the boil-off rate for the design basis heat load; and alternatively 3) spray via portable monitor nozzles from the refueling deck/floor capable of providing a minimum of 200 gallons per minute (gpm) per unit (250 gpm to account for overspray). This approach will also provide a vent pathway for steam and condensate from the SFP.

As described in NEI 12-06, Section 3.2.1.7 and JLD-ISG-2012-01, Section 2.1, strategies that have a time constraint to be successful should be identified and a basis provided that the time can be reasonably met. NEI 12-06, Section 3 provides the performance attributes, general criteria, and baseline assumptions to be used in developing the technical basis for the time constraints. Since the event is a beyond-design-basis event, the analysis used to provide the technical basis for time constraints for the mitigation strategies may use nominal initial values (without uncertainties) for plant parameters, and best-estimate physics data. All equipment used for consequence mitigation may assume to operate at nominal setpoints and capacities. NEI 12-06, Section 3.2.1.2 describes the initial plant conditions for the at-power mode of operation; Section 3.2.1.3 describes the initial conditions; and Section 3.2.1.6 describes SFP 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 55 of the Integrated Plan, the licensee stated that following the occurrence of an ELAP/LUHS event, normal SFP cooling capability is lost which, in the long term, can result in SFP boiling and loss of SFP level for adequate spent fuel cooling. Conservative analysis has shown that, based on the limiting fuel storage scenario resulting in maximum design heat load, with no operator action, the SFP will reach 212°F in approximately 12 hours and boil off to a level 10 feet above the top of fuel in approximately 51 hours from initiation of the event. Based on the extended time available for action to supplement SFP cooling, the Phase 1 coping strategy is to monitor SFP level, using instrumentation to be installed as required by NRC Order EA-12-051.

On pages 57 and 58 of the Integrated Plan, the licensee stated that the primary strategy for SFP cooling is to utilize the BDB high capacity pump to provide makeup water flow to the pool. The BDB high capacity pump will provide SFP makeup capability of up to 500 gpm, which exceeds the calculated boil-off rate of 78 gpm. The BDB high capacity pump will draw water from the station discharge canal and discharge to the pool through a flexible hose connected to the pre-installed SFP makeup connection installed outside the fuel building. The flowpath is through the existing fire protection system emergency SFP fill line inside the fuel building, which provides flow directly into the pool. The alternate strategy is to use the BDB high capacity pump to provide the water source to pressurize the fire main from the station discharge canal through a flexible hose connected to a hydrant in the yard. The flowpath for SFP make-up would be through the existing fire protection system emergency SFP fill line, which provides flow directly into the pool. Additional capability for SFP makeup utilizes methods developed for compliance with 10 CFR 50.54(hh)(2) where the BDB high capacity pump would provide flow from the discharge canal through portable spray nozzles that will be set-up on the deck near the SFP, or through a flexible hose that will be routed over the edge of the pool. The staging of equipment within the fuel building can be accomplished before the SFP area becomes inaccessible since pool boiling is not anticipated until after 12 hours and fuel building access is expected to be available for a considerable time after boiling begins. Hydraulic analysis of the flowpaths from the station discharge canal to the SFP for each of the makeup methods described above will be performed to confirm that applicable performance requirements are met. Review of the hydraulic analysis was previously identified as Confirmatory Item 3.2.1.9.B in Section 4.2 below.

On page 58 of the Integrated Plan, the licensee stated that a vent pathway for removal of steam and condensate from the SFP area is required as steam from pool boiling can condense and cause access and equipment problems in other parts of the plant. 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.

On page 63 of the Integrated Plan, the licensee stated that a separate Phase 3 strategy is not required to maintain SFP cooling. However, the Phase 2 SFP makeup strategies will be maintained using offsite pumps if the onsite portable pumps fail.

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

3.2.3 Containment Functions Strategies

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

On page 50 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 monitor containment pressure using installed instrumentation. Evaluations have been performed and conclude that containment temperature and pressure will remain below design limits and key parameter instruments subject to containment environment will remain functional for at least 7 days. Therefore, actions to reduce containment temperature and pressure and ensure continued functionality of the key parameters will not be required prior to this time and will utilize off-site equipment and resources during Phase 3. Calculation MISC-11793, "Evaluation of Long Term Containment Pressure and Temperature Profiles Following Loss of Extended AC Power (ELAP)" utilized GOTHIC version 7.2a to perform the calculation. Assumptions included in the calculation is standard Westinghouse RCP seal leakage of 21 gpm per pump, plus 1 gpm unidentified leakage, for a total leakage of 64 gpm post ELAP. Calculation MISC-11794, "Evaluation of North Anna, Surry, and Millstone Containment Instrumentation Following Extended Loss of AC (ELAP)" utilized Environmental Qualification Management System (EQMS), version 3.0 to perform the calculation. Results of this calculation confirm use of the containment pressure instrumentation for at least 7 days following and ELAP event.

On page 50 of the Integrated Plan in regards to containment pressure indication, the licensee stated that containment pressure indication is available in the MCR throughout the event.

On page 54 of the Integrated Plan, the licensee stated that further analysis is required to determine the strategy and time requirements for actions beyond seven days to reduce containment pressure and temperature, if any. 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. Review of the containment analysis and Phase 3 coping strategy for beyond 7 days is identified as Confirmatory Item 3.2.3.A in Section 4.2 below.

During the review, it was noted that there are no instruments specified in the Integrated Plan, which will provide the operators with the temperature inside the containment. Excessive temperatures could result in a loss of containment integrity due to the failure of containment penetration seals or other portions of the containment boundary. Furthermore, excessive temperatures could result in the failure of necessary measurement instruments located in the containment. During the NRC audit, the licensee was requested to provide a discussion and the technical basis for concluding that the temperature inside containment will not need to be monitored to inform the operators of the potential to exceed the limits of penetration seals or other equipment.

In response, the licensee stated that as indicated in section 5.1.2 of ETE-CPR-2012-0011, the long term containment pressure and temperature analysis have been documented in calculation MISC-11793. The calculation documents the long-term pressure and temperature profiles for the initial 7 days of the post ELAP scenario and at the end of 7 days the containment pressure and temperature are calculated to be 23.02 psia and 193.4 °F, respectively. This pressure and temperature are well below the containment design pressure of 45 psig and design basis equipment environmental qualification (EEQ) limits as documented in the calculation. A containment response analysis has been performed utilizing the same approved GOTHIC licensing model and methodology that was used for FSAR Chapter 14 containment integrity analysis. The Dominion containment analysis methodology is documented in topical report DOM-NAF-3-0.0-P-A. This topical report describes the assumptions to be used and the mathematical formulations employed for containment integrity analysis for all Dominion fleet. The NRC has approved the use of the GOTHIC code and the analysis methodology described in this topical report in a letter dated August 30, 2006. To address instrument qualification, the 7 days post ELAP long-term containment harsh environment profiles generated by GOTHIC were used to evaluate the safety significance of the long-term exposure of the credited electrical instruments inside the containment. The base line evaluations used an Arrhenius methodology, utilizing the plant design basis profile, to demonstrate the survivability of the instruments that are relied upon for effective implementation of various long term FLEX coping strategies and is documented in Dominion Calculation SM-11794. The details of the long term containment monitoring, cooldown and depressurization strategy are still under development. Detailed GOTHIC analysis will be performed to document and validate the final strategy and also to provide operators with timelines and guidelines for actions to ensure the long-term integrity of the containment throughout the postulated ELAP/LUHS event. The results will be provided in the February 2014, Six-Month Update. This has been included with 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 functions strategies, if these requirements are implemented as described.

3.2.4 Support Functions

3.2.4.1 Equipment Cooling – Cooling Water

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

> *Plant procedures/guidance should specify actions necessary to assure that equipment functionality can be maintained (including support systems or*

alternate method) in an ELAP/LUHS or can perform without ac power or normal access to the UHS.

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

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

The licensee's Integrated Plan did not address the need for additional strategies that would be needed to provide cooling functions for permanent equipment used to support FLEX strategies. During the NRC audit the licensee was requested to provide a discussion as to whether equipment functionality can be maintained in regards to cooling functions for permanent equipment used to support FLEX strategies.

In response, the licensee stated that permanently installed plant equipment used to support core cooling and heat removal, RCS inventory control, and SFP cooling FLEX strategies do not require cooling support systems, such as component cooling water and service water, 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 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 95 of the Integrated Plan, the licensee stated that the FLEX strategies for maintenance and/or support of safety functions include ensuring that ventilation, heating, and cooling is adequate to maintain acceptable environmental conditions for equipment operation. Details of the ventilation strategy are 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 NRC 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 hi and low temperatures and to prevent hydrogen accumulation while recharging the batteries.

In response, the licensee stated that during Phase 1 the batteries will be load stripped within 75 minutes from the initiation of the ELAP event in order to provide for a 14 hour Phase 1 battery life. Thus, the Phase 1 battery room heat addition load is negligible. The four battery rooms (two per unit) are rooms with concrete walls partitioned out of the control room (CR) envelope in the Emergency Switch Gear Rooms (ESGR). Calculation ME-0973, Rev 0, "Evaluation of Room Air Temperatures Following Extended Loss of AC Power (ELAP)," shows that for the loss of ventilation transient, the temperatures in the ESGR are expected to remain below 120 °F. While the battery rooms are not explicitly modeled in the loss of ventilation transient analysis model, the temperatures in the battery rooms are anticipated to be approximately the same as those of the ESGR during Phase 1 and Phase 2. The FSG procedures for Phase 2 will require ventilation to the battery rooms to be established prior to starting the battery chargers, which are powered by the portable 480 VAC diesel generators. The access doors to each battery room will be opened and portable fans used to provide temporary ventilation in the battery rooms if the normal exhaust path and fan are not available. Therefore, the Phase 2 conditions in the battery rooms would be acceptable indefinitely. The impact of extreme low temperatures is not expected to be significant due to the continuous connection of the battery rooms 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.

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.

The licensee did not address the loss of heat tracing in the Integrated Plan. The licensee screened in for extreme cold, ice and snow and thus there is a need for the licensee to address loss of heat tracing affects on FLEX strategies in its integrated plan. During the NRC 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, the licensee stated that heat trace is used to maintain highly concentrated soluble boron solutions above the temperature where the soluble boron will precipitate out of solution, and to protect piping systems and components from freezing in extreme cold weather conditions. FLEX strategies do not depend on highly concentrated soluble boron solutions. RCS Injection will use borated water sources with boron solutions below the concentration where boron precipitation is expected to occur. FSGs will provide this guidance as well as guidance for mixing borated water, if necessary. FLEX strategies have also been developed to protect piping systems and components from freezing. Commercially available heat tape and insulation rolls 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. 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 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. FLEX Strategies for the mixing of borated water in the portable boric acid batch tanks includes equipment such as an agitator and a tank heater. These components are provided to facilitate complete dissolution of the boric acid crystals. FLEX Strategies will provide guidance for mixing to maintain concentrations below the solubility limit corresponding to freezing temperatures. This will ensure that boron precipitation during an extreme cold event is not challenged.

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.

<u>Lighting</u>

On page 81 of the Integrated Plan, regarding lighting support for the initial phase, the licensee stated that the FLEX strategies for maintenance and/or support of safety functions include maintaining sufficient lighting in areas needed to successfully implement the planned FLEX strategies. Surry initially relies on emergency lighting installed for fire protection (FP)/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 100% 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, and will be identified in the FSGs. A lighting study will be performed to validate the adequacy of existing lighting and the adequacy and practicality of using portable lighting to perform FLEX strategy actions.

On page 83 of the Integrated Plan, regarding lighting support for the transition phase, the licensee stated that in addition to the Phase 1 methods for lighting, the use of supplemental lights will be available as stored BDB equipment. This includes additional small portable sources (such as flashlights and head lamps) for personal uses, as well as larger portable equipment (such as 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. In addition, power can be restored to various lighting panels in the electrical distribution system.

Communication

The NRC staff has reviewed the licensee communications assessment (ADAMS Accession Nos. ML12307A030 and ML13058A041) in response to the March 12, 2012 50.54(f) request for information letter for Surry and, as documented in the staff analysis (ADAMS Accession No. ML13189A155) 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. Confirmation of the proposed communications enhancements has been identified as Confirmatory Item 3.2.4.4.A in Section 4.2 below.

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

3.2.4.5 Protected and Internal Locked Area Access

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

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

On page 101 of the Integrated Plan, the licensee stated that the FLEX strategies for maintenance and/or support of safety functions involves the ability to access site areas required for successful implementation of the planned FLEX strategy. Potential impairments to required access include 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. Barrier functions, other than security doors and gates, include fire, flood, radiation, ventilation, tornado, and 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. This violation of normal administrative controls is acknowledged and is acceptable during the implementation of FLEX coping strategies.

The licensee further stated that 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 access to protected and internal locked areas, if these requirements are implemented as described.

3.2.4.6 Personnel Habitability – Elevated Temperature

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

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

Section 9.2 of NEI 12-06 states,

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

SFP accessibility was discussed in Section 3.2.2 above under SFP cooling strategies.

On page 95 of the Integrated Plan, the licensee stated that the FLEX strategies for maintenance and/or support of safety functions include ensuring that ventilation, heating, and cooling is adequate to maintain acceptable environmental conditions for personnel habitability. Details of the ventilation strategy are under development and will conform to the guidance given in NEI 12-06 and will be provided at a later date. This is identified as Confirmatory Item 3.2.4.6.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, if these requirements are implemented as described.

3.2.4.7 Water Sources.

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

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

In various sections of the Integrated Plan, the licensee addressed water sources for coping strategies for RCS core cooling and heat removal, RCS inventory control, and SFP cooling. Makeup flow is immediately established to the SG during the initial phase of the ELAP strategies.

On page 25 of the Integrated Plan and as updated by the April 30, 2013, Supplement to the Integrated Plan, the licensee stated that initially, AFW water supply will be provided by the installed ECST. The tank has a minimum usable capacity of 96,000 gallons and will provide a suction source to the TDAFW pump for a minimum of 5 hours of RCS decay heat removal assuming a concurrent RCS cooldown at 100°F/hr to a minimum SG pressure of 300 psig. After depletion of the inventory in the ECST, the TDAFW pump suction will be aligned to the installed ECMT, which provides an additional 72,000 gallons of water for SG injection. The water volume from the ECMT extends the time to depletion of AFW water supply to a minimum of 14.2 hours. Since ac power will not be available to support operation of the installed AFW booster pumps, water will be provided to the suction of the TDAFW pumps from the ECMT by gravity flow initially and through limited suction lift capability of the TDAFW pump as the tank level decreases.

On page 28 of the Integrated Plan, the licensee stated that for the transition phase strategy, an 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 the station circulating water discharge canal by use of the BDB high capacity pump taking suction from the discharge canal. The discharge canal communicates directly with the James River and will remain available for any of the applicable external hazards. A suction hose will be routed from the pump suction to the discharge canal 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. On page 36 of the Integrated Plan, the licensee stated that additional pumps will be provided from the RRC to be used as backups for the BDB high capacity pumps and the BDB AFW pumps.

On page 26 and 30 of the Integrated Plan and on page 3 of the six-month Update to the Integrated Plan, the licensee identified a number of modifications that were necessary to support strategy implementation for RCS cooling and heat removal. The modifications included the following:

> (1) The SG PORVs will be modified to add a protected backup air bottle system, which will be installed in the main steam valve house AFW pump room. Local manual operation of the SG PORVs using the protected backup air bottle system will continue to allow control of RCS cooldown to support the reactor core cooling and heat removal Phase 1 strategy.
>
> (2) The TDAFW discharge piping will be modified to install local AFW flowrate indication. This modification will allow local control of the TDAFW pump flowrate to support operation with suction aligned to the ECMT and extend the time to align alternate water sources.
>
> (3) A pressure gauge will be installed on the ECST fill line for local indication of ECST level to support operation of the TDAFW pump while aligned to the ECST and refill of the tank.
>
> (4) BDB ECST refill connection will be installed
>
> (5) BDB AFW Pump discharge primary connection located on the TDAFW pump discharge line in the AFW Pump Room will be installed.

During the NRC audit the licensee was requested to provide an update on the evaluation of whether there is adequate TDAFW pump net positive suction head (NPSH) from the ECMT through the idle AFW booster pump.

In response the licensee stated that adequate TDAFW pump NPSH from the ECMT through the idle AFW booster pump has been confirmed by the conservative analysis used in calculation ME-0963, "NPSH Analysis for the TD AFW Pump Taking Suction from the Emergency Condensate Makeup Tank (ECMT) Through Idle AFW Booster Pumps."

During the NRC audit, the licensee was requested to discuss how ECST level will be monitored to ensure transition to the next available water supply before the pump runs out of water, since ECST level indication will be lost in the control room and there is only a few hours of water supply available from the ECST.

In response, the licensee stated that the ECST level indication will be available in the MCR until dc bus load stripping occurs. At that point, procedures will direct monitoring of the local float level detector(s) on the ECST, and the local pressure indication provided on the ECST outlet piping for additional indirect tank level indication. Upon the occurrence of an ELAP, operators will be dispatched to the Main Steam Valve House (MSVH) to control AFW flowrate to prevent SG overfill, and control SG steam flow to initiate a RCS cooldown. The ECST and associated local level indications are in close proximity to the MSVH such that these same operators will be available to monitor ECST level. Indirect indication of ECST level is provided by the TDAFW pump suction pressure gauge in the MSVH, which will serve to alert the operators to a low level condition in the ECST and the need to begin to directly monitor level locally at the ECST. Additionally, the ELAP event time line, which includes anticipated ECST draw down time, will be available in the procedures such that operators will be able to predict low levels in the ECST.

During the NRC audit the licensee was requested to discuss the impact of injecting raw water through the main feedwater header on the "J" nozzles inside the SGs and include any filtering requirements.

In response, the licensee stated that the injection of raw water from the discharge canal, following depletion of the ECST and the ECMT, will not affect the SG feedwater ring J-nozzles. The J-nozzles are fabricated from erosion resistant material (Inconel) and are of sufficient internal diameter to prevent blockage. The BDB high capacity pump, drawing raw water from the discharge canal, includes strainers to prevent downstream pump damage, flow blockage, and excessive sediment or debris accumulation. Although the discharge canal is the ultimate credited source of AFW supply because the discharge canal will be available for all considered extreme events, other site water sources are preferred, if available, and include the normal CSTs, the main condenser hotwell, and the FP system water storage tanks, which would provide a clean source of fresh water for SG injection.

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

3.2.4.8 Electrical Power Sources/Isolations and Interactions.

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

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

The licensee's Integrated Plan, as modified by the 6-month update to the Integrated Plan, utilizes one 120/240 VAC DG/unit as the primary strategy for re-powering the vital 120 VAC circuits to provide key parameter monitoring instrumentation during the transitions phase. The alternate strategy utilizes one 480 VAC DG/unit connected to the Class 1E 480 VAC bus. The 480 VAC DG would allow for recharging the Class 1E 125 VDC batteries and restoration of other ac loads in addition to the key parameter monitoring instrumentation

For the final phase utilizing off-site resources, the licensee relies on two 4160 V portable DGs to provide power to either of the two Class IE 4160 VAC buses on each unit. The final performance criteria for the DG will be determined by an electrical loading analysis performed in accordance with the design process.

The licensee's Integrated Plan did not discuss electrical isolation and interactions to demonstrate how the portable DGs are isolated to prevent simultaneously supplying power to the same Class 1E bus from different sources. During the NRC audit, the licensee was requested to describe how electrical isolation would 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 to the request, the licensee stated that for item (a), 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 1E buses in accordance with the approved license basis for each unit. FSGs provide guidance for energizing a Class 1E bus using portable generators consistent with NEI 12-06, Section 3.2.2. The BDB portable DGs will be used only when the Class 1E DGs have been isolated. Each of the BDB portable DGs 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. Existing protection relaying protects class 1E equipment and the FLEX strategy does not change any existing equipment protection scheme.

The licensee further stated that for item (b) 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 BDB portable DGs which are connected to the emergency bus for the 4160 VAC tie-in and to permanently installed receptacles for the 480 VAC tie-in.

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

In response to the request, the licensee stated that calculation EE-0864, Rev.1 "Calculation for Flex Electrical 480 VAC and 120 VAC System Loading Analysis for SPS BDB Flex DCU SU-13-01019-003" provide the basis for the sizing of the Phase 2 portable BDB DGs. For Unit 1, the total loads for the 120 VAC and 480 VAC DGs are 15.4 kW and 196.2 kW, respectively. For Unit 2, the total loads for the 120 VAC and 480 VAC are 15.4 kW and 196.2 kW, respectively. The sizes of the 120 VAC and 480 VAC BDB DGs are 37 kW and 350 kW, respectively. Additional details for the individual 120 VAC and 480 VAC loads are provided in Attachment 13.1 of the Calculation EE-0864. A summary of the Phase 2 (120 VAC and 480 VAC) loads used to size the BDB portable generators are available on the Dominion ePortal.

The Phase 3 4160 VAC BDB DG loading analysis has not been finalized. Preliminary results indicate that the total loads will be approximately 1.3 MW for either unit. Therefore, one 2 MW portable DG per unit, that will be available from the RRC, will be more than adequate for the total loads required for that unit.

Confirmation that the final loading analysis for 4160 VAC DGs has been completed and reviewed by the staff to confirm that 2MW portable DGs are adequate to supply loads assumed in Phase 3 is identified as Confirmatory Item 3.2.4.8 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 issue related to the Confirmatory Item, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to electrical power sources/isolations and interactions, if these requirements are implemented as described.

3.2.4.9 Portable Equipment Fuel.

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

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

NEI 12-06, Section 3.2.1.3, 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 74 of the Integrated Plan regarding safety function support (fuel) in the initial phase, the licensee stated that the general coping strategy for supplying fuel oil to diesel driven portable equipment, i.e., pumps and generators, being utilized to cope with an ELAP/LUHS, is to draw fuel oil out of any available existing diesel fuel oil tanks on site.

On page 75 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 wall tanks and base tanks. The three diesel fuel oil wall tanks contain 550 gallons of fuel each (a total of 1650 gallons) and are seismically designed and housed in the tornado protected EDG rooms. Fuel can be obtained using the tank drain valve by gravity feed to suitable fuel containers for transport to BDB equipment. Each of the three EDGs also includes a 550-gallon base tank (a total of an additional 1650 gallons). These base tanks are also seismically designed and missile protected. Fuel can be obtained using a cart mounted, 12 VDC fuel pump to draw fuel from the base tank. Therefore, with two 550-gallon fuel oil tanks in each of three EDG rooms, a combined total of 3300 gallons of fuel oil is available.

The licensee further stated that a secondary source for fuel oil will be the two EDG underground diesel fuel oil storage tanks. Each tank has a 17,500-gallon capacity. These tanks are protected from high wind/tornado missiles by virtue of the underground location and are also protected from seismic and flooding events. Fuel can be obtained using a cart mounted, 12 VDC fuel pump and attaching the pump suction to any of the six (6) EDG fuel transfer pump suction strainer drain valves and pumping the fuel oil to suitable fuel containers for transport. Fuel transfer carts and pumps are stored in the BDB storage building.

It is not clear if the cited tank volumes (EDG fuel oil wall tanks and base tanks, and EDG underground diesel fuel oil storage tanks) are the tank capacities or the minimum volume controlled by technical specifications. However, the cited volumes indicate a considerable amount of diesel fuel available to support portable equipment operations and the procedure guidance governing re-fueling strategies are considered adequate to monitor fuel supplies and initiate refueling activities prior to equipment shutdown.

On pages 75, 76 and 77 of the Integrated Plan, the licensee stated that 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 equipment shutdown. The specifications for local instrumentation for portable diesel powered BDB equipment will include fuel gauges. Monitoring of fuel supplies and consumption in order to initiate refueling activities prior to equipment shutdown will be performed.

On page 79 of the Integrated Plan, the licensee stated that an evaluation of all BDB equipment fuel consumption and required re-fill strategies will be developed and will include Phase 3 equipment including any gasoline required for small miscellaneous equipment. The fuel strategy will evaluate the need for additional fuel required from the RRC or other offsite sources.

The licensee's approach described above, as currently understood, is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to 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 1 of 2 of the Integrated Plan Supplement dated April 30, 2013, the licensee stated that he completed analyses of the Class 1E station emergency battery life determined an increase in extended battery life from the original 14 hours to 20 hours for both Surry Units 1 and 2. This provides additional time to setup and engage Phase 2 BOB equipment as part of the long-term coping strategy.

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

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

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

The NRC staff concluded that the position paper provides an acceptable approach for licensees to use in demonstrating that vented lead-acid batteries can be credited for durations longer than 8 hours. The NRC staff will evaluate a licensee's application of the guidance (calculations and supporting data) in its development of the final Safety Evaluation documenting review of the licensee's Integrated Plan.

At the time the audit was conducted, the licensee had neither (1) committed to abide by the generic approach discussed above, nor (2) identified an acceptable alternate approach for justifying the battery usage for greater than 8 hours in supporting its mitigating strategy. As such, resolution of this concern for Surry is identified as Open Item 3.2.4.10.A in Section 4.1.

During the NRC 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 from Calculation EE-0046, Rev. 2, Addendum D, "125V DC System Analysis", the following duty cycles from Section 10.2 of the calculation have been evaluated using IEEE-485-2010 battery sizing methodology.

Unit 1 Batteries (cross-tied at T=45 min)
0-1 min 1-60 min 60-75 min >75min
937.81A 230A 140.5A 51A

Unit 2 Batteries (cross-tied at T=45 min)
0-1 min 1-60 min 60-75 min >75min
952.36A 230A 139.5A 49A

Specific loads for BDB mitigating strategies are provided in Section 7 "Design Input" and Section 10 of the calculation. The battery sizing spreadsheets for Unit 1 are included in Attachment 15.6 and the Unit 2 sizing spreadsheets are included in Attachment 15.7. An end voltage of 1.78VDC final per cell (106.8V for 60 cells) has been used to conservatively build in margin to address industry operating experience for battery connection degradation.

During the NRC 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. The licensee was further requested to explain which functions are lost as a result of shedding each load and discuss any impact on defense in depth and redundancy.

In response, the licensee stated that there are two (2) vital 125 VDC buses supplied by Class 1E emergency batteries per unit, with associated dc bus distribution panels located in the unit's ESGR at elevation 9' 6", directly below the MCR elevation at elevation 27'. The ESGR has multiple access points including via a stairwell from the MCR and an access point from elevation 9' 6" in the TB. The ESGR is a part of the MCR pressure envelope. This provides reasonable assurance that the 125 VDC panels will remain accessible during an ELAP/LUHS event. Additionally, there is a 125 VDC subpanel associated with each 125 VDC bus located in the MCR. The two (2) dc buses each provide power to two (2) vital bus inverters, which power the 120 VAC vital buses. There are four (4) 120 VAC vital buses per unit, each with two distribution panels. The associated distribution panels are located in the MCR and in the ESGR. All loads will be stripped from the dc buses with the exception of one (1) vital bus inverter per unit. Tables 1A, 1B, and 2 through 9 are included on the ePortal and available for review. These tables identify the dc loads that will be stripped and the basis for stripping the load. Selected 120 VAC vital bus loads will also be stripped to extend the emergency battery life. Tables 2 through 9 identify the loads being stripped from the 120 VAC vital buses and the basis for stripping the load. Tables are provided for Unit 1 only and are typical for Unit 2.

The licensee further stated that in response to an ELAP, an operator will be dispatched from the MCR to perform vital 125 VDC and 120 VAC bus load stripping per the guidance in FSG-4, "ELAP DC Bus Load Shed and Management." Load stripping will be initiated within 45 minutes following initiation of the event and is expected to take 30 minutes, such that all loads will be stripped within 75 minutes. The panels are readily accessible based on the close proximity to the normal duty station for the operator assigned this action and load stripping is an uncomplicated task requiring opening the distribution panel door and opening the specified breakers. Therefore, completing the load stripping action within 30 minutes is reasonable, and the 75 minutes time constraint can be met. 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. Therefore, instrument redundancy is not a requirement for the key parameter indications that remain available after load stripping has been performed. In addition, defense in depth may be limited due to preference for extending battery life during the time period between load stripping and implementation of the 120 VAC re-power strategy described in the Integrated Plan.

During the NRC 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.

The basis for the final 1E battery terminal voltage is the design minimum voltage per cell given in the Surry stationary battery specification NUS-2060. NUS-2060, Section 2.1.3, "General Technical Requirements" states the minimum voltage per cell for a Class 1E battery is 1.75 VDC per cell. Since Surry utilizes 60 cell safety related batteries for both nuclear units, the final Class 1E battery terminal voltage is 105 VDC (60 x 1.75VDC). Regarding the end-device terminal voltage analysis, the existing calculation 07797.06-E-001, "125 VDC Voltage Drop

Calculation for Selected Safety Related and Non-Safety Related Components," is critical in that it is used to support design basis requirements. Specifically, it calculates the component terminal voltage of the components connected to the 125VDC system in order to assure adequate voltage is available to actuate the components even with more demanding (i.e. higher loaded) design basis accident duty cycle, where feeder cables have higher voltage drops. Calculation EE-0046, Rev. 2, Addendum D, "125V DC System Analysis," Attachment 15.6, for Unit 1 and Attachment 15.7, for Unit 2 contain the battery sizing spreadsheets from IEEE 485-2010 for the BDB case. The methodology in IEEE-485 was the preferred method for determining the capability of the main station batteries to sustain the BDB phase 1 loads.

During the NRC audit, the licensee was requested to discuss which components change state when loads are shed and actions needed to mitigate resultant hazards (for example, allowing hydrogen release from the main generator, disabling credited equipment via interlocks, etc.).

In response, the licensee stated that upon a loss of power, safety related components are designed to fail to their "safe" condition. During the dc load stripping evolution, the components and circuits that are de-energized will not change state in a manner that results in a plant transient or safety hazard. Procedure ECA-0.0 directs operations to verify that containment isolation valves have closed. If they have not, the operator is directed to either close them from the control board or close them locally at the valve. Additionally, the turbine seal oil backup pumps and dc emergency oil pumps are powered from a separate station "Black" battery, which is not impacted by load stripping activities. This battery is not included in the load stripping strategy, nor is it required for any other plant safety systems. This battery is designed to provide the necessary turbine-generator loads for 2 hours after a loss of power event. Procedure ECA-0.0 directs the operators to vent the hydrogen off the main turbine-generator prior to securing these pumps.

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

3.3 PROGRAMMATIC CONTROLS

3.3.1 Equipment Maintenance and Testing

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

> In order to assure reliability and availability of the FLEX equipment required to meet these capabilities, the site should have sufficient equipment to address all functions at all units on-site, plus one additional spare, i.e., an N+1 capability, where "N" is the number of units on-site. Thus, a two-unit site would nominally have at least three portable pumps, three sets of portable ac/dc power supplies, three sets of hoses & cables, etc. It is also acceptable to have a single resource that is sized to support the required functions for multiple units at a site (e.g., a single pump capable of all water supply functions for a dual unit site). In this case, the N+1 could simply involve a second pump of equivalent capability. In addition, it is also acceptable to have multiple strategies to accomplish a function (e.g., two separate means to repower instrumentation). In this case the equipment associated with each strategy does not require N+1. The existing

50.54(hh)(2) pump and supplies can be counted toward the N+1, provided it meets the functional and storage requirements outlined in this guide. The N+1 capability applies to the portable FLEX equipment described in Tables 3-1 and 3-2 (i.e., that equipment that directly supports maintenance of the key safety functions). Other FLEX support equipment only requires an N capability.

NEI 12-06, Section 11.5 states:

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

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

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

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

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

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

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

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

[1] Testing includes surveillances, inspections, etc.

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 NRC staff reviewed the licensee's Integrated Plan and determined that the Generic concern related to maintenance and testing of FLEX equipment is applicable to the plant. This Generic concern has been resolved generically through the NRC endorsement of the EPRI technical report on preventive maintenance of FLEX equipment, submitted by NEI by letter dated October 3, 2013 (ADAMS Accession No. ML13276A573). The NRC staff's endorsement letter is dated October 7, 2013 (ADAMS Accession No. ML13276A224).

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

During the NRC audit, the licensee stated that the EPRI Templates will be used for most equipment. However, in the event 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 20 of the Integrated Plan, the licensee stated that for configuration control, the FLEX strategies and their bases will be maintained in an overall program document. The program document will address the key safety functions to: a) provide reactor core cooling and heat removal; b) provide RCS inventory and reactivity control; c) ensure containment integrity; d) provide spent fuel pool cooling; e) provide indication of key parameters; and f) provide reactor core cooling (shutdown modes). In addition to the key safety functions, support functions have been identified that provide support for the implementation of the FLEX strategies and include: a) providing load stripping of 125 VDC and 120 VAC vital buses to extend battery life; b) re-powering ac and dc electrical buses; c) providing ventilation for equipment cooling and area habitability; d) providing lighting; e) providing communications capability; f) providing for fueling of portable equipment; and g) providing plant and area access.

The licensee further stated that the program document will also contain a historical record of previous strategies and their bases. The program document will include the bases for ongoing maintenance and testing activities for the BDB equipment. 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.

In addition, the licensee stated that future changes to the FLEX strategies may be made without prior NRC approval provided that he revised FLEX strategies meet the requirements of NEI 12-06 and an engineering basis is 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 21 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). Initial and periodic training will be provided to site emergency response leaders on BDB emergency response strategies and implementing guidelines. Personnel 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 mitigating strategy time constraints. 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 RRC. "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

[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.

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. 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 22 of the Integrated Plan, the licensee stated that the industry will establish two (2) 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 (5) sets of equipment, four (4) of which will be able to be fully deployed when requested, the fifth set will have equipment in a maintenance cycle. 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 offsite resources, if these requirements are implemented as described.

4.0 OPEN AND CONFIRMATORY ITEMS

4.1 OPEN ITEMS

Item Number	Description	Notes
3.2.1.8.A	The Pressurized-Water Reactor Owners Group (PWROG) submitted to NRC a position paper, dated August 15, 2013 (ADAMS Accession No. ML 13235A135 (non-public for proprietary reasons)), 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. Since the audit discussions, the NRC endorsed the PWROG guidance with several clarifications in the letter dated January 8, 2014. The licensee should address commitment to the generic approach and the clarifications in 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 or provide an acceptable alternative approach.	
3.2.4.10.A	Battery Duty Cycle. At the time the audit was conducted, the licensee had neither (1) committed to abide by the generic approach for demonstrating that vented lead-acid batteries can be credited for durations longer than 8 hours, nor (2) identified an acceptable alternate approach for justifying the battery usage for greater than 8 hours in supporting its mitigating strategy.	

4.2 CONFIRMATORY ITEMS

Item Number	Description	Notes
3.1.1.2.A	Deployment of FLEX equipment – (Seismic Hazard, Flooding) Confirm protection of connections for maintaining containment phase 3.	
3.1.1.3.A	Procedural Interface Considerations - Seismic Hazard. Confirmation that the FSG being developed for obtaining local instrument readings addresses critical actions to perform until alternate indications can be connected.	
3.1.1.4.A	Off-Site Resources. Confirm RRC local staging area, evaluation of access routes, and method of transportation to the site.	
3.2.1.A	RCS Cooling & RCS Inventory Control. Justification of the use of that analysis may require additional information.	
3.2.1.1.A	ELAP Analysis – Confirm reflux cooling time from WCAP-17792 is reflected in the licensee's ELAP analysis and provide a definition of reflux condensate cooling.	
3.2.1.2.A	RCP Seal Leakage. 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, to include whether the FlowServe white paper justifies the use of the FlowServe N-9000 seals and bounds the 21 gpm/seal leakage rate assumed in the analysis.	
3.2.1.2.B	RCP Seal Leakage. Confirm FlowServe white paper justifies that the integrity of the O-rings will be maintained above the temperature conditions experienced during the ELAP event (approximately 556 ^{0}F) and if the SG PORV modification to add a protected backup air bottle system has an impact in the analysis.	
3.2.1.6.A	Sequence of Events. Confirm that the final timeline has been time validated after detailed designs are completed, procedures are developed, and to include deployment of equipment response times.	
3.2.1.9.A	Use of Portable Pumps. Confirm analysis to show that intermittent RCS injection by alternating between units is adequate using only one RCS injection pump.	
3.2.1.9.B	Use of Portable Pumps. Review the final calculation for the hydraulic analysis of the BDB high capacity pump / BDB AFW pump / SFP makeup connection and the associated hoses and installed piping systems to confirm the capacity of one high capacity pump can supply 300 gpm AFW flow to each unit's SG and 500 gpm to the dual unit SFP simultaneously.	
3.2.3.A	Containment. Review the containment analysis and Phase 3 coping strategy for methods to monitor and evaluate containment conditions beyond 7 days, including any cooldown and depressurization actions that may be required.	
3.2.4.2.A	Ventilation - Equipment cooling. Provide ventilation strategy detail to support equipment cooling.	

3.2.4.4.A	Communications. Confirm that upgrades to the site's communications systems have been completed.	
3.2.4.6.A	Personnel Habitability - Elevated Temperature. Confirm ventilation study for personnel habitability has been completed.	
3.2.4.8.A	Electrical Power Source/Isolation and Interactions. Confirmation that the final loading analysis for 4160 VAC DGs has been completed and reviewed by the staff to confirm that 2MW portable DGs are adequate to supply loads assumed in Phase 3.	
3.4.A	NEI 12-06, Section 12.2 lists minimum capabilities for offsite resources for which each licensee should establish the availability. Discuss implementation of Guidelines 2 through 10 in NEI 12-06, Section 12.2.	