UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 25, 2013

Mr. Randall K. Edington
Executive Vice President Nuclear/
Chief Nuclear Officer
Arizona Public Service Company
P.O. Box 52034, MS 7602
Phoenix, AZ 85072-2034

SUBJECT: PALO VERDE NUCLEAR GENERATING STATION, UNITS 1,2, AND 3 – INTERIM STAFF EVALUATION RELATING TO OVERALL INTEGRATED PLAN IN RESPONSE TO ORDER EA-12-049 - MITIGATION STRATEGIES (TAC NOS. MF0829, MF0830, MF0831)

Dear Mr. Edington:

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12054A736). By letter dated February 28, 2013 (ADAMS Accession No. ML13136A022), Arizona Public Service Company (APS) submitted its Overall Integrated Plan for Palo Verde Nuclear Generating Station (PVNGS), Units 1, 2, and 3 in response to Order EA-12-049. By letter dated June 20, 2013, the NRC sent a request for additional information to APS (ADAMS Accession No. ML13161A259). By letter dated July 18, 2013, APS replied to the request for additional information (ADAMS Accession No. ML13206A006). By letter dated August 28, 2013 (ADAMS Accession No. ML13246A007), APS submitted a six-month update to the Overall Integrated Plan.

Based on a review of APS' plan, including the six-month update dated August 28, 2013, and information obtained through the mitigation strategies audit process,[1] the NRC concludes that the licensee has provided sufficient information to determine that there is reasonable assurance that the plan, when properly implemented, will meet the requirements of Order EA-12-049 at PVNGS, Units 1, 2 and 3. This conclusion is based on the assumption that the licensee will implement the plan as described, including the satisfactory resolution of the open and confirmatory items detailed in the enclosed Interim Staff Evaluation and Audit Report.

Document transmitted herewith contains sensitive unclassified information. When separated from enclosure 2, this document is decontrolled.

[1] A description of the mitigation strategies audit process may be found at ADAMS Accession No. ML13234A503.

If you have any questions, please contact John Boska at 301-415-2901.

Sincerely,

Jeremy S. Bowen, Chief
Project Management Branch
Mitigating Strategies Directorate
Office of Nuclear Reactor Regulation

Docket Nos. 50-528, 50-529,
and 50-530

Enclosures:
1. Interim Staff Evaluation (Non-Proprietary)
2. Interim Staff Evaluation (Proprietary)

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UNITED STATES
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INTERIM STAFF EVALUATION AND AUDIT REPORT BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED TO ORDER EA-12-049 MODIFYING LICENSES WITH REGARD TO REQUIREMENTS FOR MITIGATION STRATEGIES FOR BEYOND-DESIGN-BASIS EXTERNAL EVENTS

ARIZONA PUBLIC SERVICE COMPANY

PALO VERDE NUCLEAR GENERATING STATION

UNITS 1, 2, AND 3

DOCKET NOS. 50-528, 50-529, 50-530

1.0 INTRODUCTION

The earthquake and tsunami at the Fukushima Dai-ichi nuclear power plant in March 2011 highlighted the possibility that extreme natural phenomena could challenge the prevention, mitigation and emergency preparedness defense-in-depth layers. At Fukushima, limitations in time and unpredictable conditions associated with the accident significantly challenged attempts by the responders to preclude core damage and containment failure. During the events in Fukushima, the challenges faced by the operators were beyond any faced previously at a commercial nuclear reactor. The U.S. Nuclear Regulatory Commission (NRC) determined that additional requirements needed to be imposed to mitigate beyond-design-basis external events. Accordingly, by letter dated March 12, 2012, the NRC issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" [Reference 10]. The order directed licensees to develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities in the event of a beyond-design-basis external event.

By letter dated February 28, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13136A022, Arizona Public Service Company (the licensee or APS) provided the initial Overall Integrated Plan for Compliance with Order EA-12-049 for Palo Verde Nuclear Generating Station (PVNGS) [Reference 18]. This initial plan describes the strategies and guidance under development for implementation by APS for the maintenance or restoration of core cooling, containment, and SFP cooling capabilities following a beyond-design-basis external event, including modifications necessary to support this implementation, pursuant to Order EA-12-049. By letter dated June 20, 2013 [Reference 35], the NRC staff requested additional information on the licensee's plans. The licensee responded by letter dated July 18, 2013 [Reference 36]. As further required by the order, by letter dated August 28, 2013 [Reference 37], the licensee submitted the first six month status report since the submittal of the initial plan, describing the progress made in implementing the requirements of the order. This information submitted by the licensee will be referred to as the Integrated Plan.

2.0 REGULATORY EVALUATION

Following the events at the Fukushima Dai-ichi nuclear power plant on March 11, 2011, the 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 and methodical review of the NRC's regulations and processes and with determining if the agency should make 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 [Reference 1]. These recommendations were enhanced by the NRC staff following interactions with stakeholders. Documentation of the NRC 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 [Reference 2] and SECY-11-0137, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," dated October 3, 2011 [Reference 3].

As directed by the Commission's Staff Requirement Memorandum (SRM) for SECY-11-0093 [Reference 4], 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 NRC staff's prioritization of the recommendations based upon the potential safety enhancements.

After receiving the Commission's direction in SRM-SECY-11-0124 [Reference 5] and SRM-SECY-11-0137 [Reference 6], the NRC staff conducted public meetings to discuss enhanced mitigation strategies intended to maintain or restore core cooling, containment, and SFP cooling capabilities following beyond-design-basis external events. At these meetings, the industry described its proposal for a Diverse and Flexible Mitigation Capability (FLEX), as documented in the Nuclear Energy Institute's (NEI's) letter, dated December 16, 2011 [Reference 7]. 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 than 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," [Reference 8] to the Commission, including the proposed order to implement the enhanced mitigation strategies. As directed by SRM-SECY-12-0025 [Reference 9], the NRC staff issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" [Reference 10].

Order EA-12-049, Attachment 2[2], requires that operating power reactor licensees and construction permit holders use a three-phase approach for mitigating beyond-design-basis external events. The initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment and SFP cooling capabilities. 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 off site. The final phase requires obtaining sufficient offsite resources to sustain those functions indefinitely. Specific operational requirements of the order are listed below:

1) Licensees or construction permit (CP) holders shall develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and SFP cooling capabilities following a beyond-design-basis external event.

2) These strategies must be capable of mitigating a simultaneous loss of all alternating current (ac) power and loss of normal access to the ultimate heat sink and have adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to the order.

3) Licensees or CP holders must provide reasonable protection for the associated equipment from external events. Such protection must demonstrate that there is adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to the order.

4) Licensees or CP holders must be capable of implementing the strategies in all modes.

5) Full compliance shall include procedures, guidance, training, and acquisition, staging, or installing of equipment needed for the strategies.

On May 4, 2012, NEI submitted document 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision B [Reference 11] to provide specifications for an industry developed methodology for the development, implementation, and maintenance of guidance and strategies in response to the Mitigating Strategies order. On May 13, 2012, NEI submitted NEI 12-06, Revision B1 [Reference 12]. The guidance and strategies described in NEI 12-06 expand on those that industry developed and implemented to address the limited set of beyond-design-basis external events that involve the loss of a large area of the plant due to explosions and fire required pursuant to paragraph (hh)(2) in Section 50.54, "Conditions of licenses" of Title 10 of the *Code of Federal Regulations*.

On May 31, 2012, the NRC staff issued a draft version of the interim staff guidance (ISG) document 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," [Reference 13] and published a notice of its availability for public comment in the

[2] Attachment 3 provides requirements for Combined License holders.

Federal Register (77 FR 33779), with the comment period running through July 7, 2012. JLD-ISG-2012-01 proposed endorsing NEI 12-06, Revision B1, as providing an acceptable method of meeting the requirements of Order EA-12-049. The NRC staff received seven comments during this time. The NRC staff documented its analysis of these comments in "NRC Response to Public Comments, JLD-ISG-2012-01 (Docket ID NRC-2012-0068)" [Reference 14].

On July 3, 2012, NEI submitted comments on JLD-ISG-2012-01, including Revision C to NEI 12-06 [Reference 15], incorporating many of the exceptions and clarifications included in the draft version of the ISG. Following a public meeting held July 26, 2012, to discuss the remaining exceptions and clarifications, on August 21, 2012, NEI submitted Revision 0 to NEI 12-06 [Reference 16].

On August 29, 2012, the NRC staff issued the final version of 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" [Reference 17], endorsing NEI 12-06, Revision 0, as an acceptable means of meeting the requirements of Order EA-12-049, and published a notice of its availability in the Federal Register (77 FR 55230).

The NRC staff determined that the overall integrated plans submitted by licensees in response to Order EA-12-049, Section IV.C.1.a should follow the guidance in NEI 12-06, Section 13, which states that:

> The Overall Integrated Plan should include a complete description of the FLEX strategies, including important operational characteristics. The level of detail generally considered adequate is consistent to the level of detail contained in the Licensee's Final Safety Analysis Report (FSAR). The plan should provide the following information:
>
> 1. Extent to which this guidance, NEI 12-06, is being followed including a description of any alternatives to the guidance, and provide a milestone schedule of planned actions.
>
> 2. Description of the strategies and guidance to be developed to meet the requirements contained in Attachment 2 or Attachment 3 of the order.
>
> 3. Description of major installed and portable FLEX components used in the strategies, the applicable reasonable protection for the FLEX portable equipment, and the applicable maintenance requirements for the portable equipment.
>
> 4. Description of the steps for the development of the necessary procedures, guidance, and training for the strategies; FLEX equipment acquisition, staging or installation, including necessary modifications.
>
> 5. Conceptual sketches, as necessary to indicate equipment which is installed or equipment hookups necessary for the strategies. (As-built piping and instrumentation diagrams (P&ID) will be available upon completion of plant modifications.)

6. Description of how the portable FLEX equipment will be available to be deployed in all modes.

By letter dated August 28, 2013 [Reference 38], the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049. That letter described the process used by the staff in its reviews, leading to the issuance of this interim staff evaluation and audit report for each site. 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. Additional NRC staff review and inspection may be necessary following full implementation of those actions to verify licensees' compliance with the order.

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

- Evaluation of External Hazards
- Phased Approach
    - Initial Response Phase
    - Transition Phase
    - Final Phase
- Core Cooling Strategies
- Spent Fuel Pool Cooling Strategies
- Containment Function Strategies
- Programmatic Controls
    - Equipment Protection, Storage, and Deployment
    - Equipment Quality

The technical evaluation in Section 3.0 documents the results of the NRC staff's evaluation. 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 that 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 the NRC staff considers 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 for NRC staff 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, licensee statements, commitments, and references to existing programs that are subject to routine NRC oversight (e.g., 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. The philosophy for this evaluation does not imply that there are any limits in this area to future NRC inspection activities.

3.0 TECHNICAL EVALUATION

A simplified description of the Integrated Plan for PVNGS is that the licensee will initially remove the core decay heat by adding water to the steam generators (SGs) and releasing steam from the SGs to the atmosphere. The water will initially be added by the turbine-driven auxiliary feedwater (TDAFW) pump, taking a suction from the condensate storage tank. The reactor coolant system (RCS) will be cooled down to about 360 °F, which will reduce the RCS and SG pressures. When the TDAFW pump can no longer be operated reliably, a FLEX pump will be used to add water to the SGs. FLEX generators will be used to reenergize 480 volt ac load centers. This will allow running a FLEX makeup pump to add water to the RCS, and energizing the installed battery chargers to keep the necessary direct current (dc) buses energized. In the long-term, additional equipment, such as 4160 volt ac generators, will be delivered from one of the Regional Response Centers, which are being established by industry to serve as equipment depots remote from the licensee's site and capable of transporting equipment and commodities to an affected site.

In the postulated extended loss of ac power event, the SFP will initially heat up due to the unavailability of the normal cooling system. A FLEX pump will be aligned and used to add water to the SFP to maintain level as the pool boils. This will maintain a sufficient amount of water above the top of the fuel assemblies for cooling and shielding purposes.

PVNGS has large dry containment buildings, which contain the RCS. The licensee's analysis shows that the heatup of the containment buildings is fairly slow, and that even for the worst case active cooling will not be required for several days, which allows time to utilize equipment from the Regional Response Center.

The NRC staff evaluated the Integrated Plan for PVNGS as discussed below.

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 beyond-design-basis external events leading to an extended loss of all ac power 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 Hazard

As stated in NEI 12-06, Section 5.2:

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

These areas are discussed further in Sections 3.1.1.1 through 3.1.1.4, below.

On page 10 of Reference 18, in the section of its plan regarding determination of applicable extreme external hazards, APS stated that the FLEX equipment will be protected from the current PVNGS seismic design basis event to ensure the equipment remains accessible and can be delivered to its deployed location(s). This will include ensuring that storage locations and deployment routes meet the FLEX criteria. As described in the PVNGS Updated Final Safety Analysis Report (UFSAR) [Reference 19], section 3.7, Seismic Design, the seismic criteria includes the Safe Shutdown Earthquake (SSE). The site seismic design response spectra defines the vibratory ground motion of the SSE for rock-supported structures. The magnitude of the SSE is 20% of the acceleration due to gravity (0.20g). For additional conservatism, the seismic analysis for Seismic Category I structures was performed using a 0.25g SSE. These values constitute the design basis for PVNGS.

The NRC staff has reviewed APS' screening for seismic hazards and finds that APS has followed the guidance of NEI 12-06 as endorsed by JLD-ISG-2012-01 and has appropriately included this external hazard and identified the seismic hazard level to be considered.

3.1.1.1 Protection of Portable Equipment – Seismic Hazard

As stated in NEI 12-06, Section 5.3.1:

> 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 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 28 of Reference 18, regarding protection of portable equipment from seismic hazards, APS stated that the FLEX storage building that will house the equipment for this function will be constructed to be seismically robust using, at a minimum, the requirements of American Society of Civil Engineers (ASCE) 7-10 (consistent with NEI 12-06, Section 5). Equipment inside the building will be restrained in such a way that it will not be damaged during a seismic event. In its 6-month status report, dated August 28, 2013 [Reference 37], APS stated that the location for the storage facility had been selected and contracts have been issued for building construction.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 portable equipment for seismic events, if they are implemented as described.

3.1.1.2 Deployment of Portable Equipment – Seismic Hazard

As stated in NEI 12-06, Section 5.3.2, the following five considerations for the deployment of portable equipment following a seismic event should be addressed:

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 of 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.

In the section of its Integrated Plan regarding assumptions specific to the PVNGS site, APS stated that the FLEX design hardened connections are protected against external hazards or are established at multiple and diverse locations. Connections will be designed to Seismic Category I or augmented seismic requirements. They will either be located in Seismic Category I structures or outside and above grade. APS also stated that roads and staging areas are selected considering seismic and liquefaction phenomena [Reference 21].

On page 66 of Reference 18, in the section of its plan regarding equipment and commodities for the final phase, APS lists transportation equipment and debris clearing equipment.

On page 22 of Reference 18, in the section of its plan regarding the Regional Response Center (RRC) plan, APS stated that equipment will be moved from an RRC to a local offsite assembly area, established by the Strategic Alliance for FLEX Emergency Response (SAFER) team and the licensee. Communications will be established between the affected nuclear site and the SAFER team and the required equipment will be moved to the site as needed. The first piece of critical safety function equipment, as established during development of the nuclear site's playbook, will be delivered to the site within 24 hours of the initial request. The licensee will execute and maintain a contract with the selected RRC vendor in accordance with the requirements of Section 12 of NEI 12-06.

On page 67 of Reference 18, APS listed an open item as follows:

> Structure, content, and details of the regional response center (RRC) playbook, and location of the offsite staging area will be determined.

On page 71 of Reference 18, APS identified a time constraint of 34 hours for the installation of the FLEX 500 kW 480 V generators located at the site.

The NRC staff has reviewed APS' plans for the deployment of portable equipment. With respect to the accessibility of connection points, the NRC staff has verified by reference to the figures referenced in the text of the plan that at least one connection point for each strategy requires access through only seismically robust structures. The NRC staff finds that because APS' plans for protection and accessibility of the connection points conforms to the guidance of NEI 12-06, as endorsed by JLD-ISG-2012-01, there is reasonable assurance that the guidance and strategies developed pursuant to them will comply with Order EA-12-049.

The NRC staff has insufficient information, however, to conclude that there is reasonable assurance that APS' plans for deployment of the portable equipment will conform to the guidance of NEI 12-06 because no delivery time has been identified for the final phase transportation equipment and no means to move the equipment has been identified with reasonable protection against seismic hazards capable of meeting the identified time constraints. This has been identified as Open Item 3.1.1.2.A. in Section 4.1, below.

The staff's understanding of the licensee's approach, as described above, confirms that the licensee's plans are 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 above, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to deployment of portable equipment if they are implemented as described.

3.1.1.3 Procedural Interfaces – Seismic Hazard

As stated in NEI 12-06, Section 5, the following four procedural interface considerations should be addressed:

1. Seismic studies have shown that even seismically qualified electrical equipment can be affected by BDB seismic events. In order to address these considerations, each plant should compile a reference source for the plant operators that provides approaches to obtaining necessary instrument readings to support the implementation of the coping strategy (see Section 3.2.1.10). This reference source should include control room and non-control room readouts and should also provide guidance on how and where to measure key instrument readings at containment penetrations, where applicable, using a portable instrument (e.g., a Fluke meter). Such a resource could be provided as an attachment to the plant procedures/guidance. Guidance should include critical actions to perform until alternate indications can be connected and on how to control critical equipment without associated control power.

2. Consideration should be given to the impacts from large internal flooding sources that are not seismically robust and do not require ac power (e.g., gravity drainage from lake or cooling basins for non-safety-related cooling water systems).

3. For sites that use ac power to mitigate ground water in critical locations, a strategy to remove this water will be required.

4. Additional guidance may be required to address the deployment of FLEX for those plants that could be impacted by failure of a not seismically robust downstream dam.

In its Integrated Plan, APS stated that they will develop procedures to read the necessary instrumentation locally, where applicable, using a portable instrument, as required by Section 5.3.3 of NEI 12-06.

By letter dated June 20, 2013 [Reference 35], the NRC staff requested additional information on procedural interface considerations for seismic hazards associated with large internal flooding sources that are not seismically robust and do not require ac power, the use of ac power to mitigate ground water in critical locations, or the existence of non-seismically robust downstream dams. In its response dated July 18, 2013 [Reference 36], APS provided the following discussion:

> NEI 12-06 section 5.3.3, "Procedural Interfaces," considerations 2 through 4 are discussed below:
>
> *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).*
>
> PVNGS does not have any lake or cooling basin for nonsafety related cooling water systems that are capable of draining into the safety-related portions of the power block. The circulating water basin is at an elevation lower than the unit elevations. PVNGS does not have significant internal flooding concerns as a result of nonseismic system failures or from flooding as a result of gravity drainage of external bodies of water, and there is no possibility for significant groundwater intrusion into the safety related systems, structures and components (SSC) at the station. A review of design basis internal station flooding calculations for the failure of nonseismic cooling water systems confirms that the safety structures have sufficient capacity to mitigate the consequences of flooding without any AC power. APS has verified ingress and egress are available at the times needed to locations requiring access for operator action.
>
> Flex modifications and portable equipment staging locations supporting the mitigation strategies will consider accessibility, habitability, and two-over-one (2/1) issues as required by NEI 12-06, section 5.3.3. APS will revise FSGs [FLEX Support Guidelines], if required, to ensure appropriate directions are provided for possible hazards and limitations.
>
> *3. For sites that use ac power to mitigate ground water in critical locations, a strategy to remove this water will be required.*
>
> PVNGS does not have an issue requiring continuous removal of groundwater in critical locations.
>
> *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.*
>
> PVNGS has no operational concerns or impacts to the deployment of FLEX related to the failure of a downstream dam. Additionally, as stated in the OIP, external flooding concerns do not apply to PVNGS.

The staff's understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to procedural interface considerations for seismic hazards if they are implemented as described.

3.1.1.4 Considerations in Using Offsite Resources – Seismic Hazard

As stated in NEI 12-06, Section 5.3.4, the following consideration in using offsite resources should be addressed:

> 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 Reference 18, regarding the Regional Response Center plan, APS stated:

> The industry will establish two (2) regional response centers (RRCs) to support utilities during beyond design basis events. Each RRC will hold five (5) sets of equipment, four (4) of which will be able to be fully deployed when requested, and the fifth set will have equipment in a maintenance cycle. Equipment will be moved from a RRC to a local offsite 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 the required equipment will be moved to the site as needed. The first piece of critical safety function equipment, as established during development of the nuclear site's playbook, will be delivered to the site within 24 hours of the initial request. PVNGS will execute and maintain a contract with the selected RRC vendor in accordance with the requirements of Section 12 of NEI 12-06.

On page 67 of Reference 18, APS identified an open item stating that:

> Structure, content, and details of the regional response center (RRC) playbook, and location of the offsite staging area will be determined.

The NRC staff has reviewed APS' plans for the use of offsite resources, but has been unable to conclude that there is reasonable assurance that the plans will comply with Order EA-12-049. During the audit process, the licensee stated that their local offsite assembly area would be the Phoenix RRC. However, the staff needs details on transportation to the nuclear site following a seismic event. This has been identified as Confirmatory Item 3.1.1.4.A in Section 4.2, below.

The staff's understanding of the licensee's approach, as described above, confirms that the licensee's plans are 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 discussed above, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to considerations in using offsite resources if they are implemented as described.

3.1.2 Flooding Hazard

As discussed in NEI 12-06, Flooding considerations are similarly treated in four primary areas: protection and deployment of portable equipment, procedural interfaces, and considerations in using off-site resources.

As stated in NEI 12-06, Section 6.2:

> 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.

As stated in NEI 12-06, Section 6.2.1:

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

On page 11 of Reference 18, APS stated that:

> External Flooding:
>
> Access to Seismic Category I systems, structures and components (SSCs) at PVNGS is available above the elevation of the probable maximum flood level. The PVNGS site is susceptible to brief water buildup due to probable maximum precipitation (PMP); however, the PVNGS drainage system and grading plan is designed with sufficient capacity to prevent flooding of Seismic Category I structures (UFSAR, Section 2.4.2.2.2).
>
> PVNGS is a dry site (UFSAR, Section 2.4.2.2) and does not rely on a permanently installed seawall or levee for flood protection. Therefore, PVNGS does not need to consider external flooding as a hazard defined in NEI 12-06 (Section 6.2.1).

The NRC staff has reviewed APS' screening for external flooding hazards and finds that because APS conformed to the guidance of NEI 12-06, as endorsed by JLD-ISG-2012-01, there is reasonable assurance that APS screening out this external hazard complies with the requirements of Order EA-12-049.

3.1.2.1 Protection of Portable Equipment – Flooding Hazard

As stated in NEI 12-06, Section 6.2.3.1, portable equipment necessary for the mitigating strategies should be stored as follows:

1. The equipment should be stored in one or more of the following configurations:

    a. Stored above the flood elevation from the most recent site flood analysis. The evaluation to determine the elevation for storage should be informed by flood analysis applicable to the site from early site permits, combined license applications, and/or contiguous licensed sites.

    b. Stored in a structure designed to protect the equipment from the flood.

    c. FLEX equipment can be stored below flood level if time is available and plant procedures/guidelines address the needed actions to relocate the equipment. Based on the timing of the limiting flood scenario(s), the FLEX equipment can be relocated to a position that is protected from the flood, either by barriers or by elevation, prior to the arrival of the potentially damaging flood levels. This should also consider the conditions on-site during the increasing flood levels and whether movement of the Flex equipment will be possible before potential inundation occurs, not just the ultimate flood height.

2. Storage areas that are potentially impacted by a rapid rise of water should be avoided.

On pages 28, 36, 47, and 58 of Reference 18, APS stated that protection of associated portable equipment from flooding hazards would be provided as the FLEX equipment storage building will be designed above flood level with adequate drainage.

The staff's understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to protection of portable equipment from flooding hazards if they are implemented as described.

3.1.2.2 Deployment of Portable Equipment – Flooding Hazard

As stated in NEI 12-06, Section 6.2.3.2, the following nine considerations for the deployment of portable equipment following a flooding event should be addressed:

1. For external floods with warning time, the plant may not be at power. In fact, the plant may have been shut down for a considerable time and the plant configuration could be established to optimize FLEX deployment. For example, the portable pump could be connected, tested, and readied for use prior to the arrival of the critical flood level. Further, protective actions can be taken to reduce the potential for flooding impacts, including cooldown, borating the RCS,

isolating accumulators, isolating RCP [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 [loss of ultimate heat sink], as well as ELAP [extended loss of ac power].

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

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

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

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

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

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

On pages 29, 36, 37, 47, 58, and 62 of Reference 18, APS stated that connections will be above the PVNGS flood level, and that PVNGS is a dry site, but the licensee will keep connections off the ground to avoid the potential impacts of run-off or pooling from precipitation.

The staff's understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to deployment of portable equipment with consideration for external flooding hazards if they are implemented as described.

3.1.2.3 Procedural Interfaces – Flooding Hazard

As stated in NEI 12-06, Section 6.2.3.3, the following three procedural interface considerations should be addressed:

1. Many sites have external flooding procedures. The actions necessary to support the deployment considerations identified above should be incorporated into those procedures.

2. Additional guidance may be required to address the deployment of FLEX for flooded conditions (i.e., connection points may be different for flooded vs. non-flooded conditions).

3. FLEX guidance should describe the deployment of temporary flood barriers and extraction pumps necessary to support FLEX deployment.

As discussed in Section 3.1.2.1 above, PVNGS screened as a dry site. The NRC staff has reviewed APS' plans for development and implementation of the guidance and strategies required by Order EA-12-049 and concludes that the procedural interfaces considerations of NEI 12-06, Section 6.2.3.3 for the external flooding hazard are not applicable.

3.1.2.4 Considerations in Using Offsite Resources – Flooding Hazard

As stated in NEI 12-06, Section 6.2.3.4, the following considerations should be addressed:

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

2. Sites impacted by persistent floods should consider where equipment delivered from offsite could be staged for use on-site.

On page 67 of Reference18, APS has an identified open item stating that:

> Structure, content, and details of the regional response center (RRC) playbook, and location of the offsite staging area will be determined.

The NRC staff has reviewed APS' plans for the use of offsite resources, but has been unable to conclude that there is reasonable assurance that the plans will comply with Order EA-12-049 due to the absence of identification of the local staging area and a description of the methods to be used to deliver the equipment to the site. This has been combined with Open Item 3.1.1.4.A. in Section 4.1, below.

3.1.3 High Wind Hazard

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 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 [Reference 22]); 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 [Reference 23]; 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 11 of Reference 18, in the section of its Integrated Plan regarding the determination of applicable extreme external hazards, APS stated that based upon the location of the site at 33°23'N latitude and 112°52'W longitude and the information provided in Figures 7-1 and 7-2 of NEI 12-06, PVNGS is not expected to experience winds exceeding 130 mph. Therefore, the high wind hazard is not applicable to PVNGS.

The NRC staff has reviewed APS' screening for hazards due to high winds and finds that because APS has conformed to the guidance of NEI 12-06, as endorsed by JLD-ISG-2012-01, there is reasonable assurance that APS' decision not to apply a high wind hazard complies with the requirements of Order EA-12-049.

3.1.4 Snow, Ice and Extreme Cold

As discussed in NEI 12-06, Section 8.2.1, all sites should consider the temperature ranges and weather conditions for their site in storing and deploying their 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. NEI 12-06, Section 8.2.1, further specifies that all sites located North of the 35th Parallel should provide the capability to address extreme snowfall with snow removal equipment. Finally, all sites except for those within Level 1 and 2 of the maximum ice storm severity map contained in Figure 8-2 should address the impact of ice storms.

On page 11 of Reference 18, in the section of its Integrated Plan regarding the determination of applicable extreme external hazards, APS stated that the guidance of NEI 12-06 requires the consideration of the temperature ranges and weather conditions for each site with regard to the storage and deployment of the FLEX equipment. However, NEI 12-06 further clarifies that snow, ice and extreme cold are not expected at sites in Southern California, Arizona, the Gulf Coast, and Florida. Because the site is located in Arizona and below the 35th parallel (33°23'N and 112°52' W), the extreme cold hazard (which includes snow and ice) is not applicable to PVNGS.

The NRC staff has reviewed APS' screening for hazards due to snow, ice and extreme cold and finds that APS has appropriately screened out the need to address deployment for conditions of snow, ice and extreme cold based on the location of the site being in Arizona below the 35th

Parallel. The NRC staff notes that this screening omits a discussion of the hazard due to ice storms, but notes that PVNGS' location is within the white region of NEI 12-06, Figure 8-2, which corresponds to the Level 1 ice storm severity region and that as such would not require consideration of ice storm impact on the strategies.

3.1.5 High Temperature Hazard

As stated in NEI 12-06, Section 9, all sites should address the following three considerations for extreme high temperatures:

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

2. 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 the 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.

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

On page 11 of Reference 18, in the section of its Integrated Plan regarding the determination of applicable extreme external hazards, APS stated:

> As stated in NEI 12-06, all sites are required to consider high temperatures in their characterization of site hazards. PVNGS addresses the effect of extreme heat on continued plant operation with current administrative controls if the temperature exceeds design basis values.
>
> PVNGS may experience extreme high temperatures for a prolonged duration. However, the extreme drought and high temperature meteorological events progress slowly such that existing plant administrative and operational procedures are adequate to ensure that the plant is shut down and placed in a safe condition if the temperature of any SSCs exceed design basis limiting conditions.
>
> The extreme heat event considered herein is a loss of AC power as a result of short duration high temperatures coincident with high electrical grid demands, resulting in a regional black out. During this type of event, the equipment conditions and water inventories at the station are expected to be within design limits such that no additional limitation on initial conditions/failures/abnormalities are expected.

The NRC staff has reviewed APS' screening of high temperatures and finds that APS has appropriately included this hazard.

3.1.5.1 Protection of Equipment – High Temperature Hazard

NEI 12-06, Section 9.3.1, states that the equipment should be maintained at a temperature within a range to ensure its likely function when called upon.

On pages 28, 36, 47, 58, and 61 of Reference 18, in the section of its Integrated Plan regarding the storage and protection of equipment, APS stated that protection of associated portable equipment from high temperatures would be provided since the FLEX equipment storage building will have adequate ventilation for high temperatures.

The staff's understanding of the licensee's approach, as described above, confirms that the licensee's plans are 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 equipment from high temperature if they are implemented as described.

3.1.5.2 Deployment of Equipment – High Temperature Hazard

NEI 12-06, Section 9.3.2, states that 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 66 of Reference 18, in the section of its Integrated Plan regarding equipment and commodities for the final phase, APS lists transportation equipment and debris clearing equipment. In its response to an NRC RAI dated July 18, 2013 [Reference 36], APS stated that they will determine the specifications for FLEX equipment, including environmental requirements, during the design development and procedure development phase, and that equipment specifications will meet the requirements of NEI 12-06.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 deployment of equipment with consideration for a high temperature hazard, if they are implemented as described.

3.1.5.3 Procedural Interfaces – High Temperature Hazard

On page 11 of Reference 18, in the section of its Integrated Plan regarding the determination of applicable extreme external hazards, APS states that the extreme heat event considered herein is a loss of ac power as a result of short duration high temperatures coincident with high electrical grid demands, resulting in a regional black out. During this type of event, the equipment conditions and water inventories at the station are expected to be within design limits such that no additional limitation on initial conditions/failures/abnormalities are expected.

By letter dated June 20, 2013 [Reference 35], the NRC staff requested additional information on the potential effects of high ambient temperatures on portable equipment in the locations such equipment would operate. In its response dated July 18, 2013 [Reference 36], APS provided the following discussion:

> NEI 12-06, Sections 9.3.2 and 9.3.3, state that functionality of FLEX equipment during movement in the extreme conditions applicable to the site should be a procurement consideration.
>
> APS will determine the specifications for FLEX equipment, including environmental requirements, during the design development and procedure development phase. Equipment specifications will meet the requirements of NEI 12-06. APS will provide this information in a periodic six-month update.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 for the high temperature hazard, if they are implemented as described.

3.2 Phased Approach

Attachment 2 to Order EA-12-049 describes the three-phase approach required for mitigating beyond-design-basis external events in order to maintain or restore core cooling, containment and spent fuel pool cooling (SFP) capabilities. The phases consist of an initial phase (Phase 1) using installed equipment and resources, followed by a transition phase (Phase 2) using portable onsite equipment and consumables and a final phase (Phase 3) using offsite resources.

To meet these EA-12-049 requirements, licensees will establish a baseline coping capability to prevent fuel damage in the reactor core or SFP and to maintain containment capabilities in the context of a beyond-design-basis external event that results in the loss of all ac power, with the exception of buses supplied by safety-related batteries through inverters, and loss of normal access to the UHS. As described in NEI 12-06, Section 1.3, "Plant-specific analyses will determine the duration of each phase." This baseline coping capability is supplemented by the ability to use portable pumps to provide RCS, SG, and SFP makeup in order to restore core or spent fuel pool capabilities as described in NEI 12-06, Section 3.2.2, guideline 13. This approach is endorsed by JLD-ISG-2012-01.

3.2.1 Reactor Core Cooling Strategies

NEI 12-06, Table 3-2 and Appendix D summarize one acceptable approach for the reactor core cooling strategies for pressurized-water reactors (PWRs) such as Palo Verde. This approach uses the installed auxiliary feedwater (AFW)/emergency feedwater (EFW) system to provide 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 leakage reactor coolant pump seals and/or borated high pressure RCS makeup with a letdown path if required. In mode 5 (cold shutdown) and mode 6 (refueling) with SGs not available, this approach relies on an on-site pump for RCS makeup and diverse makeup connections to the RCS for long-term RCS makeup with borated water and residual heat removal from the vented RCS.

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

Acceptance criteria for the analyses serving as the technical basis for establishing the time constraints for the baseline coping capabilities described in NEI 12-06, which provide an acceptable approach, as endorsed by JLD-ISG-2012-01, to meeting the requirements of Order 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.

NEI 12-06, Section 3.2.2, Guideline (13) states in part that "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 a diverse capability beyond installed equipment."

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

Section 3.2 of the proprietary Westinghouse technical report WCAP-17601, ADAMS Accession Nos. ML13042A011 and ML13042A013, discusses the pressurized water reactor owner group's (PWROG's) recommendations that cover various subjects for consideration in developing FLEX mitigation strategies.

During an NRC audit of Order EA-12-049 Mitigation Plans, the licensee was requested to discuss the licensee's position on each of the recommendations discussed in Section 3.2 of WCAP-17601 for developing the FLEX mitigation strategies. Specifics of the request included listing the recommendations that are applicable to the plant, providing rationale for the applicability, addressing how the applicable recommendations are considered in the ELAP coping analysis, discussing the plan to implement the recommendations, and providing rationale for each of the recommendations that are determined to be not applicable to the plant.

In response to the NRC's staff's audit questions, the licensee provided the following additional information in its response to question RAI-30 in a letter dated July 18, 2013 (Reference 36) to address the recommendations discussed in Section 3.2 of WCAP-17601.

(1) Minimizing RCP seal leakage rates - The RCP seal leakage rate assumed in the Palo Verde ELAP analysis is not dependent on the recommendation to isolate controlled-bleed-off (CBO) for Combustion Engineering (CE) designed plants as discussed in WCAP-17601. It is based on the Palo Verde specific analysis and assumptions. Therefore, isolation of CBO is not required to support the timeline for RCS inventory control provided in the Integrated Plan. As CBO isolation modifications are not planned, the licensee will adopt an early cooldown strategy as recommended. This cooldown strategy, consistent with the analytical basis presented in Westinghouse analysis report DAR-TDA-12-2 (Reference 24) supporting the mitigating strategies for Palo Verde, results in a cooldown of the RCS to a target temperature of 360 °F. This is well within the recommended time frame of 24 hours discussed in WCAP-17601. The NRC staff noted that the licensee's cooldown strategies in reducing the RCP seal leakage reflect the design of its RCP seal system and are supported by the analysis establishing the basis for mitigating strategies. Therefore, the NRC staff determines that the licensee's approach adequately addresses the concern of minimizing the RCP seal leakage rate discussed in Item 1 in WCAP-17601, Section 3.2.

(2) Adequate shutdown margin – The licensee performed a scoping reactivity analysis for ELAP. The results showed that during an ELAP event, sufficient shutdown margin is available to maintain core sub-criticality (see the response to RAI-26 in Reference 36). Specifically, during an ELAP event, increases in RCS boron concentration are not required to maintain core sub-criticality because of the substantial negative reactivity added by insertion of all control rods. Therefore, the NRC staff determines that the concern of adequacy of shutdown margin, discussed in Item 2 of WCAP-17601, Section 3.2, is adequately addressed. See more information in Section 3.2.1.8 of this evaluation.

(3) Time initiating cooldown and depressurization – A draft for the Palo Verde specific FSG has been developed. This FSG directs operators to perform an early and extensive cooldown and depressurization of the RCS subsequent to an ELAP as recommended in WCAP-17601. This cooldown is consistent with the plant-specific analysis used to establish the ELAP mitigating strategies for ELAP. The NRC staff noted that the licensee's approach is consistent with guidance specified in Item 3 of WCAP-17601, Section 3.2, and therefore, that the issue related to the cooldown and depressurization procedure is adequately addressed.

(4) Prevention of RCS overfill - The FSG directs a rapid RCS cooldown early during an ELAP event which precludes overfill conditions for Palo Verde. Plant cooldown and depressurization will not be precluded due to possibility of a solid plant condition, which is consistent with recommendations in WCAP-17601. The NRC staff noted that the licensee's approach is consistent with guidance specified in Item 4 of WCAP-17601, Section 3.2; therefore, the NRC staff has determined that this item is adequately addressed.

(5) Blind feeding an SG with a portable pump – The licensee will maintain the capability to back up the TDAFWP using FLEX equipment and will include operational guidance for deployment and connection of the FLEX pump to the appropriate FLEX connection. The determination of the capacity of backup portable pumps is based on providing adequate flow to the SGs to

remove the worst case decay heat load at one hour following shutdown at a pressure associated with preventing safety injection tank (SIT) injection into the RCS (see the response to RAI-27 in Reference 36). The NRC staff noted that the licensee's approach is consistent with guidance specified in Item 5 of WCAP-17601, Section 3.2, therefore, the NRC staff has determined that this item is adequately addressed. See more information in Section 3.2.1.9 of this evaluation.

(6) Nitrogen injection from SITs – As shown in Westinghouse Analysis Report DAR-TDA-12-2 (Reference 24), and Westinghouse Calculation CN-FSE-12-10 (Reference 40), the licensee has analyzed the potential for depletion of the SIT inventory resulting in injection of SIT nitrogen into the RCS. The licensee's FSGs will provide guidance to the operators to vent the SIT cover gas when the SITs have reached a lower limit setpoint of 10% wide-range level. The determination of this setpoint accounted for the effects of high containment temperature, resulting from an ELAP, on the heatup of the SIT cover gas. The SIT cover- gas heatup process is sufficiently slow such that adequate response time to preclude nitrogen injection is available based on SIT wide-range level indication. The NRC staff noted that the licensee's approach is consistent with guidance specified in Item 6 of WCAP-17601, Section 3.2, therefore, the NRC staff has determined that this item is adequately addressed.

(7) Asymmetric natural circulation cooldown - The guidance provided in WCAP-17601 associated with asymmetric cooldown is directed at plants that intend to perform an asymmetric cooldown as their primary strategy for performing the RCS cooldown and depressurization. The licensee will conduct a symmetric cooldown, and their primary cooldown strategy for ELAP has been developed based on a symmetric plant cooldown. Procedural steps are included in the Palo Verde FSGs for symmetric cooldown and depressurization of the RCS subsequent to an ELAP. The NRC staff noted that the licensee's approach is consistent with guidance specified in Item 7 of WCAP-17601, Section 3.2; therefore, the NRC staff has determined that this item is adequately addressed.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 reactor core cooling strategies, if they are implemented as described.

3.2.1.1 Computer Code Used for the ELAP Analysis

NEI 12-06 Section 1.3 states that "Plant-specific analyses will determine the duration of each of each phase," and that "To the extent practical, generic thermal hydraulic analysis will be developed to support plant-specific decision-making."

The licensee has provided a sequence of events (SOE) in Reference 18, which included the time constraints and the technical basis for the site. That SOE is based on an analysis using the Combustion Engineering Nuclear Transient Simulation (CENTS) computer code. CENTS, described in Westinghouse topical report WCAP-15996-A (Reference 26), is a computer code for calculation of the transient thermal-hydraulic (T-H) conditions in the RCS primary and secondary systems of a PWR for design non-loss-of-coolant accident (LOCA) transients. It was previously reviewed and approved by NRC (ADAMS Accession No. ML032790634) for referencing in a licensing application for the calculation of the T-H response in the PWRs designed by Combustion Engineering (CE) and Westinghouse Electric Company. The NRC staff's review of the licensee's mitigating strategy identified a generic concern associated with the use of the CENTS code for performing analysis of the ELAP event. This generic concern is applicable to Palo Verde. The generic concern associated with the use of CENTS for ELAP analysis arose because NRC staff reviews for previous applications of the CENTS code had imposed a condition limiting the code's heat transfer modeling in natural circulation (NC) to the single-phase liquid flow regime. This condition was imposed due to the lack of benchmarking for the two-phase flow models that would be activated in LOCA scenarios. Because the postulated ELAP scenario includes leakage from RCP seals and other sources, two-phase NC flow may be reached in the RCS prior to reestablishing primary makeup. Therefore, the NRC staff requested that the industry provide adequate basis for reliance on simulations with the CENTS code as justification for licensees' mitigation strategies.

To address the NRC staff's concern associated with the use of CENTS to simulate two-phase NC flow that may occur during an ELAP for CE-designed PWRs, the Pressurized Water Reactor Owners Group (PWROG) submitted a proprietary position paper (ADAMS Accession No. ML13297A174), which provided a comparison of several small-break (SB) LOCA simulations using the CENTS code to the CEFLASH-4AS code that is approved by the NRC for analysis of design-basis SBLOCAs. The analyses in the position paper show that the predictions of CENTS were similar or conservative relative to CEFLASH-4AS for key figures of merit for NC conditions, including the predictions of loop flow rates and the timing of the transition to reflux boiling. The NRC staff further observed the fraction of the initial RCS mass remaining at the transition to reflux boiling predicted by the CENTS code for the ELAP simulations in WCAP-17601 to be in reasonable agreement with confirmatory analysis performed by the NRC staff with the TRACE code. Therefore, as documented in a letter dated October 7, 2013 (ADAMS Accession No. ML13276A555), the NRC staff's review of the white paper concluded that the approach therein would acceptably address the generic concern associated with the application of CENTS to beyond-design-basis ELAP analysis with the following limitation:

- The use of CENTS in the ELAP analysis for CE plants is limited to the flow conditions before reflux boiling initiates.

The licensee indicated on page 72 of Reference 18 that the deployment of the RCS makeup pump should be initiated at 36 hours and be operational within 49 hours of the event initiation in order to maintain sub-cooled NC and to prevent two-phase NC.

During an audit process, the NRC staff requested that the licensee discuss the results of the CENTS analysis and show that:

(a) CENTS is not used outside of any ranges of applicability discussed in the position paper addressing the use of CENTS (e.g., prior to the reflux boiling initiation and the use of the same definition for initiation of reflux boiling specified in the position paper), and

(b) the predicted reactor vessel mixture level covers the top of the active fuel throughout the ELAP event.

In a response to NRC question RAI-17 (Reference 36) the licensee provided the results of the ELAP analysis which was used in determining the required time for operators to establish the RCS makeup flow in order to control RCS inventory. The calculated results presented were:

the integrated total flow; mixture levels in the inner vessel, reactor vessel upper head and pressurizer; void fraction at SG upper region; inner vessel void fraction; RCS hot leg void fraction; cold- and hot-leg temperatures; and loop flow rate. The results showed (Figure 17.2) that the mixture level covers the top of the fuel throughout the ELAP event. Also, Figure 17.3 showed that for the transient period up to 49 hours, except for a brief time due to fluid injection from the SIT, the calculated void fraction at the SG tube upper region is zero percent. This result indicated that no steam bubble formation occurs at the SG tube upper region. Although steam bubble formation occurs in the hot legs (with void fraction of less than 5 percent, as shown in Figure 17.5), those bubbles quickly collapse in the SG tubes within the first few feet of the tube length, as they enter the SG tubes and the RCS liquid transfers heat to the SG secondary side. The fast condensation of the bubbles occurs because the fluid conditions in the secondary side of the SG, near the tube sheet, is highly subcooled based on feedwater temperature and there is very little recirculation flow at the low steam flow rates. The flow entering the secondary side tube region from the downcomer is close to the temperature of the makeup feedwater supply. Figures 17.1 through 17.5 also showed that minor transitory bubble formation can occur and then disappear due to fluid injection from the SIT adding inventory to the RCS. Therefore, the time chosen for the start of [[

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Based on the above discussion, the NRC staff noted that the licensee's analysis satisfies the following guidance: (1) the mixture level covers the top of the fuel throughout the ELAP event (Figure 17.2), and (2) the licensee's use of the CENTS is within the condition that no bubble formation occurs in the SG tube upper region at 49 hours, before the RCS makeup flow is injected to the RCS (Figure 17.3). The NRC-endorsed NEI position paper limits the use of CENTS prior to initiation of reflux boiling, which is defined as a condition with the flow quality at the top of the SG tubes not exceeding a certain value (proprietary). This limitation allows the use of CENTS during conditions with existence of some amount of bubbles in the top of the SG tubes. Comparison of above licensee's guidance 2 with the NEI's limitation imposing on the use of CENTS indicated that the licensee's use of CENTS is within the allowable range. Therefore, the NRC staff determined that the licensee's use of CENTS in the ELAP analysis is acceptable.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to the use of CENTS for ELAP analysis, if they are implemented as described.

3.2.1.2 RCP Seal Leakage Rates

NEI 12-06, Section 3.2.1.7, Principle 6, states that "Strategies that have a time constraint to be successful should be identified and a basis provided that the time can be reasonably met."

During an ELAP event, cooling to the RCP seal packages will be lost and water at high temperatures will degrade seal materials, leading to seal leakage from the RCS. Without ac power available to the emergency core cooling system, the RCS inventory loss from the seal leakage for an extended period of time will result in inadequate core cooling conditions, as the water level in the reactor vessel drops below the top of the fuel assemblies. The ELAP analysis credits operator actions to align RCS makeup sources and replenish the RCS inventory to maintain the core covered with water. The effect of the seal leakage rates on the results of the

ELAP analysis is that greater values of the seal leakage rates will result in a shorter required operator action time for the operator to align the RCS makeup water sources.

On page 74 of Reference 18, the licensee indicates that Palo Verde RCP seals are assumed to have a maximum leakage of 17 gpm per pump at normal operating pressure during the ELAP event. During the audit process, the NRC staff requested the licensee to justify the use of the RCP seal leakage rate of 17 gpm per pump assumed in the ELAP analysis.

In its response to NRC question RAI-24 (Reference 36), the licensee indicated that the maximum RCP seal leakage rate was calculated by a thermal-hydraulic (T-H) analysis based on a seal-leakage model. The analysis used the following assumptions: (1) a stationary RCP shaft, (2) total loss of all seal cooling, and (3) an initial RCS pressure of 2250 pounds per square inch absolute (psia) and RCS cold-leg temperature of 555 ^{0}F, which represents the initial conditions for an ELAP event.

The T-H analysis simulates the fluid-flow characteristics through the seal housing assembly, including all flow regions associated with the Palo Verde RCPs from the RCP impeller through the third seal and controlled bleed-off (CBO) flow path. The NRC staff noted that the licensee did not address the adequacy of the flow paths used in the T-H model to represent the RCP seal leakage flow paths, nor discuss the uncertainties of the calculated pressure losses across the flow paths used for the determination of the seal leak rate.

In addition, the analysis assumed an increase in seal gap of 0.01 inches for each stage for the degraded seal during an ELAP. The licensee claimed that the assumed seal gap increase of 0.01 inches is conservative, resulting in the maximum reactor coolant leakage from the idle RCP across the three stages of the RCP shaft seal. The RCP seal failure is based on a combination of highly restrictive design flow passages such as shaft-to-casing gaps and limited shaft downward motion (less than 0.01 inches). The downward shaft movement allows the seal faces to open to a value significantly greater than the seals' severely worn face gap of 0.001 inches and does not occur until RCS pressure lowers to 50 psia. However, no RCP seal leakage testing data were presented to support the assumed seal gap increase of 0.01 inches used in the Palo Verde ELAP analysis.

To determine the adequacy of the RCP seal leakage used in the ELAP analysis, the NRC staff requested that the licensee provide:

- RCP seal leakage testing data applicable to ELAP conditions for Palo Verde and show the following:

  (a) the calculated maximum RCP seal leakage exceeds the RCP seal leakage rate obtained from the RCP seal testing data, and
  (b) the assumed maximum seal gap increase of 0.01 inches exceeds the seal gap increase obtained from the RCP seal testing data

The testing data used to support the calculated maximum leakage rate and the assumed maximum increase in the seal gap should be applicable to Palo Verde seals (with respect to the seal design and material, and seal cooling system), and ELAP conditions (in terms of the maximum temperature and pressure conditions) for an extended testing period consistent with the ELAP coping time. This is identified as Open Item 3.2.1.2.A in Section 4.1.

Regarding operating limits for maintaining the seal integrity, the information discussed in Section 4.4.2 of WCAP-17601, which states, "It has been shown that the probability of seal failure greatly increases when there is [[ ]]", is addressed in WCAP-16175. This WCAP explains that hydrodynamic stability analyses of various seal designs indicate the hydrodynamic response of RCP seals is influenced by several operational and design parameters. Specifically, analyses have shown that the face seal will remain stable under the following conditions:

(a) The inlet fluid is sufficiently subcooled [[ ]]
(b) The backpressure acting on the seal is greater than half the saturation pressure at the inlet temperature.

In addressing the NRC staff's question regarding applicability of the information in Section 4.4.2 of WCAP-17601 discussed above, the licensee stated in its response to NRC question RAI-24 that "Changes to the CE-designed plant generic operational guidance requiring performance of a rapid RCS cooldown and depressurization early during an ELAP event provided action to address the RCP-seal pop-open concern as well as O-ring degradation by lowering RCS temperature." Also, it stated that "The CBO relief valve actuates at 240 psia, providing backpressure for the number-3 seal. Since the temperature must reach 460 ^{0}F at the inlet of the third stage seal prior to posing a pop-open concern, criterion (b) is met.'

To determine whether the licensee adequately addressed the information discussed above relating to Section 4.4.2 of WCAP-17601, the NRC staff requested the licensee to provide the following information:

(a) Confirm whether an instruction step is available or not for the operator to maintain a [[ ]] fluid temperature for an ELAP event. If the procedure step is not available, provide justification.
(b) Justify the following statement that was used to satisfy above criterion (b): "...the temperature must reach 460 ^{0}F at the inlet of the third stage seal prior to posing a pop open concern."

The requested information is identified as Open Item 3.2.1.2.B in Section 4.1.

Regarding determination of the pressure-dependent RCP seal leakage rate, the licensee provided the information in its response to NRC question RAI-25 (Reference 36). [[

]] This causes an open flow path or complete failure of the affected seal stage. Thus, seal material degradation would not further increase the effective flow area through the

RCP seals. CENTS has two critical flow corrections: Henry-Fauske (HF) and homogeneous equilibrium model (HEM). The licensee used the HEM correction in its ELAP analysis. Its choice of the HEM critical flow correction is based on an assumption that the fluid conditions at the seals would be two-phase for a long period into the ELAP event. It noted that the HF correlation does calculate higher flow rates while the fluid is a subcooled liquid at the RCP location. The licensee performed a sensitivity study to quantify the effects of using the HF correction versus the HEM model. In its response to NRC question RAI-17 (Reference 36), the licensee showed that the transition time to two-phase NC flow reduced slightly when the HF correlation is used as compared to using the HEM model. As indicated in Attachment 1A of Reference 18, the operator is required to begin deployment of the RCS makeup pumps by 36 hours into the event and complete within 49 hours. The NRC staff agreed with the licensee that there is sufficient margin in achieving RCS makeup flow prior to commencing two phase NC flow. The NRC staff noted that the CENTS with adequate critical flow models was used to determine the seal leak rates for the ELAP analysis, and the margin of the required time to establish RCS makeup flow was identified for cases with use of the HF and HEM critical models. Therefore, the NRC staff determines that the method used to determine the pressure-dependent leakage rates for an ELAP analysis is acceptable.

The staff's current understanding of the licensee's approach, as described above, has raised concerns which must be addressed before confirmation can be provided that the approach is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, or that an acceptable alternative was provided, such that there would be reasonable assurance that the requirements of Order EA-12-049 will be met with respect to RCP seal leakage. These questions are identified as Open Items 3.2.1.2.A and 3.2.1.2.B above and in Section 4.1.

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.

Attachment 1A (pages 68 through 73 of Reference 18) contains the time constraints for ELAP mitigating strategies. The ELAP analyses used to establish the time constraints credit operator actions to begin to a cooldown immediately following the declaration of ELAP. The cooldown will decrease the RCS temperature and pressure, which decreases the RCP seal leakage and decreases the reduction of the RCS inventory. The operator actions are modeled to perform the cooldown by steaming through SG atmospheric dump valves (ADVs) and feeding water to the SGs from the condensate storage tank (CST) using the turbine driven auxiliary feedwater pump (TDAFWP). When the CST empties, the operator is to realign the TDAFWP suction path to the reactor makeup water tank (RMWT) or refueling water tank (RWT), and subsequently realign to the water reclamation facility (WRF) when water in the RMWT or RWT depletes. The ELAP analyses also credit operator actions to align the high pressure RCS makeup sources and replenish the RCS inventory in order to maintain the core covered with water. Based on the operator actions for the cooldown and RCS inventory makeup discussed above, the effects of the use of different values of the decay heat curve on the ELAP analysis are that the greater values of the decay heat curve will result in shorter operator action times required for the operator to complete the switchover of feedwater sources, and makeup of the RCS inventory.

The licensee stated on page 74 of Reference 18 that it used a plant-specific best-estimate (BE) decay heat model in the ELAP analysis. The licensee's approach deviates from WCAP-17601 which recommends to use the decay heat curve of ANS-5.1-1979 + 2* Sigma. The licensee stated that the deviation from the WCAP-17601 recommendation is justified by a Westinghouse Electric Company calculation, CN-REA-12-36 (Reference 25).

In response to NRC question RAI-31 on decay heat, the licensee provided additional information relating to the BE decay heat curve used in the ELAP analysis for Palo Verde. The decay heat analysis for Palo Verde was performed using the ORIGEN-S code that is a module of the Oak Ridge National Lab's (ORNL) SCALE 6.1 package. ORIGEN-S used ORIGEN-ARP cross section libraries that are also part of the ORNL SCALE package. Since the licensee for Palo Verde has no regulatory commitment to use ANSI/ANS-5.1-1979 or a standard review plan methodology for calculating decay heat for the ELAP event (which is a beyond-design-basis event), it elected to use the 'hybrid methodology' (ORIGEN-S) instead of ANS-5.1 1979 + 2* Sigma method which was recommended in Section 4.2.1 of WCAP-17601-P.

Westinghouse Electric Company Calculation, CN-REA-12-36 (Reference 25), presents details of the hybrid BE Palo Verde calculations and comparison with the ANS 5.1 standard calculations performed by Westinghouse. Major assumptions for the Palo Verde analysis are: (1) the nominal initial core power is 3990 megawatts thermal; (2) Uranium mass per assembly is 0.448 metric tons which is obtained from a total core mass of uranium (108 metric tons of uranium) divided by the number of fuel assemblies (241); (3) decay heat contribution from light elements such as fuel assembly structure activation products was factored into the ORIGEN-S calculations by multiplying each component mass by the ratio of neutron thermal flux at the location of the material to the flux at the center of the active fuel region (maximum); (4) core average enrichment considered for the Palo Verde model varies in the range of 3.0 to 5.0 weight percent of U-235; and (5) the other reactor internals activation products decay heat is not included in the decay curve.

These hybrid Palo Verde decay heat calculations consisted of [[

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Therefore, the decay curve generated is considered conservative but realistic compared to the actual core loading pattern.

Table 31.3 of Reference 36 lists the BE decay heat curves for the entire core for Palo Verde Units 1, 2 and 3. Decay heat contributions from actinides, fission products (FP) and fuel assembly activation products are included in the results. The end-of-cycle (EOC) curve represents the peak decay heat curve during the cycle for cooling times greater than 1.0E+04 seconds or for any cooling times if the reactor trip occurs after [[ ]] effective full power days (EFPD).

Comparison of ANS 5.1 calculations with the hybrid Palo Verde calculations has shown that the ANS 5.1 calculation results for decay heat is comparable with the PVNGS core decay heat for cooling times up to 1 year. For longer cooling times, the ANS 5.1 decay heat shows lower values. The reason for the difference is due to the Palo Verde methodology where the instantaneous isotopic fractions of the U-235, U-238, and Pu-239 are sampled at intermediate burnup steps for each of the three batches composing the core. Also, ANS 5.1 does not include decay heat power from activation products in reactor materials. Decay heat curves for various burnups, enrichments, cycle lengths, cooling times, and cross section libraries are illustrated in Figures 31.2 through 31.6 of Reference 36. The results from these calculations are considered realistic and conservative, therefore, an additional 2-sigma conservatism is not required for the analysis.

In summary, based on review of the licensee's response to RAI-31 (Reference 36) and its supporting calculations performed by Westinghouse (Reference 25), the NRC staff has determined that the hybrid Palo Verde calculations provide reasonable accuracy for decay heat calculation compared to the ANS 5.1 calculation, and therefore, are acceptable.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to the use of the decay heat model, if they 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.) are required to conform. When considering the code used by the licensee and its use in supporting the required event times for the sequence of events (SOE), it is important to ensure that the initial key plant parameters not only conform to the assumptions provided in NEI 12-06, Section 3.2, but that they also represent the starting conditions of the code used in the analyses and that they are included within the code's range of applicability.

On pages 12 through 15 of Reference 18 the licensee indicated that initial plant conditions and assumptions are consistent with those discussed in NEI 12-06, Section 3.2.1, and that analysis has been performed consistent with the recommendations contained within the executive summary of the PWROG Core Cooling Position Paper (PA-PSC-0965). The assumptions from that document are incorporated into the plant-specific analytical bases.

The licensee also discussed in its Integrated Plan and in plant calculation (DAR-TDA-12-2, Reference 24) the following key plant-specific assumptions used in the ELAP analysis.

1. The initial values of all key plant parameters are assumed at the nominal values corresponding to full power conditions. The applicable parameters include the power level, core inlet temperature, pressurizer pressure, RCS flow rate, and pressurizer water level.

2. The best estimate values of the physics data at the end of the cycle are assumed. The applicable physics data includes the xenon reactivity, moderator reactivity coefficient, Doppler feedback coefficient, control rod worth with all the rods in, and inverse boron worth.

3. Capacities of ADVs and TDAFW pump are based on the nominal design values.

4. No subsequent single failures of structures, systems, and components (SSCs) are assumed.

Regarding assumptions 1, 2, and 3, the NRC staff noted that the use of the nominal values for key plant parameters, the BE values for the physics data, and the nominal design values for the capacities of ADVs and TDAFW Pump are consistent with the industry approach and the NRC practice applied to the analysis of a beyond-design-basis event (BDBE). Since the ELAP event involves multiple initial failures that result in an extended loss of all ac power, it is a BDBE, compared to a design-basis event (DBE), which has an initiating event and a subsequent single failure of a mitigating system. Therefore, the NRC staff has determined that assumptions 1 through 3 are reasonable and adequate.

Regarding assumption 4, the NRC staff notes that in 10 CFR 50.2, "Definitions," that a concurrent single failure (SF) is not required to be considered in the definition of a station blackout (SBO). Since an SBO is caused by multiple initial failures of SSCs, it is a BDBE. The ELAP is similar to an SBO, but with a longer duration, is also a BDBE. Therefore, the NRC staff determines that for a BDBE such as the ELAP event, assumption 4 without consideration of an SF in the analysis is adequate. This conforms to the endorsed guidance in NEI 12-06, Section 3.2.1.4, boundary condition 4, stating that "no independent failures, other than those causing the ELAP/LUHS event, are assumed to occur in the course of the transient."

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 plant conditions and assumptions, if they 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 [Severe Accident Management Guidelines]. 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 25 and 26 of Reference 18, the licensee listed the installed instrumentation required to remain functional for maintaining core cooling and heat removal during phase 1 of an ELAP. For Mode 1, the required instrumentation includes: (1) SG water level wide range (WR); (2) SG pressure; (3) core exit thermocouples (CETs); (4) T_{hot}, T_{cold} (two hot leg and two cold leg on the same loop); (5) subcooling/saturation margin (RCS and CET); (6) RCS pressure (WR); and (7) containment building pressure. Note 3 on page 26 indicates that as a result of breaker alignments performed to energize the required instrumentation listed above, the following additional instrumentation is also available to the operator for monitoring: (1) safety injection tank 2A and 2B level and pressure; (2) pressurizer level; (3) reactor vessel level monitoring system (RVLMS); (4) ADV positions; (5) TDAFW pump flow to each SG (A-train); and (6) condensate storage tank level.

For Modes 5 and 6, the required instrumentation includes (1) CETs; (2) T_{hot}, T_{cold} (two hot leg and two cold leg on the same loop); (3) subcooling/saturation margin (RCS and CET); (4) RCS pressure (WR); and (5) containment building pressure.

As indicated on pages 33, 34, 36, and 38 of Reference 18, the same set of installed instrumentation discussed in this section are required to remain functional for maintaining RCS inventory control during phases 1 through 3 of an ELAP event.

The NRC staff requested the licensee to justify that the instrumentation listed on pages 25, 26, 28, 30, 33, 34, 36, and 38 of Reference 18, and the associated setpoints credited in the ELAP analysis for automatic actuations and indications required for the operator to take appropriate actions are reliable and accurate in the containment harsh conditions during the ELAP event.

In response to NRC question RAI-23.b, the licensee replied (Reference 36) that instruments identified above are safety related, seismically qualified, meet the environmental qualification requirements of 10 CFR 50.49, "Environmental qualification of electric equipment important to safety for nuclear power plants," and are verified qualified consistent with the criteria in NEI 12-06, Section 3.2.1.12, "Qualification of Installed Equipment." The ELAP analysis does not credit automatic actuation beyond the SBO scenarios, and such actuations would occur within the first hour of the event, which is prior to developing harsh environmental conditions. The analysis supporting the SBO response strategies was previously reviewed and approved (ADAMS Accession No. ML062910280) by the NRC. Operator actions directed by the FSG are manual actions after the first hour. Instrumentation and components credited are qualified to 10 CFR 50.49 for the events of a loss of coolant accident and steam line break. In addition, the estimated maximum temperature within the containment during an ELAP remains below the threshold of the equipment qualification harsh limit of 230°F. Based on the above discussion of the highly qualified instrumentation, and containment temperature during ELAP remaining lower than the equipment qualified harsh limit, the NRC staff agrees that the identified instrumentation and components will remain reasonably accurate and reliable for use in mitigating the consequences of an ELAP event.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 they are implemented as described.

3.2.1.6 Sequence of Events of the ELAP Analysis

NEI 12-06, Section 3.2.1.7, Principle (6) states that "Strategies that have a time constraint to be successful should be identified and a basis provided that the time can reasonably be met."

The following SOE for an ELAP event is based on the information included in Table 5.1.1 of Westinghouse analysis report, DAR-TDA-12-2 (Reference 24), for the case with the RCP seal leakage rate of 17 gpm per pump for the first 0.22 hours, which was confirmed by the licensee as correct information (RAI-29 response, Reference 36). The remaining SOE is based on the information in Attachment 1A of Reference 18. The analysis (DAR-TDA-12-2) assumed that at the initiation of the event, an instantaneous loss of all ac power occurred. This assumption resulted in a trip of the RCPs, and initiated turbine trip and reactor trip. Within 4 seconds of the reactor trip signal, the control rods inserted. The turbine trip resulted in the increase of SG pressure, and main steam safety valves (MSSVs) opened at 13 seconds, resulting in the decrease of the SG water level that resulted in initiation of the auxiliary feedwater (AFW) actuation signal from steam generator (SG) 1 at 0.203 hours. With a 60-second delay, the AFW flow to both SGs began from the TDAFW pump at 0.22 hours.

At one hour after the ELAP event initiated, the operator begins a cooldown at the normal cooldown rate of 70 ^{0}F per hour by steaming both SGs through the atmospheric dump valves (ADVs).

At 3 hours, the cooldown resulted in enough of a decrease of the RCS pressure that the SITs began to inject water into the RCS.

At 4.11 hours, the operator completed the cooldown. The licensee indicated in its RAI-28 response (Reference 36) that it relied on the following operation actions to complete the cooldown: (1) initiate a cooldown by adjusting the B Train ADV position on each SG to increase steam flow and establish a cooldown rate of approximately 70°F per hour; (2) feed the SGs with the TDAFWP to achieve and maintain SG water levels at 85% narrow range, which increases the available volume of secondary water; and (3) stop the cooldown and stabilize the plant by adjusting the B Train ADV position on each SG to decrease steam flow. The plant is stabilized at an analytical limit of 350°F (primary) and 135 psia (secondary). All of the credited actions are performed from the control room.

At 16 hours, the nitrogen supply used as the motive force for the ADV operation is depleted, and the operator begins to manually operate the ADVs. The licensee indicated in its RAI-18 response (Reference 36) that each ADV is a pneumatically modulated control valve supplied by instrument air or supplied by four dedicated, seismically qualified nitrogen accumulators. The accumulators are sized to allow cooldown of the plant during the NC cooldown from post-trip temperatures to 350°F. The Palo Verde SBO licensing calculation verifies that the nitrogen accumulator contains sufficient nitrogen content to perform eleven strokes of ADV function over the 16 hour SBO coping period. In addition, high-pressure nitrogen cylinders are installed on a manifold assembly as a backup to the accumulators. The SBO procedure includes direction to the operators to connect the supplemental nitrogen system, as needed, to back up the nitrogen accumulators for extended operation of the ADVs. The Palo Verde load shedding study also showed that sufficient power is available for two ADVs to remain available for greater than 16 hours after load shed along with the associated control, indication and power to four DC solenoid valves for nitrogen supply to the ADVs. Manual operation of the ADVs is accomplished using Appendix 18, "Local ADV Operation," of procedure 40EP-9EO10. The time required to align the ADV for local/manual operation is less than 15 minutes once the operator is at the ADV location.

At 36 hours, the operator used an installed charging pump to replenish the RCS inventory. If the charging pump was not available, the operator was required to begin to install the RCS makeup pump and replenish the RCS inventory. The action is required within 49 hours to maintain single phase NC and to prevent two-phase NC, satisfying the limitation that allows the use of CENTS prior to initiation of reflux boiling (see more discussion in Section 3.2.1.1 of this evaluation). As indicated in the licensee's RAI-27 response (Reference 36), the analysis, Westinghouse Calculation CN-FSE-12-10 (Reference 40), has shown that a FLEX RCS makeup pump capable of supplying 30 gpm at 400 psia is needed 49 hours following initiation of the event. (See more discussion in section 3.2.1.9 of this evaluation regarding adequacy of the pump capacity for RCS inventory controls).

At 42 hours, the water in the condensate storage tank (CST) is depleted, and the operator begins to connect the TDAFW pump suction path to the reactor makeup water tank (RMWT) or the refueling water tank (RWT) for the high seismic event. This operator action is required to complete within 45 hours and maintain the SG heat removal function. As indicated in the licensee's RAI-20 response (Reference 36), the CST-RMWT switchover at 45 hours is based on an analysis assuming that the CST water volume is sufficient to remove the heat within the water and metal mass of the RCS in addition to decay heat.

At 48 hours, the operator begins to stage the SG makeup pump used to replace the TDAFW pump in case of TDAFW pump mechanic failures due to the long-term use exceeded the design limits. The licensee indicated in its RAI-27 response (Reference 36) that the capacity of the FLEX SG makeup pump is based on analysis assuming that the pump capacity is sufficient to remove the maximum decay heat at one hour after shutdown (See more discussion in Section 3.2.1.9 of this evaluation regarding adequacy of the pump capacity for heat removal).

At 72 hours, the operator began to connect the water source from the water reclamation facility (WRF) to the CSTs at each unit. The operator action is required to complete within 116 hours before available water in the CST and RMWT depletes. As indicated in the licensee's RAI- 20 response, the CST-WRF switchover at 116 hours is based on an analysis assuming that the CST and RMWT water volume is sufficient to remove the heat within the water and metal mass of the RCS in addition to decay heat.

At 72 hours and beyond, the operator begins to deploy diesel fuel to support the diesel SG makeup pump, and turn on the diesel SG makeup pump and turn off the TDAFW pump.

In addressing the NRC staff's question RAI-23 regarding reliability of equipment credited in the ELAP analysis for mitigating the consequences, the licensee indicated in its response (Reference 36) that equipment, systems, and structures credited for the mitigating strategies are safety related except for the upper portion of the CST and the RMWT and its associated piping. Both the RMWT and the upper portions of the CST are designed to 10 CFR 50 Appendix B augmented quality (i.e., seismic 2 over 1) and to withstand an operating basis earthquake. As described on page 26, Notes: Item 1, of Reference 18, the seismic fragility evaluations were performed using the guidance contained in EPRI NP-6041-SL Revision 1, "A Methodology for Assessment of Nuclear Plant Seismic Margin," August 1991. The CST upper portions and the RMWT and associated systems were found to be robust with a calculated acceptable high-confidence-of-low-probability-of-failure (HCLPF) capacity compared with the station Safe Shutdown Earthquake seismic level. As a contingency for these water sources, the FSG also provide guidance for the transfer of water from the RWT, which is a seismic category 1, quality-related structure. Equipment needed to transfer water from the RWT to the CST is currently on site and would be deployed as a mitigating strategy. In addition, the NRC staff noted that the UFSAR (Reference 19), Chapter 3, describes the CST as being protected against tornado missiles. Therefore, the NRC staff determines that the equipment credited in ELAP analysis is reasonably reliable and will provide its required functions on demand.

In addressing the NRC staff's question RAI-2 regarding procedures and training programs for implementing the mitigating strategies, the licensee indicated in its response that it is developing an FSG, and will develop administrative control programs and training plans consistent with the guidance in NEI 12-06, Section 2.4, to implement and maintain the FSG. Implementation of these programs will be consistent with existing Palo Verde programmatic controls. Verification of output documents is an integral part of these processes. The licensee will provide to the NRC a description of the beyond-design-basis program, administrative controls, and training program as a part of a periodic six-month update to the Integrated Plan.

Based on the discussion above, the NRC staff noted that: (1) the identified SOEs are consistent with the analyses used in establishing mitigating strategies for ELAP at Palo Verde; (2) the equipment credited in the ELAP analysis is reasonably reliable; (3) the licensee FSG, and the associated administrative control programs and training plans under development will be consistent with the guidance in NEI 12-06, Section 2.4, ensuring that the required operator actions identified in the SOE can be reasonably achievable within the required time constraints. Therefore, the NRC staff determined that the licensee's approach above conforms to the endorsed guidance in NEI 12-06, Section 3.2.1.7, Item (6), stating that "Strategies that have a time constraint to be successful should be identified and a basis provided that the time can reasonably be met," and thus, concluded that the SOE is adequately identified, and the required completion of operator actions can be reasonable achievable within the required time constraints.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 sequence of events, if they are implemented as described.

3.2.1.7 Cold Shutdown and Refueling

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

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

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

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

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 implementation during shutdown and refueling, if they are implemented as described.

3.2.1.8 Core Subcriticality Analysis

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

> All plants provide means to provide borated RCS makeup.

Item 6 on page 69 of Reference 18 indicates that at one hour after an ELAP event initiates, the operator is required to promptly start a cooldown at the normal rate of 70 ^{0}F/hour. Cooldown of the RCS will result in a decrease in loss of the RCS inventory from RCP seal leakages, and, in turn, an increase in available time for the operator to take action and maintain the core covered with water. However, during the cooldown, the RCS temperature and pressure will decrease. In the presence of a negative moderator temperature coefficient, the cooldown by steaming through the atmospheric dump valves (ADVs) increases positive reactivity in the core. If the control rod worth from the inserted control rods following a reactor trip and any boron addition from RCS injection are not sufficient to overcome the positive reactivity addition from the cooldown, the reactor will return back to power. As a result of the power increase and RCS pressure decrease, the calculated departure from nucleate boiling ratios may decrease, possibly causing fuel damage.

The third paragraph on page 35 of the Integrated Plan states that "...PVNGS control rod shutdown margin and borated water inventory in the RCS and SITs are sufficient to prevent re-criticality of the core."

During the review, the NRC staff requested that the licensee discuss the boron mixing model used for the re-criticality analysis, and address the adequacy of the boron mixing model for the intended purpose. In response to the NRC staff's question RAI-26, the licensee indicated (Reference 36) that a scoping re-criticality analysis was performed to determine the required boration for maintaining sub-criticality with consideration of a plant trip and NC cooldown. The analysis (DAR-TD-12-2, Reference 24) was performed using CENTS. As discussed in Section 3.2.1.1 of this evaluation, the use of the CENTS was adequate since it was within the allowable range. The analysis credited the initial insertion of negative reactivity due to the xenon transient. This assumption is acceptable, since (1) the assumption is similar to that of the SBO analysis, and (2) the assumption is consistent with the supplemental staff guidance (on page 8 of the Enclosure to the guidance documented in ADAMS Accession No. ML13238A286), which states that for the reactor re-criticality analysis "the buildup of negative reactivity from xenon can be credited". The analysis considered the positive reactivity associated with RCS cooldown to the cold leg temperature associated with the target SG pressure in accordance with mitigation strategies. The results of the re-criticality analysis showed that during an ELAP event, increases in RCS boron concentration (from either boration of the RCS during RCS cooldown due to SIT injection, or RCS boration due to RCS makeup injection) are not required to maintain core sub-criticality because of the substantial negative reactivity added by insertion of all control rods. Since the analysis did not rely on increases in RCS boron concentration to maintain core sub-criticality during ELAP, the boron mixing model was not used in the re-criticality analysis, and thus, the NRC staff determines that adequacy of the model is not of concern. The above discussion identified that: (1) the use of CENTS is within the allowable range; (2) the assumption crediting the initial insertion of negative reactivity due to the xenon transient is consistent with NRC staff supplemental guidance or the licensee's mitigation strategies; (3) the analysis is conservative, as credit is not taken for the boration from the SIT and RCS makeup injections, resulting in a minimum shutdown margin; and (4) the results of the re-criticality analysis show that the shutdown margin is sufficient to remain core sub-criticality throughout the ELAP event. Therefore, the NRC staff determined that the re-criticality analysis is adequate in support of the licensee's position stating that post-reactor-trip re-criticality will not occur during the entire ELAP event.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 subcriticality, if they are implemented as described.

3.2.1.9 Use of Portable Equipment

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

> Regardless of installed coping capability, all plants will include the ability to use portable pumps to provide RPV/RCS/SG makeup as a means to provide diverse capability beyond installed equipment. The use of portable pumps to provide RPV/RCS/SG makeup requires a transition and interaction with installed systems. For example, transitioning from RCIC to a portable FLEX pump as the source for RPV makeup requires appropriate controls on the depressurization of the RPV and injection rates to avoid extended core uncovery. Similarly, transition to a portable pump for SG makeup may require cooldown and

> depressurization of the SGs in advance of using the portable pump connections. Guidance should address both the proactive transition from installed equipment to portable and reactive transitions in the event installed equipment degrades or fails. Preparations for reactive use of portable equipment should not distract site resources from establishing the primary coping strategy. In some cases, in order to meet the time-sensitive required actions of the site-specific strategies, the FLEX equipment may need to be stored in its deployed position.

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.

The licensee's plan for using portable pumps for maintaining core cooling and heat removal, and RCS inventory control was reviewed. On page 27 and page 35 of Reference 18, the licensee discussed the use of portable pumps for maintaining RCS core cooling and heat removal and RCS inventory control, respectively. Pages 64 and 65 list the portable pumps required for the ELAP mitigation. Page 64 listed four self-priming pumps and four high pressure RCS makeup pumps that are required during phase 2 of ELAP. The required capacities of the pumps are 370 gpm at 500 psi, and 30 gpm at 1525 psi for the priming pumps and high pressure RCS makeup pumps, respectively. Page 65 listed for phase 3 high pressure RCS makeup pumps and pumps to make up to the CSTs from the site reservoirs. The required capacities of respective pumps for phase 3 are 30 gpm at 1525 psi and 1200 gpm at 130 psi.

During the NRC review, the NRC staff requested the licensee to provide the following information:

(1) Specify the required time for the operator to realign each of the above discussed pumps and confirm that the required time constraints are consistent with the results of ELAP analysis.
(2) Discuss how the required flow rates for the portable pumps were determined, and justify that the capacities of each of the above discussed portable pumps are adequate to maintain core cooling during phases 2 and 3 of the ELAP event.

In response to the NRC staff's question RAI-27, the licensee provided (Reference 36) the following additional information to address item (1).

The licensee indicated that required time constraints for the operator to realign each of the above discussed pumps are listed in Attachment 1A of Reference 18. The sequence of events timeline listed in Attachment 1A is based the ELAP analyses discussed in Westinghouse calculations (DAR-TDA-12-2 (Reference 24), CN-FSE-12-10 (Reference 40), and CN-SEE-II-12-33 (Reference 41)), and Westinghouse Report TR-TSE-13-6, which assumed the most limiting plant conditions during an ELAP event. Procedural actions based on actual plant conditions during an event will ensure the equipment is placed in service as necessary to maintain key safety functions.

In response to the NRC staff's question RAI-27, the licensee provided (Reference 36) the following additional information to address item (2).

- For RCS Makeup (high pressure RCS makeup pumps required or phases 2 and 3):

The licensee indicated that determining the FLEX RCS makeup capacity is based on the ability to borate the RCS to maintain the reactor subcritical and the ability to control the RCS inventory to sustain natural circulation (NC) flow to maintain adequate core cooling. For Palo Verde, the limiting condition is providing RCS makeup prior to initiation of two-phase NC. The NRC staff noted that the limiting condition used for determining the required time constraint to establish RCS makeup flow is within the allowable range of use of CENTS, which was used to determine the required time constraint for the RCS makeup pumps. Therefore, the NRC staff determines that this required time constraint for the operator to align the FLEX RCS makeup pump is adequate (See more discussion in Section 3.2.1.1 of this evaluation).

The analysis (Westinghouse Calculation CN-FSE-12-10) has shown that a FLEX RCS makeup pump capable of supplying [[ ]] is needed at 49 hours following initiation of the event. This required flow rate is sufficient to account for RCS inventory loss via RCP seal leakage and restore RCS level to normal operating range in the pressurizer. The pump discharge pressure is sufficient to provide the required flow rate at the RCS injection point for the expected pressure at 49 hours into the event. To provide additional margin, a FLEX RCS makeup pump capable of supplying 30 gpm at 1525 psi is considered as it provides the ability to control RCS inventory earlier in the event. The NRC staff noted that the pump capacity is established to provide sufficient RCS flow injection to restore RCS inventory to the normal operating level. Therefore, the NRC staff determined that the required capacity of the FLEX RCS makeup pump is adequate for use as a backup to maintain RCS inventory control.

- For SG Makeup (phase 2 self-priming pumps):

The licensee indicated that determining the FLEX SG makeup pump capability is based on the ability to restore and maintain SG level if and when the auxiliary feedwater system is not capable of providing this function. The Palo Verde FLEX SG makeup pump has been sized to provide 370 gpm at 500 psi. The licensee's design criterion used to determine the flow rate is that the SG makeup pump flow rate is sufficient to remove the maximum decay heat at one hour after shutdown.

The pump discharge pressure is sufficient to deliver the required flow rate at the SG injection point when SG pressure is 300 psi. This pressure has been identified as a potential hold point during the RCS cooldown in order to vent or isolate the SIT to prevent SIT nitrogen injection into the RCS. The cooldown strategy in the FSGs will ultimately reduce SG pressure to approximately 135 psia to support continued operation of the installed AFW equipment as long as possible.

As the FLEX SG makeup pump is sized to exceed the flow rate required to remove decay heat one hour into the event, it can support recovering level in the SG and RCS if necessary. There is no specific time during the event that requires this pump to be placed in service, assuming the TDAFWP continues to operate. However, to provide additional margin to safety, the pump will be staged as a backup for SG feed based on the future staffing study required per 10 CFR 50.54(f) , Recommendation 9.3. The time provided in Item 20 in Attachment 1A of Reference 18 to stage the FLEX SG makeup pump is associated with a timing and deployment study performed to support development of the FLEX Integrated Plan. Actual plant parameters such as SG level and RCS temperature will trigger actions in the controlling procedure to put the FLEX SG feed pump in service as necessary to maintain adequate core cooling.

Based on the above discussion, [[

]] Therefore, the NRC staff determined that the capacity of the SG makeup pump is adequate for use as a backup to remove decay heat.

- For CST Makeup (phase 3 pumps to make up to the CST from reservoir):

The licensee indicated that for long term coping, the CST may be used as a water source for SG makeup, spent fuel makeup, and RCS makeup, in combination with boron mixing capability. The Palo Verde CST makeup pump has been sized to provide 1200 gpm at 130 psi. The pump flow rate is sufficient for RCS decay heat removal, spent fuel pool cooling makeup and RCS makeup requirements. As shown in Westinghouse calculation CN-SEE-II-12-33, the requirements have been determined to be [[ ]] per unit and [[ ]] for three units. The required pump flow rate of 1200 gpm provides additional margin above the required makeup flow to all three units.

Further, the CST makeup pump is needed before the CST and RMWT inventory is depleted at 116 hours as discussed on page 24 of Reference 18 to ensure a continuous supply of coolant for core cooling through the SGs. This pump provides makeup from site reservoirs to the CST at each unit. Since it is not needed until 116 hours, it is a phase 3 pump to be provided from a regional response center. A future staffing study will evaluate the licensee staff's capabilities to ensure this pump is available when needed.

Based on the above discussion, the NRC staff noted that (1) the pump capacity was established to provide sufficient water inventory in meeting the requirements of RCS decay heat removal, spent fuel pool cooling makeup and RCS makeup, and (2) the required time of 116 hours was established to provide sufficient water supply prior to depletion of the CST and RWST inventory. Therefore, the NRC staff determined that the required capacity of the CST makeup pump and the required alignment time are adequate for the intended use.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance in NEI 12-06, as endorsed by JLD-ISG-2012-01, and provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to the use of portable equipment, if they are implemented as described.

3.2.1.10 Acceptability of Core Cooling Strategies

For an ELAP initiated from full power, the ELAP analysis shows that, with credit for the above operator actions and associated action times, the RCS inventory is maintained such that the core is covered, and control rod worth and borated water injected from the SITs are sufficient to prevent the core re-criticality throughout the ELAP duration. The decay heat removal and core cooling are reasonably achievable through the combined operations of the ADVs, TDAFW pump, SITs and portable pumps including the high pressure RCS makeup pumps, self priming pumps and pumps to makeup to the CST from reservoirs.

With the implementation of appropriate ELAP mitigation procedures for the plant operators, the NRC staff concludes that the SGs will have sufficient water supplies to remove the decay heat and the RCS will have sufficient water makeup sources to maintain the RCS inventory for core cooling, and prevent two phase NC.

Based on its review discussed above, the NRC staff found that (1) the analysis used an NRC-approved code within the applicable range, (2) the instrument and equipment credited for consequence mitigation were reliable, (3) the assumed plant conditions were adequate, and (4) the results showed that core coolability and sub-criticality could be maintained for the duration of an ELAP event. The NRC staff also identified the following Open Items:

- Open Item 3.2.1.2.A RCP Seal Leakage Rate
- Open Item 3.2.1.2.B RCP Seal Leakage Rate (Operating Conditions)

The staff's understanding of the licensee's approach, as described above, confirms that the licensee's plans are 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 items and confirmatory item above, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to core cooling strategies if they are implemented as described.

3.2.2 Spent Fuel Pool Cooling Strategies

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

As described in NEI 12-06, Section 3.2.1.7 and JLD-ISG-2012-01, Section 2.1, strategies that have a time constraint to be successful should be identified and a basis provided that the time can be reasonably met. NEI 12-06, Section 3 provides the performance attributes, general criteria, and baseline assumptions to be used in developing the technical basis for the time constraints. Since the event is a beyond-design-basis event, the analysis used to provide the technical basis for time constraints for the mitigation strategies may use nominal initial values (without uncertainties) for plant parameters, and best-estimate physics data. All equipment used for consequence mitigation may assume to operate at nominal setpoints and capacities. NEI 12-06, Section 3.2.1.2 describes the initial plant conditions for the at-power mode of operation; Section 3.2.1.3 describes the initial conditions; and Section 3.2.1.6 describes SFP 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 Order EA-12-049 for maintaining SFP cooling. This criterion is keeping the fuel in the SFP covered.

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

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

On pages 44 and 45 of Reference 18, in the section of its Integrated Plan discussing <u>phase 1</u> of the strategy to maintain SFP cooling, APS stated:

> The PVNGS SFP conditions were analyzed for a number of postulated scenarios for the ELAP event. The scenario with ELAP following a seismic event (summarized in Reference [21]) was found to be the limiting case due to higher SFP inventory losses. The event conditions considered that would affect time to boil are:
>
> - SFP decay heat during Mode 1 to Mode 6 with core not off-loaded
> - SFP decay heat following full core offload
>
> The flow rates to makeup for SFP boil-off were determined using the decay heat load from the spent fuel assemblies in the SFP storage racks. There are two conditions analyzed for the SFP decay heat load: normal operation and the worst case scenario which is defined as a full core offload beginning 100 hours after shutdown plus 964 fuel assemblies from the 12 previous refueling cycles (Reference [19]). Table 4.6.2- 1 from Reference [19] shows the decay heat loads for the normal and worst case scenarios. The time to boil calculations are determined based on the site elevation and an assumed SFP coolant bulk temperature of 125 F (Reference [19]). Additionally, the calculations assume loss of SFP inventory resulting from seismic sloshing, loss of non seismically qualified piping entering the pool and system leakage.
>
> In a postulated ELAP, the required SFP makeup flow rate to match the boil-off for the Mode 1- 6 with core not off-loaded case is 27 gpm and the SFP makeup flow rate for the full core offload case is 100 gpm (Reference [21]).
>
> The inventory loss resulting from system leakage and pool gate seal leakage is estimated to be 31 gpm (assuming leakage through the fuel transfer canal gate and fuel transfer tube containment isolation valve PC-V118). Therefore, SFP makeup flow rate requirement to maintain adequate SFP level (10 ft above the

> fuel) is 58 gpm for the Mode 1- 6 with core not off-loaded case and 131 gpm for the full core offload case. Diesel driven pumps will be used to deliver the required flow rate through monitor type nozzles to provide water to the spent fuel pool.
>
> In phase 1, action is taken to open the Fuel Building rollup door to maintain accessibility to the alternate SFP makeup pump location which will be used in phase 2.
>
> In the event of a postulated ELAP with maximum SFP heat loads due to a full core offload, the time to boil is reduced. The most conservative case time to boil is 3.3 hours after an ELAP. As a result of boiling, SFP level will reach 10 ft of water above the irradiated fuel assemblies in approximately 17 hours after the initiating event. Procedures will be established to support the SFP cooling safety function during events with full core offload conditions.
>
> Conservatively, for the Mode 1 to Mode 6 with core not off-loaded case, SFP boiling will occur approximately 11.5 hours after the initiating event. As a result of boiling, SFP level will reach 10 ft of water above the irradiated fuel assemblies in approximately 39 hours after the initiating event. Within 39 hours, phase 2 actions should be initiated to provide makeup to the SFP.

The NRC staff has reviewed the basis for the minimum flow rates and the identification of the time constraints for initiation of makeup to the SFPs and concludes that that because they conform to the guidance of NEI 12-06 as endorsed by JLD-ISG-2012-01, there is reasonable assurance that the guidance and strategies developed based on these analyses will comply with EA-12-049.

On page 46 of Reference 18, in the section of its Integrated Plan discussing phase 2 of the strategy to maintain SFP cooling, APS states:

> Phase 2 actions will stage a FLEX pump outside the fuel building. In Mode 1 through Mode 4, the RWT will be used as the primary source for SFP makeup. In Modes 5 and 6 and during a full core offload, the CST will be used as the primary source for SFP makeup.
>
> The FLEX pump discharge hose is routed to one of the two permanent SFP makeup connections. The primary connection is on the outside of the north wall of the fuel building. The alternate connection is just inside the rollup door to the fuel building.

On page 64 of Reference 18, in Table A, "PWR Portable Equipment Phase 2," APS identifies 4 SFP makeup pumps with performance criteria to provide 110 gpm at 20 psi. Because the performance criterion for flow is lower than the identified minimum flow rate of 131 gpm, the NRC asked the licensee to explain. During the audit process, the licensee stated that the previous flow rate was incorrect, and committed to provide at least 200 gpm from each SFP makeup pump. This has been identified as Confirmatory Item 3.2.2.A., in Section 4.1, below.

The staff's understanding of the licensee's approach, as described above, has raised concerns which must be addressed before confirmation can be provided that the Integrated Plan is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, or that an acceptable alternative was provided, such that there would be reasonable assurance that the requirements of Order EA-12-049 will be met with respect to SFP cooling strategies. This concern is identified as an open item above and in Section 4.1.

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 PWR containment strategies to effectively maintain containment functions during all phases of an ELAP. One of these acceptable approaches is by analysis. This is the approach which was selected by APS.

On page 17 of Reference 18, APS stated that containment integrity was reviewed using computer code modular accident analysis program (MAAP) version 4.0.7. MAAP was used to model the containment response for 72 hours post event and the calculated containment pressure and temperature did not exceed 50 percent of containment design limits. Table 6.2.1-3 of the Updated Final Safety Analysis Report UFSAR for PVNGS shows the internal containment design pressure to be 60 psig and the maximum design basis accident design temperature to be 300°F.

As stated on page 40 of Reference 18, this evaluation was based on the boundary conditions described in Section 2 of NEI 12-06. Specifically, the APS Integrated Plan referenced an analysis which demonstrated the maintenance of containment functions during an ELAP for Mode 1 to Mode 4.

In Mode 1 to Mode 4 conditions, the SGs are available to remove decay heat from the reactor with minimal addition of heat to the containment atmosphere. The only additions of heat and mass to the containment atmosphere under such conditions are the ambient heat losses from the surfaces of hot equipment and the leakage of reactor coolant from the Reactor Coolant Pump (RCP) seals. On page 32 of Reference 18, it is stated that the RCP seals are assumed to have a maximum leakage of 17 gpm per pump at normal operating pressure. Also stated on page 32 is the fact that plant personnel will cool down the reactor coolant system (RCS) to approximately 350°F and depressurize it accordingly. As RCS pressure diminishes, so will the attendant leakage. Thus, it is conservative to assume a total combined RCP seal leakage value of 68 gpm (17gpm for each of the 4 RCPs) being discharged into the containment atmosphere for the duration of the ELAP. Table 6.2.1-3 of the UFSAR shows that the net free volume of the containment is 2.62 million cubic feet. In general, the NRC staff has not previously evaluated the capability of the MAAP code for performing analyses to demonstrate the integrity of large-dry containments during ELAP conditions. However, the relatively small amount of heat and mass being added to the containment atmosphere when the steam generators are available coupled with the large net free volume of the containment provide reasonable assurance that the overall conclusion of the MAAP analysis would not be invalidated even if minor discrepancies were identified in the code. There is, however, a clear nexus between the resolution of Open Item 3.2.1.2.A and the seal leakage assumption in the calculation for containment response. This resolution has been identified as Confirmatory Item 3.2.3.A in Section 4.2.

Additionally, the NRC staff requested information which demonstrates that the mass and energy leakage into containment modeled in the MAAP analysis is consistent with that predicted by the CENTS code.

In a response to these requests dated July 18, 2013 [Reference 36], the licensee stated that:

> This RAI was identified as a generic concern or question during the NRC public meeting on April 18, 2013, regarding the NRC order on mitigating strategies (Order EA-12-049). The nuclear industry will resolve this concern generically through the Nuclear Energy Institute (NEI) and the applicable industry groups (e.g., PWROG, EPRI, etc.). Once this concern is resolved, APS will provide an update to this RAI response in a periodic six-month update to the OIP. NEI will be coordinating with the NRC on the schedule for resolution.

The resolution of this issue has been combined with the seal leakage concern specified above and is listed as Confirmatory Item 3.2.3.A in Section 4.2.

The analysis did not credit (or necessitate) any portable or temporary equipment which would be required to maintain containment functions in any phase of the ELAP. As such, no modification to existing plant equipment or storage and protection of portable equipment was required.

Section 3.2.1.10 of NEI 12-06 specifies that there is a minimum set of parameters necessary to support strategy implementation. In the associated table for PWRs, the parameter of containment pressure is listed. On pages 40, 41, and 43 of Reference 18, the licensee states that PVNGS will monitor containment pressure conditions via permanent and/or portable equipment (as available) throughout all phases of an ELAP, and will furthermore develop procedures to read this instrumentation locally as required by Section 5.3.3 of NEI 12-06. This monitoring function is also consistent with the baseline capability and performance attributes shown in Table 3-2 and Table D-2 of NEI 12-06. This conforms to the guidance of JLD-ISG-2012-01 and NEI 12-06.

For Modes 5 and 6, Cold Shutdown and Refueling, the licensee committed to incorporate the guidance from the NEI position paper entitled "Shutdown/Refueling Modes, " ADAMS Accession No. ML13273A514, which was endorsed by the NRC by letter dated September 30, 2013, ADAMS Accession No. ML13267A382. See section 3.2.1.7 above.

The staff's understanding of the licensee's approach, as described above, has raised concerns which must be addressed before confirmation can be provided that the Integrated Plan is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, or that an acceptable alternative was provided, such that there would be reasonable assurance that the requirements of Order EA-12-049 will be met with respect to containment functions strategies. This concern is identified as Confirmatory Item 3.2.3.A above and in Section 4.2.

3.2.4 Support Functions

3.2.4.1 Equipment Cooling – Cooling Water

NEI 12-06, Section 3.2.2, Paragraph (3) provides that:

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

In Reference 18, APS provided technical justifications for the ability to carry out the mitigation strategies with the loss of the normal cooling systems during phase 1, phase 2, and phase 3.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 need for equipment cooling water, if they are implemented as described.

3.2.4.2 Ventilation – Equipment Cooling

NEI 12-06, Section 3.2.2, Paragraph (10) provides that:

> *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/[LNUHS] 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, HPCI and RCIC pump rooms, the control room, and logic cabinets. Air flow may be accomplished by opening doors to rooms and electronic and relay cabinets, and/or providing supplemental air flow.
>
> Air temperatures may be monitored during an ELAP/[LNUHS] event through operator observation, portable instrumentation, or the use of locally mounted thermometers inside cabinets and in plant areas where cooling may be needed. Alternatively, procedures/guidance may direct the operator to take action to provide for alternate air flow in the event normal cooling is lost. Upon loss of

these systems, or indication of temperatures outside the maximum normal range of values, the procedures/guidance should direct supplemental air flow be provided to the affected cabinet or area, and/or designate alternate means for monitoring system functions.

For the limited cooling requirements of a cabinet containing power supplies for instrumentation, simply opening the back doors is effective. For larger cooling loads, such as HPCI, RCIC, and AFW pump rooms, portable engine-driven blowers may be considered during the transient to augment the natural circulation provided by opening doors. The necessary rate of air supply to these rooms may be estimated on the basis of rapidly turning over the room's air volume.

Temperatures in the HPCI pump room and/or steam tunnel for a boiling-water reactor (BWR) may reach levels which isolate HPCI or RCIC steam lines. Supplemental air flow or the capability to override the isolation feature may be necessary at some plants. The procedures/guidance should identify the corrective action required, if necessary.

Actuation setpoints for fire protection systems are typically at 165-180°F. It is expected that temperature rises due to loss of ventilation/cooling during an ELAP/[LNUHS] 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/[LNUHS], 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 18 of Reference 18, APS stated:

Table Item 8 - Open TDAFWP Room Door for Ventilation: During an ELAP, the essential heating ventilation and air conditioning (HVAC) unit in the TDAFWP room is inoperable. However, the TDAFWP would be actuated automatically shortly after the initiation of the event. The system is powered by steam sources from each steam generator and from essential 120V AC power. This pump is bunkered at the 80 ft elevation (20 ft below ground elevation) in a water tight compartment. The TDAFWP room temperature would increase as a result of heat addition from multiple sources such as steam piping, turbine, and gland seal or other leakages and heat generated by the control panel. To ensure that the functionality of the TDAFWP is maintained for the duration of the event, a new analysis using the GOTHIC computer code was performed. The analysis results show that if the doors to the TDAFWP room are opened within 2 hours, the room temperature will remain below the control cabinet critical component acceptable temperature (Reference [32]) so that the TDAFWP will continue to perform its function. Therefore, it is concluded that, to maintain temperature in the compartment for the duration of the event to a value at or below this limit, access doors to the TDAFWP room will need to be opened (Reference [32]).

On page 24 of Reference 18, APS stated:

> Without ventilation, the TDAFWP room temperature will exceed 130°F within four (4) hours. PVNGS has determined that opening the access doors to the room within 2 hours will limit the temperature to a maximum of 130°F, thereby maintain pump availability.

The implication of this statement is that there is no inherent conservatism or operating margin within the evaluation. For this reason, the NRC staff determined that APS had initially supplied insufficient information to conclude that the equipment in the TDAFWP room will perform its function and assist in core cooling throughout all phases of an ELAP. The licensee was requested to supply more information concerning the analysis performed to conclude the continued function of the equipment within the TDAFWP room including inherent conservatisms in the evaluation, the postulated outside air temperature, the heat loads from other equipment in the TDAFWP room, and the qualification level for temperature and pressure for electrical components for the duration that the TDAFWP is assumed to perform its mitigating strategies function.

In a response to these requests dated July 18, 2013 [Reference 36], the licensee stated that:

> The statement referenced above contains an error. It should read, "Without ventilation, the TDAFWP room temperature will not exceed 130 °F within four (4) hours." A mitigating strategy has been developed that credits opening doors at the 80 ft and 100 ft elevation at two hours when the room temperature is near 120 °F. This mitigating action will limit the maximum temperature to less than 130 °F for the remainder of the event.

The licensee further explained the assumptions of the analysis and the qualification levels for the electrical components in the room. The NRC staff found this acceptable, as the room temperature remains below the qualification level of the electrical components.

On pages 18 and 19 of Reference 18, APS stated:

> Table Item 9 – Open Control Room Doors: Block open doors to provide ventilation to maintain control room temperature. Reference [33], Section IX.3 provides a list of rooms reviewed (including the control room) and predicted temperatures. Because load shed is to be completed within 2 hours, heat loads in the control room are minimal (only essential identified instrumentation is powered). It is predicted that long term control room temperature would approach outside air temperature, per design. The PVNGS FSG ... will also include steps to open control room doors.

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.

Pages 50 and 52 of Reference 18 also state that ventilation is not required in phase 1, and it will not be recovered until phase 2 which is approximately 28 hours after the onset of the ELAP.

Under these conditions, if the temperature of the control room does approach outside air temperature, the environmental conditions within the control room would exceed the habitability limits defined in NUMARC 87-00 for efficient human performance. NUMARC 87-00 provides the technical basis for this habitability standard as MIL-STD-1472C, which concludes that 110 °F is tolerable for light work for a 4 hour period while dressed in conventional clothing with a relative humidity of about 30%. The NRC staff determined that APS had supplied insufficient information to conclude that the habitability limits of the control room will be maintained in all phases of an ELAP. The licensee was requested to supply more information concerning the analysis performed to conclude the continued habitability of the control room including postulated outside air temperature, the heat loads from personnel in the control room, and any additional relief efforts for the control room staff (e.g. short stay time cycles, use of ice vests/packs, supplies of bottled water, etc.).

In a response to these requests dated July 18, 2013 [Reference 36], the licensee stated that:

> No analysis has been performed for the control room envelope (CRE) since an engineered solution could not be implemented early in this event. The statement on pages 50 and 52 should have indicated that ventilation is "not available" rather than "not required." The statements made on pages 18 and 19 of our submittal are based on the Palo Verde Nuclear Generating Station (PVNGS) Station-Blackout (SBO) analysis and conservative engineering judgment. Control room temperature during normal operation, with outside temperature at 113 °F and full operator and staff complement, is maintained less than 75 °F by design (American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Weather Station Data, Luke AFB/Phoenix, AZ, USA, WMO#722785, 2009 ASHRAE Handbook - Fundamentals - Reference 1). The environmental condition inside the control room during an ELAP is similar to that for an SBO for the first hour of the event. During this time period, the control room SBO analysis assumes a full complement of staff and actuation of most indicators and alarms in the control room with no functional essential ventilation. The predicted temperature at one hour has been calculated to remain below 110 °F. The prediction of ELAP control room temperature after entry into the FSG was based on three assumptions:
>
> 1. If the CRE is maintained, room temperature will increase due to heat loads from emergency lighting, plant instrumentation, and the control room staff.
> 2. The heat load in the room is reduced after the first hour of the event since the amount of energized instrumentation is reduced to one channel, and one train of emergency lighting will be turned off.
> 3. Notwithstanding items 1 and 2, room temperature will increase at a constant rate as result of fixed heat load and limited heat losses through the walls and floor. Therefore, sometime after the event, control room temperature could possibly exceed the outside environmental condition. Any time sensitive action will depend on the outside air temperature (OSA). The cooler the OSA, the sooner the control room doors could be opened. If the OSA temperature is hotter

> than the control room, the control room should be kept isolated. In either case, the CRE will approach and possibly exceed the outside temperature if doors are not opened.
>
> Therefore, because of the conditions experienced during an ELAP event, no control room ventilation is available. The two hour action statement to open the control room doors, as identified in Attachment A of the OIP, is reasonable based on engineering judgment and NEI 12-06, section 3.2.1.7(1). In conclusion, a course of action will be established in the FSG for responding to a beyond design-basis event. The FSGs will contain directions for operating crews to open the CRE prudently for the best possible outcome.

The NRC staff continues to have concerns over the lack of plans to provide ventilation to the control room, as the FSG has not been developed. This has been identified as Confirmatory Item 3.2.4.2.A., in Section 4.2, below.

Regarding fuel building ventilation, on page 19 of Reference 18, APS stated:

> Fuel Building rollup door is manually opened prior to earliest predicted spent fuel pool time to boil (11.5 hours). This provides a large ventilation pathway to maintain Fuel Building accessibility to the alternate SFP makeup pump location.

The NRC staff determined that APS had supplied insufficient information to conclude that opening the Fuel Building rollup door will ensure a habitable environment for support personnel to perform mitigating actions in the vicinity of the SFP throughout all phases of an ELAP. The NRC staff requested additional information regarding this evaluation.

In a response dated July 18, 2013 [Reference 36], the licensee explained that the primary connection point does not require access to the Fuel Building. The alternate connection point is located inside the Fuel Building, but very close to the rollup door. Opening the rollup door means that the temperature and humidity at that location are expected to be close to outside ambient conditions. The NRC staff finds this acceptable, as it means that the alternate connection point will be accessible.

With regard to battery room ventilation, pages 52 and 53 of Reference 18 provide the following:

> The critical electrical equipment required during phase 2 is vital instrumentation, battery chargers, FLEX RCS makeup pumps, installed charging pumps, ventilation, and lighting. Energizing these loads will be accomplished using two 480V FLEX generators connected to either train of the Class 1E 480V switchgear and alignment of the required equipment in that train. ....
>
> Eight 500kW FLEX generators, as required for N+1, will be stored onsite. Twenty eight hours after the ELAP, two FLEX generators will be deployed to the staging area south of the diesel building (see Figures 3-16 and 3-18). Although the storage area is not yet determined, the expected deployment path is shown in Figure 3-17. FLEX generators will be trailer mounted for ease of deployment. A set of FLEX cables will be stored with each generator and will be either

deployed on the generator trailer or on a separate cart. These cables provide a positive locking mechanism to ensure a tight waterproof connection. Phase rotation will be verified during installation.

Each FLEX generator will be grounded via a flexible cable to a ground test well which will provide an accessible ground in the staging area that will not affect traffic.

The FLEX generators will be connected to the Class 1E 480V load centers via FLEX connection junction boxes. Two boxes will be mounted on the south wall of the control building to support the primary connection. See Figure 3-19 for an overview of the primary strategy. Two boxes will be mounted on the east wall of the diesel building to support the alternate connection. See Figure 3-23 for an overview of the alternate strategy. Both 480V strategies will be designed to be available for BDBEE, as defined in Study 13-NSA108.R000 (Reference [33]), although Train B may have limited access after a seismic event due its close proximity to a non seismic structure.

The primary strategy is to repower the 480V Class 1E load centers on Train A (L31, L33, and L35, respective Figures 3-20, 3-21, and 3-22). Repowering these load centers will allow PVNGS to repower the vital battery chargers A and C, thus allowing for indefinite vital battery coping time. Prior to energizing the FLEX generators, breakers in load centers L31, L33 and L35 must be opened (approximately 30 breakers). Breakers in the motor control centers (MCCs) M31, M33, M35, M37 and M71 must be opened also (approximately 120 breakers). This will isolate loads so the FLEX generators do not fail because of overload. When the FLEX generators are running, then the 12 loads identified in Table 1 can be systematically energized. Guidance for aligning the system will be included in procedure 79IS-9ZZ07 ..., "PVNGS Extended Loss of All Site AC Guideline."

If the installed charging pumps are not operational, the primary FLEX strategy for energizing the FLEX RCS pumps is to energize MCC M33 from load center L33 (Figure 3-35). The pumps will be connected to a FLEX junction box located outdoors near the RWT. Power will be provided from spare breakers in MCC M33.

The alternate strategy is to repower the 480V Class 1E load centers on Train B (L32, L34, and L36). Repowering these load centers will allow PVNGS to repower the vital battery chargers B and D, thus allowing for indefinite vital battery coping time. Prior to energizing the FLEX generators, breakers in load centers L32, L34 and L36 must be opened (approximately 30 breakers). Breakers in MCCs M32, M34, M36, and M72 also must be opened (approximately 90 breakers). This will isolate the affected loads so the FLEX generators do not fail because of overload. When the FLEX generators are running, then the loads identified in Table 1 below can be systematically energized. Guidance for aligning the system will be included in procedure 79IS-9ZZ07, "PVNGS Extended Loss of All Site AC Guideline."

The NRC staff noted that the loads listed in Table 1 on page 53 of Reference 18 include "HJA/B-J01A/B (1hp) "A/B" Battery Room Exhaust Fan" and "HJA/B-J01B/A (1hp) "C/D" Battery Room Exhaust Fan" as well as "PKC/D-H13/H14 (58kVA) "C/D" Battery Charger" and "PKA/B-H11/12 (80/92kVA) "A/B" Battery Charger," but provided insufficient details of the exhaust fan operation to support a conclusion that there is reasonable assurance the hydrogen concentration in the battery rooms will be maintained below the limits established by national codes and standards (i.e., less than 2% according to IEEE Standard 484 as endorsed by Regulatory Guide 1.128, "Installation Design and Installation of Vented Lead-Acid Storage Batteries for Nuclear Power Plants" and less than 1% according to the National Fire Code) when the batteries are being recharged during phase 2 and 3. By letter dated June 20, 2013, ADAMS Accession No. ML13131A265, the NRC staff requested additional information on how hydrogen concentration in the battery rooms will be maintained below the limits when the batteries are being recharged during Phase 2 and 3. In its response dated July 18, 2013 (Reference 36), APS provided the following discussion:

> PVNGS is not committed to Regulatory Guide 1.128, Regulatory Guide 1.189, or IEEE Standard 484-2002. APS's strategy will meet the plant's design basis calculation (13-EC-PK-0204), which calculates 2% hydrogen accumulation in 130 hours with a complete loss of ventilation.
>
> During normal and essential plant operations, exhaust fans maintain the hydrogen concentration of the battery rooms at an acceptable level while the batteries are being charged. If the exhaust fans are not available, battery room doors can be opened.
>
> Battery room exhaust fans are listed in Table 1: Installed Loads Credited in Phase 2, page 53, of the OIP. According to this submittal, when the FLEX 480 VAC generators are running, the loads identified in Table 1 can be systematically energized. Guidance for aligning the system will be included in the FSG. Per Attachment 1A, "Sequence of Events Timeline Modes 1-4," of the OIP, these FLEX generators will be installed and functional by 39 hours into the event. The FSG will ensure the battery room essential exhaust fans are in service prior to placing the battery charger into service. This strategy is consistent with the station essential HVAC design basis and eliminates any hydrogen concerns.

The NRC staff finds this acceptable, as the hydrogen concentration will be maintained below 2%, which is the plant's design basis.

The staff's understanding of the licensee's approach, as described above, confirms that the licensee's plans are 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 above, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to ventilation strategies if they are implemented as described.

The staff's understanding of the licensee's approach, as described above, has raised concerns which must be addressed before confirmation can be provided that the Integrated Plan is consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, or that an acceptable alternative was provided, such that there would be reasonable assurance that the requirements of Order EA-12-049 will be met with respect to ventilation strategies. This concern is identified as Confirmatory Item 3.2.4.2.A above and in Section 4.2.

3.2.4.3 Heat Tracing

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

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

In its Integrated Plan, APS makes no mention of the use of heat tracing. By letter dated June 20, 2013 (Reference 35), the NRC staff requested additional information on the use of heat tracing at PVNGS. In its response dated July 18, 2013 (Reference 36), APS confirmed that freeze protection is not required at PVNGS. The NRC staff has reviewed APS' plans with respect to the loss of heat tracing and concludes that no action is necessary with respect to heat tracing at PVNGS.

3.2.4.4 Accessibility – Lighting and Communications

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

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

On page 50 of Reference 18, in the section of its Integrated Plan regarding safety functions support during the initial phase, APS stated that:

> PVNGS emergency lighting batteries will last up to 16 hours (Reference [33], Section V.2.1). ....
>
> PVNGS emergency communications use the guidance of NEI 12-01, Rev. 0, (Reference [34]). Two-way hand-held radios and sound powered phones will be used by in-plant teams. Satellite phones will be used by offsite radiological field assessment teams to support mitigation strategies.

The NRC staff has reviewed APS' plans for the development of guidance and strategies with regard to the provision of portable lighting and communications devices to facilitate personnel access to areas necessary for instrumentation monitoring or equipment operation, and requested the licensee to provide additional information on portable lighting.

In a response dated July 18, 2013 [Reference 36], the licensee stated that:

> The standard gear/equipment for operators with duties outside the control room includes flashlights. This requirement is currently described in a station procedure and will be added to the FSG. The DC powered, control room emergency lighting system will be available for a duration of up to 16 hours as indicated in OIP page 50.
>
> Although not credited, Appendix R lighting provides for emergency lighting in select areas of the plant where operators or maintenance personnel may need to perform actions during loss of power conditions. The Appendix R lights have batteries that last a minimum of 8 hours.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 availability of lighting and communications, if they are implemented as described.

3.2.4.5 Protected and Internal Locked Area Access

NEI 12-06, Section 3.2.2, Paragraph (9) provides that:

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

The NRC staff has reviewed the licensee's plans for the development of guidance and strategies with regard to the access to the Protected Area and internal locked areas, and requested additional information from the licensee.

In a response dated July 18, 2013 [Reference 36], the licensee discussed the ability of plant personnel to gain entry to areas needed for equipment operation. The NRC staff finds this satisfactory, as the operators will be able to access the necessary areas.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 they are implemented as described.

3.2.4.6 Personnel Habitability – Elevated Temperature

NEI 12-06, Section 3.2.2, Paragraph (11) provides that:

> *Plant procedures/guidance should consider accessibility requirements at locations where operators will be required to perform local manual operations.*
>
> Due to elevated temperatures and humidity in some locations where local operator actions are required (e.g., manual valve manipulations, equipment connections, etc.), procedures/guidance should identify the protective clothing or other equipment or actions necessary to protect the operator, as appropriate.
>
> FLEX strategies must be capable of execution under the adverse conditions (unavailability of installed plant lighting, ventilation, etc.) expected following a BDBE resulting in an ELAP/[LNUHS]. 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.

On page 17 of Reference 18, in the section of its Integrated Plan regarding general integrated plan elements, APS stated that:

> Environmental conditions within the control room and safety related battery rooms were evaluated using methods and tools from NUMARC 87-000 (sic), PCFLUD (Bechtel software) or GOTHIC 8.0 (Electric Power Research Institute (EPRI) software).

On pages 18 and 19 of Reference 18, in the section of its Integrated Plan regarding the time constraints, APS stated:

> Table Item 8 - Open TDAFWP Room Door for Ventilation: During an ELAP, the essential heating ventilation and air conditioning (HVAC) unit in the TDAFWP room is inoperable. However, the TDAFWP would be actuated automatically shortly after the initiation of the event. The system is powered by steam sources from each steam generator and from essential 120V AC power. This pump is

> bunkered at the 80 ft elevation (20 ft below ground elevation) in a water tight compartment. The TDAFWP room temperature would increase as a result of heat addition from multiple sources such as steam piping, turbine, and gland seal or other leakages and heat generated by the control panel. To ensure that the functionality of the TDAFWP is maintained for the duration of the event, a new analysis using the GOTHIC computer code was performed. The analysis results show that if the doors to the TDAFWP room are opened within 2 hours, the room temperature will remain below the control cabinet critical component acceptable temperature (Reference [32] so that the TDAFWP will continue to perform its function. Therefore, it is concluded that, to maintain temperature in the compartment for the duration of the event to a value at or below this limit, access doors to the TDAFWP room will need to be opened (Reference [32]).
>
> Table Item 9 – Open Control Room Doors: Block open doors to provide ventilation to maintain control room temperature. Reference [33], Section IX.3 provides a list of rooms reviewed (including the control room) and predicted temperatures. Because load shed is to be completed within 2 hours, heat loads in the control room are minimal (only essential identified instrumentation is powered). It is predicted that long term control room temperature would approach outside air temperature, per design. The PVNGS FSG ... will also include steps to open control room doors.
>
> Table Item 12a – Establish a Fuel Building Vent Path: Fuel Building rollup door is manually opened prior to earliest predicted spent fuel pool time to boil (11.5 hours). This provides a large ventilation pathway to maintain Fuel Building accessibility to the alternate SFP makeup pump location.

On page 50 of Reference 18, in the section of its Integrated Plan regarding safety functions support during the initial phase, APS stated that:

> Ventilation is not required during phase 1, although doors may be propped open to alleviate high temperatures in the main control room and electrical equipment rooms. The temperature increase above ambient in the control building will be minimal since very few instruments are powered.

For the NRC staff's evaluation and findings associated with Table Item 8, Table Item 9, and Table Item 12a, see Section 3.2.4.2: Ventilation.

3.2.4.7 Water Sources

NEI 12-06, Section 3.2.2, Paragraph (5) provides that:

> *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/[LNUHS] 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/[LNUHS] at their nominal capacities. Water in robust UHS piping may also be available for use but would need to be evaluated to ensure adequate NPSH can be demonstrated and, for example, that the water does not gravity drain back to the UHS. Alternate water delivery systems can be considered available on a case-by-case basis. In general, all CSTs should be used first if available. If the normal source of makeup water (e.g., CST) fails or becomes exhausted as a result of the hazard, then robust demineralized, raw, or borated water tanks may be used as appropriate.
>
> Heated torus water can be relied upon if sufficient [net positive suction head] NPSH can be established. Finally, when all other preferred water sources have been depleted, lower water quality sources may be pumped as makeup flow using available equipment (e.g., a diesel driven fire pump or a portable pump drawing from a raw water source). Procedures/guidance should clearly specify the conditions when the operator is expected to resort to increasingly impure water sources.

The licensee states that each unit's condensate storage tank (CST) holds 300,000 gallons in a seismically qualified volume. The licensee has performed evaluations of the CSTs and determined that the full volume of 550,000 gallons should be available for use based on the structure being sufficiently robust to survive an ELAP event. The licensee has also perform evaluations of the RMWT and determined that its volume of 480,000 gallons is sufficiently robust to survive an ELAP event and should be available for use if necessary. Therefore, the licensee calculates a coping time of 116 hours using the TDAFWP with the water available in the CST and RMWT.

The licensee's strategy to extend the current run time availability of the TDAFW pump is by making up to the CST, performing a load shed of the dc buses, and eventually repowering the battery chargers using portable generators in order to keep the dc buses powered. The CST makeup strategy will be employed during phase 2. The licensee plans to use temporary piping to transfer water from the 45 acre or 85 acre water reservoirs to the suction of the TDAFWP.

The licensee intends to continue with this strategy until resources can be brought in from offsite during the final phase 3. The final phase 3 involves transporting assets that are stored offsite in a regional response center to on-site in order to provide long term core cooling. These assets will include additional pumps, generators, and fuel. A 4160 kv generator for each unit will be brought on site to repower a motor-driven AFW pump. Phase 3 equipment will also include pumps to makeup to the CST from the 45 acre or 85 acre reservoirs. Each pump will be capable of 1200 gpm at 130 psig.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 availability of water sources, if they are implemented as described.

3.2.4.8 Electrical Power Sources/Isolations/Interactions

NEI 12-06, Section 3.2.2, Paragraph (13) provides that "[t]he use of portable equipment to charge batteries or locally energize equipment may be needed under ELAP/[LNUHS] conditions. Appropriate electrical isolations and interactions should be addressed in procedures/guidance.

To facilitate FLEX generator connections, the licensee plans to install primary and alternate FLEX junction boxes that will be permanently connected to the 480 Volt Class 1E load centers. To facilitate FLEX RCS makeup pump connections, the licensee will install primary and alternate FLEX junction boxes, double throw switches, cabling and conduit that will be permanently connected to the electrical system. With regard to FLEX electrical equipment, the licensee noted that the 4.16 kV Medium Voltage FLEX generator will be connected to the Class 1E 4.16 kV switchgear via an installed FLEX junction box mounted outside on either the west or east wall of the diesel building. The NRC staff did not consider this to be sufficient information on electrical isolations and interactions to conclude there is reasonable assurance that the guidance and strategies developed following APS' Integrated Plans will comply with this aspect of the requirements of Order EA-12-049. The staff asked the licensee to describe how the FLEX generator and the Class 1E diesel generators are isolated to prevent simultaneously supplying power to the same Class 1E bus in order to conform to NEI 12-06, Section 3.2.2, guideline (13), which specifies that appropriate electrical isolations and interactions should be addressed in procedures and guidance.

In a response dated July 18, 2013 [Reference 36], the licensee stated that:

> The Medium Voltage (MV) FLEX generator will be used only when the Class 1E Diesel Generators are isolated. The FSG (Reference 6) provides guidance for energizing a Class 1E bus using portable generators consistent with NEI 12-06, Section 3.2.2, guideline. The FSG will provide instructions for aligning the MV FLEX generator(s) to either Train A or Train B Class 4.16 KV switchgear. Prior to connecting the MV FLEX generators to a switchgear, the respective Class 1E Diesel Generator output breaker will be racked out to prevent potential for cross connection of the two generators.

The NRC staff finds this is an appropriate method to prevent unwanted and potentially dangerous system interactions.

The licensee stated that instrumentation on FLEX equipment will be used to confirm adequate performance of equipment functions. The NRC staff was concerned with the level of accuracy of this instrumentation to ensure that electrical equipment remains protected (from an electrical standpoint – e.g., power fluctuations) and with the ability of this instrumentation to provide operators with accurate information ensure the maintenance of core cooling, containment, and spent fuel cooling, and requested additional information from the licensee.

In a response dated July 18, 2013 [Reference 36], the licensee stated that:

> APS will address instrumentation to monitor portable FLEX electrical power equipment and provide a response to this RAI during the design and procedure development phase. Safety functions such as core, containment, and spent fuel cooling and inventory control will be monitored from the unit's control room using seismically qualified, class instrumentation. Each control room will have the capability of communicating with temporary equipment operators to operate FLEX equipment within the needed range of the safety parameter of interest. APS anticipates providing this information and FLEX portable instrumentation capabilities as a part of a periodic six-month update to the OIP.

This has been identified as Confirmatory Item 3.2.4.8.A., in Section 4.1, below.

The staff's understanding of the licensee's approach, as described above, confirms that the licensee's plans are 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 above, provides reasonable assurance that the requirements of Order EA-12-049 will be met with respect to electrical power sources, isolations, and interactions if they are implemented as described.

3.2.4.9 Portable Equipment Fuel

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

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

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

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

On page 54 of Reference 18, in the section of its Integrated Plan discussing phase 2 of the strategy for safety functions support, following the discussion of the deployment of two FLEX diesel generators per unit, APS stated:

> The FLEX generators will be stored onsite with no fuel. Once deployed to the staging area, the FLEX generators will be fueled with a gravity-fed hose from either of the two safety-related diesel day tanks located in the nearby diesel building. Each tank in the diesel building has a capacity of 1100 gallons and a Technical Specification minimum volume of 550 gallons. Each FLEX generator will be filled with 250 gallons using the 550 gallons from one tank and leaving the other full if the installed Class 1E generators are recovered. The FLEX generators will consume 36 gal/hr of fuel at 100 percent load; therefore, 250

> gallons will last approximately 7 hours before refueling. Once the FLEX generators are running, the existing 480V 3hp diesel transfer pump will be available, allowing the day tanks to be refilled from the underground 7-day tanks.

The NRC staff noted that there was no corresponding discussion of fuel for the diesel driven pumps described on page 46 of Reference 18, in the section on phase 2 of the strategy for maintaining SFP cooling. The NRC staff requested that the licensee provide a discussion on the diesel fuel oil supply (e.g., fuel oil storage tank volume, supply pathway, etc.) for the diesel driven pumps and how continued operation to ensure core and spent fuel pool cooling is maintained indefinitely.

In a response dated July 18, 2013 [Reference 36], the licensee stated that:

> The initial strategy is to fill the phase 2 diesel driven SFP make-up pump from a selected day tank. Each day tank in the diesel building has a capacity of 1,100 gallons and a Technical Specification minimum volume of 550 gallons. The diesel driven pumps and smaller generators (120 VAC) will be filled using portable fuel containers. These fuel containers will be hand carried to the equipment deployment locations. These containers are filled from the diesel day tank using a hose attached to the day tank drain line. Additionally, a modification is being planned to provide a connection point at the ground level in order to attach a hose, which will be used primarily to fill the MV FLEX (480 VAC) portable generators.
>
> The diesel driven pumps for SFP makeup are not needed for 24 hours. At that time, additional personnel will be available to set up and fuel this equipment. Additionally, after 24 hours, fuel deliveries to the site, if needed, can be arranged to maintain on-site fuel supplies. Because the portable pumps do not have a recirculation feature they will be operated in a batch method to raise SFP and SG levels when needed. When they are stopped, at the top of the level band, the pumps may be refueled.
>
> Per page 54 of the OIP, the phase 2 MV FLEX generators will be fueled with a gravity-fed hose from either of the two safety-related diesel day tanks located in the nearby diesel building. Each MV FLEX generator will be filled with 250 gallons using 550 gallons from one day tank and leave the other day tank full to allow recovery of the installed Class 1E generators. The MV FLEX generators will consume 36 gal/hr of fuel at 100% load; therefore, 250 gallons will last approximately 7 hours before requiring refueling. Once the MV FLEX generators are running, the existing 480 V, 3 hp diesel fuel transfer pump will be available, allowing the day tanks to be refilled from the underground 84,000-gallon diesel fuel oil storage tanks. The 4,160 VAC diesel generators will be fueled in the same manner as the 480 VAC generators.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 fuel for portable equipment, if they are implemented as described.

3.2.4.10 Load Reduction to Conserve DC Power

NEI 12-06, Section 3.2.2, guideline (6) provides that:

> *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 18 of Reference 18, in the section of its Integrated Plan describing the time constraints, APS listed:

> Table Item 7 – Complete DC Load Shed: DC load shed must be completed within 2 hours in order to achieve a battery coping time of 47 hours on battery bank B (Reference 16, Section 8.6). For phase 1, PVNGS can cope on the installed DC batteries for up to 10 hours with no load shedding. If load shedding, as described in PVNGS Study 13-NS-A108 (Reference [33]), is completed, the battery coping period is extended to 47 hours. This load shed strategy will preserve station batteries and provide additional time prior to needing to re-energize battery chargers.

The Institute of Electrical and Electronics Engineers (IEEE) Standard 535-1986, "IEEE Standard for Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations," as endorsed by Regulatory Guide 1.158, "Qualification of Safety-Related Lead Storage Batteries for Nuclear Power Plants," provides guidance for qualifying nuclear-grade batteries and describes a method acceptable to the NRC staff for complying with Commission regulations with regard to qualification of safety-related lead storage batteries for nuclear power plants. Based on a previous concern with extended battery duty cycle durations, the NRC staff requested an official interpretation of IEEE Standard 535-1986. The NRC specifically requested the IEEE to identify the length of the duty cycle for which a vented lead-acid battery is qualified for per IEEE Standard 535 and to identify any limitations on the length of the duty cycle for a vented lead-acid battery. In its response to the NRC's interpretation request, the IEEE stated that in order to meet the requirements of IEEE Standard 535, applications with duty cycles over 8 hours will need to demonstrate that the [battery] cells fully comply with the qualification principles in clause 5 and meet the basis requirements in clause 8.2 of IEEE Standard 535. The IEEE response to the NRC's interpretation request can be located in ADAMS Accession No. ML13094A397. Based on the above, the NRC staff was concerned about the capability of the PVNGS station batteries to provide dc power for the durations specified in the licensee's Integrated Plan. Based on its concern, the NRC staff requested the licensee to provide documentation that shows that the PVNGS battery cells comply with the qualification principles in clause 5 and meet the requirements in clause 8.2 of IEEE Standard 535, for the duration the licensee credited in the PVNGS Integrated Plan.

In a response dated July 18, 2013 [Reference 36], the licensee stated that:

> This RAI was identified as a generic concern or question during the NRC public meeting on April 18, 2013, regarding the NRC order on mitigating strategies (Order EA-12-049). The nuclear industry will resolve this concern generically through the Nuclear Energy Institute(NEI) and the applicable industry groups (e.g., PWROG, EPRI, etc.). Once this concern is resolved, APS will provide an update to this RAI response in a periodic six-month update to the OIP. NEI will be coordinating with the NRC on the schedule for resolution.

The NRC staff reviewed the Integrated Plan for PVNGS and determined that the Generic Concern related to battery duty cycles beyond 8 hours is applicable to the plant. The Generic Concern related to extended battery duty cycles has been resolved generically through the NRC endorsement of Nuclear Energy Institute (NEI) position paper entitled "Battery Life Issue" (ADAMS Accession no ML13241A186 (NRC endorsement letter) and ML13241A188 (NEI position paper)).

The Generic Concern related to extended battery duty cycles required clarification of the capability of the existing vented lead-acid station batteries to perform their expected function for durations greater than 8 hours throughout the expected service life. The position paper provided sufficient basis to resolve this concern by developing an acceptable method for demonstrating that batteries will perform as specified in a plant's Integrated Plan that satisfy NRC Order EA-12-049. The methodology relies on the licensee's battery sizing calculations developed in accordance with the Institute of Electrical and Electronics Engineers Standard 485, "Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations," load shedding schemes, and manufacturer data to demonstrate that the existing vented lead-acid station batteries can perform their intended function for extended duty cycles (i.e., beyond 8 hours). The NRC staff will evaluate a licensee's application of the guidance (calculations and supporting data) in its development of the final Safety Evaluation documenting compliance with NRC Order EA-12-049.

This has been documented as Confirmatory Item 3.2.4.10.A., in Section 4.2, below.

Review of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance found in NEI 12-06, as endorsed by JLD-ISG-2012-01, such that there would be reasonable assurance that the requirements of Order EA-12-049 will be met with respect to using load reduction to extend battery life, if they are implemented as described. The battery analysis is identified as a confirmatory item above and in Section 4.2.

3.3 Programmatic Controls

3.3.1 Equipment Storage.

NEI 12-06, Section 11.3 provides the following with respect to equipment storage:

1. Detailed guidance for selecting suitable storage locations that provide reasonable protection during specific external events is provided in [NEI 12-06] Sections 5 through 9.

2. A technical basis should be developed for equipment storage for portable equipment that directly performs a FLEX mitigation strategy for core, containment, and SFP that provides the inputs, assumptions, and documented[3] basis that the mitigation strategy and support equipment will be reasonably protected from applicable external events such that the equipment could be operated in place, if applicable, or moved to its deployment locations. This basis should be auditable, consistent with generally accepted engineering principles, and controlled within the configuration document control system.

3. FLEX mitigation equipment should be stored in a location or locations[4] informed by evaluations performed per Sections 5 through 9 such that no one external event can reasonably fail the site FLEX capability (N).

4. Different FLEX equipment can be credited for independent events.

5. Consideration should be given to the transport from the storage area following the external event recognizing that external events can result in obstacles restricting normal pathways for movement.

6. If portable FLEX equipment is pre-staged such that it minimizes the time delay and burden of hook-up following an external event, then the equipment should be evaluated to not have an adverse effect on existing SSCs and the primary connection point should be as close to the intended point of supply as possible, e.g., a staged power supply to recharge batteries should be connected as close to the battery charger as practicable to maintain diversity and minimize the reliance on other installed equipment.

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[3] FLEX documentation should be auditable but does not require Appendix B qualification. Manufacturer's information may be used in establishing the basis for the equipment use.

[4] Location or locations may include areas outside the owner controlled area provided equipment can be relocated in time to meet FLEX strategy requirements.

7. FLEX equipment should be stored and maintained in a manner that is consistent with assuring that it does not degrade over long periods of storage and that it is accessible for periodic maintenance and testing.

8. If 50.54(hh)(2) equipment is credited in the FLEX mitigating strategies, it should meet the above storage requirements in addition to the 50.54(hh)(2) requirements.

9. If debris removal equipment is needed, it should be reasonably protected from the applicable external events such that it is likely to remain functional and deployable to clear obstructions from the pathway between the FLEX equipment's storage location and its deployment location(s).

10. Deployment of the FLEX equipment or debris removal equipment from storage locations should not depend on off-site power or on-site emergency ac power (e.g., to operate roll up doors, lifts, elevators, etc.).

On page 21 of Reference 18, in the section of its Integrated Plan discussing programmatic controls, APS stated that:

> Programs and controls will be established to protect the equipment from applicable NEI 12-06 hazards. In addition, these programs will provide guidance to protect the staging location, deployment roads and pathways, and system connections for implementation of the FLEX strategies.
>
> Equipment associated with these strategies will be procured as commercial grade equipment. The storage, maintenance, testing, and configuration control of the equipment will be in accordance with NEI 12-06, Section 11.0.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 equipment storage, if they are implemented as described. Details of protection of the equipment from external hazards are discussed in Section 3.1 above.

3.3.2 Equipment Maintenance and Testing

NEI 12-06, Section 3.2.2, Guideline (15) provides that:

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

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

NEI 12-06, Section 11.5 provides that:

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

2. Portable equipment that directly performs a FLEX mitigation strategy for the core, containment, or SFP should be subject to maintenance and testing[5] guidance provided in INPO AP 913, Equipment Reliability Process, to verify proper function. The maintenance program should ensure that the FLEX equipment reliability is being achieved. Standard industry templates (e.g., EPRI) and associated bases will be developed to define specific maintenance and testing including the following:
   a. Periodic testing and frequency should be determined based on equipment type and expected use. Testing should be done to verify design requirements and/or basis. The basis should be documented and deviations from vendor recommendations and applicable standards should be justified.
   b. Preventive maintenance should be determined based on equipment type and expected use. The basis should be documented and deviations from vendor recommendations and applicable standards should be justified.
   c. Existing work control processes may be used to control maintenance and testing. (e.g., PM Program, Surveillance Program, Vendor Contracts, and work orders).

3. The unavailability of equipment and applicable connections that directly performs a FLEX mitigation strategy for core, containment, and SFP should be managed such that risk to mitigating strategy capability is minimized.
   a. The unavailability of installed plant equipment is controlled by existing plant processes such as the Technical Specifications. When installed plant equipment which supports FLEX strategies becomes unavailable, then the FLEX strategy affected by this unavailability does not need to be maintained during the unavailability.
   b. Portable equipment may be unavailable for 90 days provided that the site FLEX capability (N) is available.
   c. Connections to permanent equipment required for FLEX strategies can be unavailable for 90 days provided alternate capabilities remain functional.

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[5] Testing includes surveillances, inspections, etc.

d. Portable equipment that is expected to be unavailable for more than 90 days or expected to be unavailable during forecast site specific external events (e.g., hurricane) should be supplemented with alternate suitable equipment.
e. The short duration of equipment unavailability, discussed above, does not constitute a loss of reasonable protection from a diverse storage location protection strategy perspective.
f. If portable equipment becomes unavailable such that the site FLEX capability (N) is not maintained, initiate actions within 24 hours to restore the site FLEX capability (N) and implement compensatory measures (e.g., use of alternate suitable equipment or supplemental personnel) within 72 hours.

On page 21 of Reference 18, in the section of its Integrated Plan discussing programmatic controls, APS stated that:

> Programs and controls will be established to protect the equipment from applicable NEI 12-06 hazards. In addition, these programs will provide guidance to protect the staging location, deployment roads and pathways, and system connections for implementation of the FLEX strategies.
>
> Equipment associated with these strategies will be procured as commercial grade equipment. The storage, maintenance, testing, and configuration control of the equipment will be in accordance with NEI 12-06, Section 11.0. PVNGS will use the standard EPRI industry preventative maintenance template for establishing the maintenance and testing actions for FLEX components. The administrative program will include maintenance guidance, testing procedures and frequencies established based on type of equipment and considerations made within the EPRI templates.
>
> The unavailability of equipment and applicable connections that directly perform a FLEX mitigation strategy will be managed using plant equipment control guidelines developed in accordance with NEI 12-06, Section 11.5.

The NRC staff reviewed APS' plans for equipment maintenance and testing and found that there was insufficient information on the EPRI industry program for maintenance, which was then under development. The NRC staff requested that the licensee provide additional information.

In a response dated July 18, 2013 [Reference 36], the licensee stated that:

> This RAI was identified as a generic concern or question during the NRC public meeting on April 18, 2013, regarding the NRC order on mitigating strategies (Order EA-12-049). The nuclear industry will resolve this concern generically through the Nuclear Energy Institute (NEI) and the applicable industry groups (e.g., PWROG, EPRI, etc.). Once this concern is resolved, APS will provide an update to this RAI response in a periodic six-month update to the OIP. NEI will be coordinating with the NRC on the schedule for resolution.

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

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

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 of portable equipment, if they are implemented as described.

3.3.3 Configuration Control

NEI 12-06, Section 11.8 provides that:

1. The FLEX strategies and basis will be maintained in an overall program document. This program document will also contain a historical record of previous strategies and the basis for changes. The document will also contain the basis for the ongoing maintenance and testing programs chosen for the FLEX equipment.

2. Existing plant configuration control procedures will be modified to ensure that changes to the plant design, physical plant layout, roads, buildings, and miscellaneous structures will not adversely impact the approved FLEX strategies.

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

On page 21 of Reference 18, in the section of its Integrated Plan discussing programmatic controls, APS stated that:

> The FLEX strategies and basis will be maintained in an overall program document. 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 in accordance with NEI 12-06, Section 11.8.
>
> The phase 2 and 3 FLEX equipment for ELAP will have unique identification labels.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 they are implemented as described.

3.3.4 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. Periodic training should be provided to site emergency response leaders7 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 Reference 18, APS stated that:

> New training of emergency response organization (ERO) and plant personnel involved in the implementation of FLEX mitigation strategies will be performed in 2014, prior to the Unit 1 (lead unit) implementation. Licensed and non-licensed operator training will be performed as part of the normal operator training schedule. Programs and controls will be established to assure personnel proficiency in the mitigation of beyond-design-basis events is developed and maintained in accordance with NEI 12-06, Section 11.6.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 they 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 Reference 18, in the section of its Integrated Plan regarding the Regional Response Center plan, APS stated:

> The industry will establish two (2) regional response centers (RRCs) to support utilities during beyond design basis events. Each RRC will hold five (5) sets of equipment, four (4) of which will be able to be fully deployed when requested, and the fifth set will have equipment in a maintenance cycle. Equipment will be moved from a RRC to a local offsite 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 the required equipment will be moved to the site as needed. The first piece of critical safety function equipment, as established during development of the nuclear site's playbook, will be delivered to the site within 24 hours of the initial request. PVNGS will execute and maintain a contract with the selected RRC vendor in accordance with the requirements of Section 12 of NEI 12-06.

The staff's current understanding of the licensee's approach, as described above, confirms that the licensee's plans are consistent with the guidance 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 they are implemented as described. Refer to section 3.1.1.4 above for a discussion of Confirmatory Item 3.1.1.4.A on this topic.

4.0 OPEN AND CONFIRMATORY ITEMS

This section contains a summary of the open and confirmatory items identified as part of the technical evaluation. The NRC staff has assigned each unresolved review item to one of the following categories:

A. Acceptable item – an item that the NRC considers resolved, consistent with the endorsed guidance, or otherwise acceptable to the staff. No further NRC review is required, provided the licensee implements the plan as described. Licensee implementation may be subject to inspection.

B. Confirmatory item – an item that the NRC considers 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.

C. Open item – an item for which the licensee has not presented a sufficient basis for NRC to determine that the issue is on a path to resolution. The intent behind designating an issue as an open item is to document significant items that need resolution during the review process, rather than being verified after the compliance date through the inspection process.

These summary tables provide a brief description of the issue of concern. Further details for each open and confirmatory item are provided in the corresponding sections above, identified by the item number.

4.1 Open Items

Item Number/Subject	Description	Notes
3.1.1.2.A. Means to move equipment.	In its Integrated Plan, APS has identified that there is a time constraint of 34 hours to install portable 500 kW 480 V generators in order to recharge batteries. APS has not identified a means to move the generators along with the concomitant method for reasonable protection of that means from the identified hazards applicable to PVNGS as would be required to conform to the guidance of NEI 12-06, Section 5.3.2, consideration 5 and Section 9.3.2.	
3.2.1.2.A: RCP Seal Leakage Rate	The licensee was requested to provide RCP seal leakage testing data applicable to ELAP conditions for Palo Verde and show the following: (a) the calculated maximum RCP seal leakage of 17 gpm/seal exceeds the RCP seal leakage rate obtained from the RCP seal testing data, and (b) the assumed maximum seal gap increase of 0.01 inches exceeds the seal gap increase obtained from the RCP seal testing data. The testing data used to support the calculated maximum leakage rate and the assumed maximum increase in the seal gap should be applicable to Palo Verde seals (with respect to the seal design and material, and seal cooling system), and ELAP conditions (in terms of the maximum temperature and pressure conditions) for an extended testing period consistent with the ELAP coping time.	
3.2.1.2.B: Operating Conditions	To determine whether the licensee adequately addressed the information discussed in Section 3.2.1.2 of this evaluation relating to Section 4.4.2 of WCAP-17601, the NRC staff requested the licensee to provide the following information. (a) Confirm whether an instruction step is available or not for the operator to maintain the subcooled margin which is credited for an ELAP event. If the procedure step is not available, provide justification. (b) Justify the following statement that was used to satisfy criterion (b) discussed in Section 3.2.1.2 of this evaluation: "...the temperature	

	must reach 460 0F at the inlet of the third stage seal prior to posing a pop open concern."	

4.2 Confirmatory Items

Item Number/Subject	Description	Notes
3.1.1.4.A.: Utilization of offsite resources.	APS has provided information regarding its use of the offsite resources through the industry SAFER program, and identified the local staging area, but needs to provide details on transportation to the site following a seismic event.	
3.2.2.A.: SFP cooling makeup flow rates.	Table A of Reference 18 identifies a performance criterion of 110 gpm for the identified SFP makeup pumps. This flow rate is lower than the identified minimum flow rate to compensate for boil off due to the design basis heat load and postulated losses due to leakage, which total 131 gpm. The licensee stated they would change this to provide at least 200 gpm per pump. Confirm this change.	
3.2.3.A.: Containment Functions Strategies	Consistent with the resolution of Open Item 3.2.1.2.A, ensure that the finalized containment analysis properly utilizes the correct RCP seal leakage values and the mass/energy values consistent with the approved CENTS analysis.	
3.2.4.2.A.: Ventilation of main control room.	In its Integrated Plan, APS has presented insufficient information for the NRC staff to conclude that the habitability limits of the control room will be maintained in all phases of an ELAP.	
3.2.4.8.A.: Portable equipment instrumentation.	In its Integrated Plan, APS stated that instrumentation will be provided for portable equipment operation. The NRC staff requested the licensee to describe the instrumentation that will be used to monitor portable/FLEX electrical power equipment including their associated measurement tolerances/accuracy in order to support a conclusion that the equipment will be capable of being operated in a manner to protect installed equipment from adverse electrical interactions in conformance with the guidance of NEI 12-06, Section 3.2.2, guideline (13), as endorsed by JLD-ISG-2012-01. The licensee committed to provide this in a future update.	
3.2.4.10.A.: Battery Duty	During the audit process, the licensee stated	

Cycle.	that the FLEX strategy station battery run-time was calculated in accordance with the IEEE-485 methodology using manufacturer discharge test data applicable to the licensee's FLEX strategy as outlined in the NEI position paper entitled "EA-12-049 Mitigating Strategies Resolution of Extended Battery Duty Cycles Generic Concern," ADAMS Accession No. ML13241A186. The NRC staff will evaluate a licensee's application of the guidance (calculations and supporting data) in its development of the final Safety Evaluation documenting compliance with NRC Order EA-12-049.	

Based on a review of APS' plan, including the six-month update dated August 28, 2013, and information obtained through the mitigation strategies audit process, the NRC concludes that the licensee has provided sufficient information to determine that there is reasonable assurance that the plan, when properly implemented, will meet the requirements of Order EA-12-049 at PVNGS. This conclusion is based on the assumption that the licensee will implement the plan as described, including the satisfactory resolution of the open and confirmatory items.

5.0 SUMMARY

As required by Order EA-12-049, the licensee is developing, and will implement and maintain, guidance and strategies to restore or maintain core cooling, containment, and SFP cooling capabilities in the event of a beyond-design-basis external event. These new requirements provide a greater mitigation capability consistent with the overall defense-in-depth philosophy, and, therefore, greater assurance that the challenges posed by beyond-design-basis external events to power reactors do not pose an undue risk to public health and safety.

The NRC's objective in preparing this interim staff evaluation and audit report is to provide a finding to the licensee on whether or not their Integrated Plan, if implemented as described, provides a reasonable path for compliance with the order. For areas where the NRC staff has insufficient information to make this finding (identified above in Section 4.0), the staff will review these areas as they become available or address them as part of the inspection process. The staff notes that the licensee has the ability to modify their plans as stated in NEI 12-06, Section 11.8. However, additional NRC review and/or inspection may be necessary to verify compliance.

The NRC staff has reviewed the licensee's plans for additional defense-in-depth measures. With the exception of the items noted in Section 4.0 above, the staff finds that the proposed measures, properly implemented, will meet the intent of Order EA-12-049, thereby enhancing the licensee's capability to mitigate the consequences of a beyond-design-basis external event that impacts the availability of ac power and the ultimate heat sink. Full compliance with the order will enable the NRC to continue to have reasonable assurance of adequate protection of public health and safety. The staff will issue a safety evaluation confirming compliance with the order and may conduct inspections to verify proper implementation of the licensee's proposed measures.

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Principal Contributors: E. Bowman
S. Sun
B. Titus
M. McConnell
M. Panicker
S. Gardocki
J. Boska

Date: November 25, 2013

If you have any questions, please contact John Boska at 301-415-2901.

Sincerely,

/RA/

Jeremy S. Bowen, Chief
Project Management Branch
Mitigating Strategies Directorate
Office of Nuclear Reactor Regulation

Docket Nos. 50-528, 50-529,
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OFFICE	NRR/MSD/MESB/BC*	NRR/MSD/MRSB/BC	NRR/MSD/D	NRR/MSD/MSPB/BC
NAME	SBailey	SWhaley	JDavis	JBowen
DATE	11/22/13	11/22/13	11/25/13	11/25/13

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