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

January 31, 2017

Mr. Brian D. Boles
Site Vice President
FirstEnergy Nuclear Operating
Company
c/o Davis-Besse NPS
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SUBJECT: DAVIS-BESSE NUCLEAR POWER STATION, UNIT 1 – SAFETY EVALUATION REGARDING IMPLEMENTATION OF MITIGATING STRATEGIES AND RELIABLE SPENT FUEL POOL INSTRUMENTATION RELATED TO ORDERS EA-12-051 AND EA-12-049 (CAC NOS. MF0960 AND MF0961)

Dear Mr. Boles:

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" and Order EA-12-051, "Order to Modify Licenses With Regard To Reliable Spent Fuel Pool Instrumentation," (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML12054A736 and ML12054A679, respectively). The orders require holders of operating reactor licenses and construction permits issued under Title 10 of the *Code of Federal Regulations* Part 50 to modify the plants to provide additional capabilities and defense-in-depth for responding to beyond-design-basis external events, and to submit for review Overall Integrated Plans (OIPs) that describe how compliance with the requirements of Attachment 2 of each order will be achieved.

By letter dated February 27, 2013 (ADAMS Accession No. ML13064A243), FirstEnergy Nuclear Operating Company (FENOC, the licensee) submitted its OIP for Davis-Besse Nuclear Power Station, Unit 1 (Davis-Besse, DBNPS), in response to Order EA-12-049. At six month intervals following the submittal of the OIP, the licensee submitted reports on its progress in complying with Order EA-12-049. These reports were required by the order, and are listed in the attached safety evaluation. By letter dated August 28, 2013 (ADAMS Accession No. ML13234A503), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" (ADAMS Accession No. ML082900195). By letters dated February 21, 2014 (ADAMS Accession No. ML14007A670), and February 8, 2016 (ADAMS Accession No. ML16019A367), the NRC issued an Interim Staff Evaluation (ISE) and audit report, respectively, on the licensee's progress. By letter dated September 23, 2016 (ADAMS Accession No. ML16267A471), FENOC submitted a compliance letter and Final Integrated Plan (FIP) in response to Order EA-12-049. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-049.

By letter dated February 27, 2013 (ADAMS Accession No. ML13059A495), FENOC submitted its OIP for Davis-Besse in response to Order EA-12-051. At six month intervals following the submittal of the OIP, the licensee submitted reports on its progress in complying with Order EA-12-051. These reports were required by the order, and are listed in the attached safety evaluation. By letters dated December 11, 2013 (ADAMS Accession No. ML13340A130), and February 8, 2016 (ADAMS Accession No. ML16019A367), the NRC staff issued an ISE and audit report, respectively, on the licensee's progress. By letter dated March 26, 2014 (ADAMS Accession No. ML14083A620), the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-051 in accordance with NRC NRR Office Instruction LIC-111, similar to the process used for Order EA-12-049. By letter dated June 24, 2016 (ADAMS Accession No. ML16176A244), FENOC submitted a compliance letter in response to Order EA-12-051. The compliance letter stated that the licensee had achieved full compliance with Order EA-12-051.

The enclosed safety evaluation provides the results of the NRC staff's review of FENOC's strategies for Davis-Besse. The intent of the safety evaluation is to inform FENOC on whether or not its integrated plans, if implemented as described, appear to adequately address the requirements of Orders EA-12-049 and EA-12-051. The staff will evaluate implementation of the plans through inspection, using Temporary Instruction 2515-191, "Implementation of Mitigation Strategies and Spent Fuel Pool Instrumentation Orders and Emergency Preparedness Communications/Staffing/ Multi-Unit Dose Assessment Plans" (ADAMS Accession No. ML15257A188). This inspection will be conducted in accordance with the NRC's inspection schedule for the plant.

If you have any questions, please contact John Hughey, Orders Management Branch, Davis-Besse Project Manager, at 301-415-3204 or at John.Hughey@nrc.gov.

Sincerely,

Mandy K Halter

Mandy K. Halter, Acting Chief
Orders Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket No.: 50-346

Enclosure:
Safety Evaluation

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO ORDERS EA-12-049 AND EA-12-051

FIRSTENERGY NUCLEAR OPERATING COMPANY

DAVIS-BESSE NUCLEAR POWER STATION, UNIT 1

DOCKET NO. 50-346

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 already in place in nuclear power plants in the United States. 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 and beyond the anticipated design-basis of the plants. The U.S. Nuclear Regulatory Commission (NRC) determined that additional requirements needed to be imposed at U.S. commercial power reactors to mitigate such beyond-design-basis external events (BDBEEs).

On 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 4]. This 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 BDBEE. Order EA-12-049 applies to all power reactor licensees and all holders of construction permits for power reactors.

On March 12, 2012, the NRC also issued Order EA-12-051, "Order Modifying Licenses With Regard to Reliable Spent Fuel Pool Instrumentation" [Reference 5]. This order directed licensees to install reliable SFP level instrumentation with a primary channel and a backup channel, and with independent power supplies that are independent of the plant alternating current (ac) and direct current (dc) power distribution systems. Order EA-12-051 applies to all power reactor licensees and all holders of construction permits for power reactors.

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 regulations and processes and determining if the agency should make additional improvements

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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]. Following interactions with stakeholders, these recommendations were enhanced by the NRC staff and presented to the Commission.

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 2] to the Commission. This paper included a proposal to order licensees to implement enhanced BDBEE mitigation strategies. As directed by the Commission in staff requirements memorandum (SRM)-SECY-12-0025 [Reference 3], the NRC staff issued Orders EA-12-049 and EA-12-051.

2.1 Order EA-12-049

Order EA-12-049, Attachment 2, [Reference 4] requires that operating power reactor licensees and construction permit holders use a three-phase approach for mitigating BDBEEs. 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 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 ac power and loss of normal access to the ultimate heat sink [UHS] and have adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to this 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 this Order.

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

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

On December 10, 2015, following submittals and discussions in public meetings with NRC staff, the Nuclear Energy Institute (NEI) submitted document NEI 12-06, Rev. 2, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," [Reference 6] to the NRC to provide revised

specifications for an industry-developed methodology for the development, implementation, and maintenance of guidance and strategies in response to the Mitigation Strategies order. The NRC staff reviewed NEI 12-06, Rev. 2, and on January 22, 2016, issued Japan Lessons-Learned Directorate (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-01, Rev. 1, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," [Reference 7], endorsing NEI 12-06, Rev. 2, with exceptions, additions, and clarifications, as an acceptable means of meeting the requirements of Order EA-12-049, and published a notice of its availability in the *Federal Register* (81 FR 10283).

2.2 Order EA-12-051

Order EA-12-051, Attachment 2, [Reference 5] requires that operating power reactor licensees and construction permit holders install reliable SFP level instrumentation. Specific requirements of the order are listed below:

> All licensees identified in Attachment 1 to the order shall have a reliable indication of the water level in associated spent fuel storage pools capable of supporting identification of the following pool water level conditions by trained personnel: (1) level that is adequate to support operation of the normal fuel pool cooling system, (2) level that is adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck, and (3) level where fuel remains covered and actions to implement make-up water addition should no longer be deferred.
>
> 1. The spent fuel pool level instrumentation shall include the following design features:
>
> 1.1 Instruments: The instrumentation shall consist of a permanent, fixed primary instrument channel and a backup instrument channel. The backup instrument channel may be fixed or portable. Portable instruments shall have capabilities that enhance the ability of trained personnel to monitor spent fuel pool water level under conditions that restrict direct personnel access to the pool, such as partial structural damage, high radiation levels, or heat and humidity from a boiling pool.
>
> 1.2 Arrangement: The spent fuel pool level instrument channels shall be arranged in a manner that provides reasonable protection of the level indication function against missiles that may result from damage to the structure over the spent fuel pool. This protection may be provided by locating the primary instrument channel and fixed portions of the backup instrument channel, if applicable, to maintain instrument channel separation within the spent fuel pool area, and to utilize inherent shielding from missiles provided by existing recesses and corners in the spent fuel pool structure.

1.3 Mounting: Installed instrument channel equipment within the spent fuel pool shall be mounted to retain its design configuration during and following the maximum seismic ground motion considered in the design of the spent fuel pool structure.

1.4 Qualification: The primary and backup instrument channels shall be reliable at temperature, humidity, and radiation levels consistent with the spent fuel pool water at saturation conditions for an extended period. This reliability shall be established through use of an augmented quality assurance process (e.g., a process similar to that applied to the site fire protection program).

1.5 Independence: The primary instrument channel shall be independent of the backup instrument channel.

1.6 Power supplies: Permanently installed instrumentation channels shall each be powered by a separate power supply. Permanently installed and portable instrumentation channels shall provide for power connections from sources independent of the plant ac and dc power distribution systems, such as portable generators or replaceable batteries. Onsite generators used as an alternate power source and replaceable batteries used for instrument channel power shall have sufficient capacity to maintain the level indication function until offsite resource availability is reasonably assured.

1.7 Accuracy: The instrument channels shall maintain their designed accuracy following a power interruption or change in power source without recalibration.

1.8 Testing: The instrument channel design shall provide for routine testing and calibration.

1.9 Display: Trained personnel shall be able to monitor the spent fuel pool water level from the control room, alternate shutdown panel, or other appropriate and accessible location. The display shall provide on-demand or continuous indication of spent fuel pool water level.

2. The spent fuel pool instrumentation shall be maintained available and reliable through appropriate development and implementation of the following programs:

2.1 Training: Personnel shall be trained in the use and the provision of alternate power to the primary and backup instrument channels.

2.2 Procedures: Procedures shall be established and maintained for the testing, calibration, and use of the primary and backup spent fuel pool instrument channels.

2.3 Testing and Calibration: Processes shall be established and maintained for scheduling and implementing necessary testing and calibration of the primary and backup spent fuel pool level instrument channels to maintain the instrument channels at the design accuracy.

On August 24, 2012, following several NEI submittals and discussions in public meetings with NRC staff, the NEI submitted document NEI 12-02, "Industry Guidance for Compliance With NRC Order EA-12-051, To Modify Licenses With Regard to Reliable Spent Fuel Pool Instrumentation," Rev. 1 [Reference 8] to the NRC to provide specifications for an industry-developed methodology for compliance with Order EA-12-051. On August 29, 2012, the NRC staff issued its final version of JLD-ISG-2012-03, "Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation" [Reference 9], endorsing NEI 12-02, Rev. 1, as an acceptable means of meeting the requirements of Order EA-12-051 with certain clarifications and exceptions, and published a notice of its availability in the *Federal Register* (77 FR 55232).

3.0 <u>TECHNICAL EVALUATION OF ORDER EA-12-049</u>

By letter dated February 27, 2013 [Reference 10], FirstEnergy Nuclear Operating Company (FENOC, the licensee) submitted its Overall Integrated Plan (OIP) for Davis-Besse Nuclear Power Station, Unit 1 (Davis-Besse, DBNPS) in response to Order EA-12-049. By letters dated August 26, 2013 [Reference 11], February 27, 2014 [Reference 12], August 28, 2014 [Reference 13], February 26, 2015 [Reference 14], August 27, 2015 [Reference 34], and February 26, 2016 [Reference 35], the licensee submitted six-month updates to the OIP. By letter dated August 28, 2013 [Reference 15], the NRC notified all licensees and construction permit holders that the staff is conducting audits of their responses to Order EA-12-049 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" [Reference 36]. By letters dated February 21, 2014 [Reference 16], and February 8, 2016 [Reference 17], the NRC issued an Interim Staff Evaluation (ISE) and an audit report on the licensee's progress. By letter dated September 23, 2016 [Reference 18], the licensee reported that full compliance with the requirements of Order EA-12-049 was achieved, and submitted a Final Integrated Plan (FIP).

3.1 <u>Overall Mitigation Strategy</u>

Attachment 2 to Order EA-12-049 describes the three-phase approach required for mitigating BDBEEs in order to maintain or restore core cooling, containment, and SFP cooling capabilities. The phases consist of an initial phase (Phase 1) using installed equipment and resources, followed by a transition phase (Phase 2) in which portable onsite equipment is placed in service, and a final phase (Phase 3) in which offsite resources may be placed in service. The timing of when to transition to the next phase is determined by plant-specific analyses.

While the initiating event is undefined, it is assumed to result in an extended loss of ac power (ELAP) with a loss of normal access to the UHS. Thus, the ELAP with loss of normal access to the UHS is used as a surrogate for a BDBEE. The initial conditions and assumptions for the analyses are stated in NEI 12-06, Section 3.2.1, and include the following:

1. The reactor is assumed to have safely shut down with all rods inserted (subcritical).
2. The dc power supplied by the plant batteries is initially available, as is the ac power from inverters supplied by those batteries; however, over time the batteries may be depleted.

3. There is no core damage initially.
4. There is no assumption of any concurrent event.
5. Because the loss of ac power presupposes random failures of safety-related equipment (emergency power sources), there is no requirement to consider further random failures.

Davis-Besse is a Babcock & Wilcox (B&W) pressurized-water reactor (PWR); with a dry ambient pressure containment. The licensee's three-phase approach to mitigate a postulated ELAP event, as described in the FIP, is summarized below.

At the onset of an ELAP the reactor is assumed to trip from full power. The reactor coolant pumps coast down and flow in the reactor coolant system (RCS) transitions to natural circulation. Operators will take prompt actions to minimize RCS inventory losses by isolating potential RCS letdown paths. Decay heat is removed by steaming to atmosphere from the steam generators (SGs) through the main steam safety valves (MSSVs) and later with manual operator action, via the atmospheric vent valves (AVVs) using the installed remote hand wheels. Makeup to the SGs is initially provided by the turbine-driven auxiliary feedwater (TDAFW) pumps taking suction from the condensate storage tanks (CSTs), if available. The CSTs are not seismically qualified or missile protected. If the CSTs are not available, makeup to the SGs is provided by manually starting, from the control room, the diesel driven emergency feedwater pump (EFWP), which takes suction from the emergency feedwater storage tank (EFWST). When using emergency feedwater (EFW), cooling water is initially provided only to SG number 1 and later, with operator action, SG number 2. Subsequently, the operators would begin a controlled cooldown and depressurization of the RCS by manually operating the SG AVVs. The RCS Cooldown would begin within 4.5 hours after the event at 30 degrees Fahrenheit (°F) per hour (°F/hr) to an RCS temperature between 320 and 350°F. Depressurizing the SGs reduces RCS temperature and pressure. The reduction in RCS temperature will result in inventory contraction in the RCS. For RCS inventory control and to ensure the core is maintained subcritical, borated water injection into the RCS is provided from the borated water storage tank (BWST) when available, or from the clean waste receiver tank (CWRT) 1, which provides the protected borated water source via the RCS FLEX charging pumps. The RCS Injection will begin within 2.5 hours after the start of the event. During RCS cooldown, if core flood tank (CFT) injection is likely or in progress, the CFTs are either vented to remove the nitrogen overpressure or isolated via the CFT isolation valves. This prevents undesired injection of CFT inventory into the RCS when RCS inventory is available via the RCS FLEX charging pumps.

As discussed in its cooldown timeline, the licensee expects to further depressurize the SGs in order to further reduce RCS temperature and pressure. In addition, as noted in the FIP, the licensee expects to use FLEX equipment from offsite response centers to restore the decay heat removal (DHR) system and supporting equipment.

Operators can transition the SG water supply from the TDAFW pumps or the EFW pump to portable FLEX pumps using water from the EFWST. The FIP described various alternative water sources that are available to refill the EFWST including the UHS, which is Lake Erie.

The operators will perform dc bus load stripping within 1 hour following event initiation to ensure safety-related battery life is extended up to 14.6 hours. Following dc load stripping and prior to battery depletion, the 850-kilowatt (kW), 480 volt alternating current (Vac) diesel generator (DG) that is prestaged in the emergency feedwater facility (EFWF) will be connected to a motor control center (MCC) in the EFWF. This prestaged DG will be used to repower essential battery

chargers, as well as repowering CFT isolation valves, pressurizer heaters, RCS FLEX charging pump and associated booster pumps. If required, a backup 850 kW, 480 Vac DG can be positioned outside of the EFWF or auxiliary building and connected to the MCC in the EFWF.

In addition, a National Strategic Alliance for FLEX Emergency Response (SAFER) Response Center (NSRC) will provide high capacity pumps and large turbine-driven DGs. There are two NSRCs in the United States.

The SFP is located in the auxiliary building. Upon initiation of the ELAP event, the SFP will heat up due to the unavailability of the normal cooling system. The licensee has determined that boiling would begin at approximately 8 hours after ELAP is declared. To maintain SFP cooling capabilities, the licensee described that makeup to the SFP can be gravity-fed from the BWST, if available. If the BWST is not available, SFP makeup can be provided from EFWST using the EFWP, through connections, to supply the FLEX SFP makeup header. In addition, the FIP described that two diesel-driven FLEX spray pumps will also be available in on-site storage locations. These pumps have adequate capacity and can be deployed within the time available to be used as alternate SFP makeup sources. Ventilation of the generated steam is accomplished by opening rollup door 300 or door 301 in the SFP area to establish a steam release path to the environment.

For Phases 1 and 2 the licensee's calculations demonstrate that no actions are required to maintain containment pressure below design limits. The licensee's calculations has shown that no actions or systems are needed to ensure continued containment function. Containment pressure and temperature both remain acceptable, at relatively low values, without any active containment cooling. During Phase 3, containment cooling and depressurization, as needed, would be accomplished by operating containment cooling fans, with service water (SW) for cooling supplied by an NSRC FLEX pump. The containment cooling fans would be powered by a DG supplied by the NSRC.

Below are specific details on the licensee's strategies to restore or maintain core cooling, containment, and SFP cooling capabilities in the event of a BDBEE, and the results of the staff's review of these strategies. The NRC staff evaluated the licensee's strategies against the endorsed NEI 12-06, Rev. 2, guidance.

3.2 Reactor Core Cooling Strategies

Order EA-12-049 requires licensees to maintain or restore cooling to the reactor core in the event of an ELAP concurrent with a loss of normal access to the UHS. Although the ELAP results in an immediate trip of the reactor, sufficient core cooling must be provided to account for fission product decay and other sources of residual heat. Consistent with endorsed guidance from NEI 12-06, Phase 1 of the licensee's core cooling strategy credits installed equipment (other than that presumed lost to the ELAP with loss of normal access to the UHS) that is robust in accordance with the guidance in NEI 12-06. In Phase 2, robust installed equipment is supplemented by onsite FLEX equipment, which is used to cool the core either directly (e.g., pumps and hoses) or indirectly (e.g., FLEX electrical generators and cables repowering robust installed equipment). The equipment available onsite for Phases 1 and 2 is further supplemented in Phase 3 by equipment transported from the NSRCs.

To adequately cool the reactor core under ELAP conditions, two fundamental physical requirements exist: (1) a heat sink is necessary to accept the heat transferred from the reactor core to coolant in the RCS and (2) sufficient RCS inventory is necessary to transport heat from the reactor core to the heat sink via natural circulation. Furthermore, inasmuch as heat removal requirements for the ELAP event consider only residual heat, the RCS inventory should be replenished with borated coolant in order to maintain the reactor in a subcritical condition as the RCS is cooled and depressurized.

As reviewed in this section, the licensee's core cooling analysis for the ELAP with loss of normal access to the UHS event presumes that, per endorsed guidance from NEI 12-06, the plant would have been operating at full power prior to the event. Therefore, the SGs may be credited as the heat sink for core cooling during the ELAP with loss of normal access to the UHS event. Maintenance of sufficient RCS inventory, despite ongoing system leakage expected under ELAP conditions, is accomplished through a combination of installed systems and FLEX equipment. The specific means used by the licensee to accomplish adequate core cooling during the ELAP with loss of normal access to the UHS event are discussed in further detail below. The licensee's strategy for ensuring compliance with Order EA-12-049 for conditions where one or more units are shut down or being refueled is reviewed separately in Section 3.11 of this evaluation.

3.2.1 Core Cooling Strategy and RCS Makeup

3.2.1.1 Core Cooling Strategy

3.2.1.1.1 Phase 1

Immediately following the trips of the reactor and RCPs, RCS temperature and pressure will stabilize at no-load conditions. Core cooling would be accomplished by natural circulation flow in the RCS using the two SGs as the heat sink. The credited strategy is, within 10 minutes of reactor trip, operators would initiate SG inventory makeup by remotely starting the diesel-driven EFWP, which takes suction from the EFWST with steam vented via the MSSVs and AVVs. There are two TDAFW pumps at Davis-Besse, which would start automatically upon a loss of all ac power; however, these pumps take suction from the CSTs which are not robust to seismic or wind-borne missile hazards. If the CSTs are available, the TDAFW pumps would initially provide makeup to the SGs, but these pumps and the CSTs are not credited for any FLEX response by the licensee.

The EFWP and the EFWST are located within the EFWF, which is designed to be robust relative to all applicable external hazards. The diesel-driven EFWP can be started by operators from the control room during a loss of all ac power, and will begin discharging to the #1 SG immediately upon starting. Local operator action is required to establish the cross-tie function of the EFW system so that makeup feedwater will flow to the #2 SG as well, allowing operators to conduct a symmetric RCS cooldown. The licensee has identified starting the EFWP (within 10 minutes of the ELAP) and aligning EFW flow to the #2 SG (within 90 minutes of the ELAP) as time-sensitive operator actions.

The EFWST minimum volume is 226,670 gallons of makeup water, which the licensee calculates is sufficient to supply the makeup water requirements associated with decay heat removal and RCS cooldown, as well as makeup water to the SFP, for the first 16 hours of the event.

Decay heat would initially be removed from the SGs by automatic lifting of the MSSVs, which have a setpoint of 1050 per square inch gage (psig) (two per SG) or 1100 psig (seven per SG). The licensee states that approximately 45 minutes after the initiating event, operators would establish local manual control of the AVVs via reach rods, and maintain SG pressure constant at approximately 980-1020 psig, below the lowest MSSV lift pressure setpoint. The AVVs are robust to all applicable external hazards.

3.2.1.1.2 Phase 2

The licensee's primary Phase 2 strategy is to cool down and depressurize the RCS at a rate of 30 °F/hr to a target RCS temperature of 320-350 °F. Starting this deliberate cooldown is identified by the licensee as a time-sensitive operator action and must begin no later than 4.5 hours after the start of the event. The licensee would preferably perform a symmetric cooldown, feeding and steaming both SGs simultaneously. However, as a contingency, should RCS conditions require an asymmetric cooldown (e.g. if RCS makeup is unavailable within 6 hours of the event) then procedure DB-OP-02700, "Station Blackout," contains guidance for performing an asymmetric cooldown, feeding and steaming the #1 SG only, with the #2 SG idle.

A symmetric RCS cooldown would begin only after FLEX RCS charging is made available, which is itself a time-sensitive operator action and would be completed no later than 2.5 hours into the event (see Section 3.2.2.1.2). Operators would first raise pressurizer level to 250 inches (compensated) before commencing the cooldown, and operate the charging pumps so as to maintain pressurizer level between 100 and 250 inches during the cooldown.

The feedwater makeup to the SGs would continue to be supplied by the EFWP. In order to have an alternative flow path and meet the guidance of NEI 12-06, the licensee also can deploy one of two portable diesel-driven alternate low-pressure (LP) EFW pumps. The alternate LP EFW pumps have limited capacity: 115 gallons per minute (gpm) total flow when feeding two SGs with SG pressure at 400 psig, and 280 gpm total flow when feeding two SGs with SG pressure at 250 psig. The licensee identifies these pumps as less preferable for use than either the EFWP or the Turbine Driven Auxiliary Feedwater pumps (TDAFWPs), and notes that their use in a FLEX scenario would only be required as the "result of events beyond the FLEX strategy assumptions".

As noted above, the minimum volume in the EFWST will support decay heat removal and core cooling for at least 16 hours. Before the tank is depleted, DB-OP-02706, "EFW Storage Tank Makeup," directs operators to deploy a portable FLEX replenishment pump to take suction from any of several on-site makeup sources of varying water quality. Higher-quality sources such as the CSTs and DWST are not guaranteed to survive the initiating event; if a demineralized water grade source is not readily available, the preferred source would be the Training Center ponds, with an essentially unlimited supply of makeup water. The ultimate heat sink (Lake Erie) is also available as a source of EFWST makeup water.

3.2.1.1.3 Phase 3

The licensee's FIP states that Phase 3 will initially be a continuation of the Phase 2 coping strategy, with the EFWP, TDAFWPs or alternate EFW LP pumps continuing to supply makeup water to the SGs. Eventually, a high capacity pump from the NSRC will allow operators to restore a SW train by taking suction from the ultimate heat sink. Operators will then be able to restore cooling water to the Component Cooling Water (CCW) system, and then to the DHR system. The 4160-volt generators, also furnished by the NSRC, will restore the C1 and/or D1 essential buses, allowing operators to re-power the electrical components of the CCW and DHR systems. When this is complete, indefinite coping ability will have been established.

3.2.1.2 RCS Makeup Strategy

3.2.1.2.1 Phase 1

Following initiation of the ELAP event, operators would verify isolation of normal letdown and other isolable flowpaths to conserve RCS inventory. However, under ELAP conditions, RCS inventory would tend to diminish gradually due to leakage through RCP seals and other leakage points. Thermal contraction from an RCS cooldown, if conducted in the absence of active RCS makeup, would result in a further volumetric reduction of the RCS inventory, to the extent that the pressurizer would drain and a vapor void would form in the upper head of the reactor vessel.

Davis-Besse, Unit 1 is a B&W PWR with two once-through SGs and raised RCS loops. In order to maintain natural circulation in the RCS loops for this design configuration, plant operators should avoid taking actions that tend to drain the pressurizer. For this reason, the licensee intends to delay the RCS cooldown until the Phase 2 RCS makeup strategy can adequately refill the RCS. Passive RCS injection from the nitrogen-pressurized CFT is not expected to occur in Phase 1, since RCS pressure will remain higher than CFT pressure (normally 600 psig) until Phase 2 strategies (i.e. deliberate cooldown) are in progress.

3.2.1.2.2 Phase 2

No later than 2.5 hours into the event, the licensee would power one of two installed FLEX charging pumps, and its associated booster pump, using the 480V FLEX DG. These 60-gpm pumps and their respective booster pumps are pre-staged at two different locations in the Auxiliary Building. The charging pumps are pre-connected to their associated booster pump, but not to plant systems. One pump is designated by the licensee to take suction from the BWST and discharge to the RCS via the #1 high pressure injection (HPI) train, and the other would normally take suction from the CWRT1 and discharge to the #2 HPI train. However, operators have the ability to align both pumps to take suction from either tank and discharge to either HPI train.

The seismically-qualified BWST is the preferred source for RCS makeup in a FLEX scenario, but is potentially vulnerable to damage from a high wind generated missile. During at-power operations, it would contain at least 500,100 gallons of water at a boron concentration of 2600-2800 parts per million (ppm). If the BWST is not available, CWRT1 would be used. The CWRT1 contains at least 80,000 gallons of borated water between 2600-2800 ppm during at-power operations. This tank is located within the Auxiliary Building and is therefore protected

from wind-borne missiles; the licensee has also performed modifications to one pipe support and one conduit support to make the tank seismically adequate for design-basis seismic loads.

As discussed in Section 3.2.1.1.2 above, operators would raise pressurizer level to 250 in. (compensated) as soon as a FLEX RCS charging pump is aligned. Operators will then commence the core cooldown through the AVVs. During the cooldown, operators would cycle the charging pump to maintain pressurizer level between 100 and 250 in. (compensated). Pressurizer heaters will be re-powered by the F1 (preferable) or E1 (alternate) essential bus, itself supported by a 480V FLEX DG, which will allow for pressure control. Using pressurizer heaters for pressure control during Phase 2 is desirable, but not required; if for some reason the heaters cannot be restored, the Station Blackout procedure directs operators to conduct the cooldown using charging pumps to control pressure while monitoring RCS pressure carefully.

Injection of borated water from the CFTs is not desirable during the FLEX response, due to the risk of injecting nitrogen cover gas into the RCS and potentially disrupting natural circulation. Therefore, the Station Blackout procedure directs operators to shut the CFT isolation valves or vent the pressurized nitrogen cover gas if at any time CFT injection is "likely or in progress." The CFT isolation is preferable, and requires that the CFT isolation valves be re-powered from the E1 and/or F1 essential buses (energized by a 480V FLEX DG). Venting the CFTs is an alternate strategy to prevent nitrogen injection, and would require containment entry.

3.2.1.2.3 Phase 3

The licensee's FIP states that Phase 3 will be a continuation of the Phase 2 coping strategy, supplemented by a high-pressure (60 gpm at 2000 psig) NSRC backup pump, diesel generators, and diesel fuel transfer capability. This high-pressure NSRC pump is not required for the licensee's FLEX strategy, but would be provided for defense-in-depth.

3.2.2 Variations to Core Cooling Strategy for Flooding Event

The licensee has conducted a Flood Hazard Reevaluation Report (FHRR) per the recommendation of the NRC Near-Term Task Force (NTTF). The FHRR and the corresponding Interim Staff Assessment issued by the staff identified two flooding hazards which were not bounded by the existing design-basis: Local Intense Precipitation (LIP) and Probable Maximum Storm Surge (PMSS). The licensee is currently evaluating the potential impact of these hazards on the FIP, and will incorporate the results of their analysis in a revision to the FIP, if required. Also, the licensee intends to conduct a Focused Evaluation to determine the impact of the LIP and PMSS hazards on the existing design-basis, but states that this should have no impact on the FIP. In summary, there are no variations to the FLEX response for a flooding event at Davis-Besse.

3.2.3 Staff Evaluations

3.2.3.1 Availability of Structures, Systems, and Components (SSCs)

Guidance document NEI 12-06 provides guidance that the baseline assumptions have been established on the presumption that other than the loss of the ac power sources and normal access to the UHS, installed equipment that is designed to be robust with respect to design basis external events is assumed to be fully available. Installed equipment that is not robust is

assumed to be unavailable. Below are the baseline assumptions for the availability of SSCs for core cooling during an ELAP caused by a BDBEE.

3.2.3.1.1 Plant SSCs

Core Cooling

The licensee provided descriptions in its FIP for the permanent plant SSCs to be used to support core cooling. There are two TDAFWPs, each capable of taking steam from and providing feedwater to either SG. The TDAFWPs can automatically start on loss of all ac power and provide makeup water from the CSTs. The licensee stated that the TDAFWs are not credited as part of the SG makeup strategy due to the CSTs not being seismically or missile protected. Therefore, the credited SG makeup strategy relies on the EFW system. The TDAFWPs and the CSTs will be used for ELAP events until the CST is depleted or if the TDAFWPs become unavailable due to loss of ventilation or other operational issues. The licensee constructed a new EFW Facility that is designed to be protected from all applicable external hazards. The components used for the SG makeup strategy to be permanently installed in the EFW Facility will also be protected from all applicable external hazards. These components include EFWST, a high-head diesel-driven EFW pump and associated piping, the "N" LP EFW pump, a diesel oil storage tank to provide fuel oil for diesel driven loads, and a FLEX 480 Volt AC generator. The EFW pump can be started from the Control Room during a loss of all AC power. The system includes a flow control valve that can be used from the Control Room to control flow from the EFWST to one of the SGs. The EFW System includes cross tie capability such that, with manual operator action in the field, inventory can also be provided to the second SG to allow a symmetric RCS Cooldown as directed by emergency operating procedure (EOP) DB-OP-02700, "Station Blackout."

The EFWST contains 226,670 gallons of makeup water credited for FLEX, which will allow the EFW pump to provide SG makeup for a minimum of 16 hours before the EFWST needs to be replenished. Replenishment of the EFWST is directed by FLEX Support Guideline (FSG) DB-OP-02706, "EFW Storage Tank Makeup." The FIP identifies the Training Center Pond as a source that can replenish the EFWST for up to the first 23 hours of the ELAP event. Tank capacities are listed, but BDBEE damage to the tanks or tank support equipment may require exploring alternate methods of acquiring the usable volume still contained in the tank (i.e., using tank or system breaches to deploy a submersible pump or suction line). Water sources are listed in preferred order of makeup usage based upon chemistry considerations and accessibility. Potential connection points are also listed to aid Technical Support Center (TSC) guidance for discussions on usable inventories and retrieval possibilities. Table 1 in Section 3.2.6 of the FIP provides a list of potential water sources that can be used to replenish the EFWST. The UHS, Lake Erie, can be used, once the preferred water sources are exhausted, through the intake water system for Phase 3 core cooling.

The licensee also indicated that AVVs are used within approximately 45 minutes to support core decay heat removal. Initially upon loss of ac power, the MSSVs on each SG will provide core cooling and decay heat removal. The AVVs are manually operated with a local manual reach rod to maintain constant SG pressure and maintain the pressure below the lowest MSSV lift pressure setpoint. Local manual reach rod control does not require electrical power or instrument air to operate the valve. The SG AVV's are missile protected, seismically qualified valves located inside the Auxiliary Building.

During the audit, the NRC staff reviewed the locations of the permanent and installed SSCs described above to confirm that the SSCs will be protected from all applicable external hazards and have supporting procedures that will direct operators to take action as needed to support the core cooldown FLEX strategy. The NRC staff also reviewed the procedures to confirm that the manual actions can be performed within the milestones as indicated in Section 3.1 of the FIP. Based on the design and location of the protected water sources and the permanent and newly installed plant SSCs as described in the FIP, the staff finds that the licensee's strategy should be available to support core cooling during an ELAP caused by a BDBEE, consistent with Condition 4 of NEI 12-06, Section 3.2.1.3.

RCS Inventory Control

The FIP describes the borated water sources that are located in permanent tanks on site to supply RCS makeup via one of two RCS FLEX charging pumps (as described in Section 3.2.3.5). The CWRT is a stainless steel tank located inside the Auxiliary Building on the 545 ft. elevation level. The Auxiliary Building is protected from all applicable external hazards. The CWRT was also evaluated by the licensee to be protected from seismic loads. The licensee stated that the borated water available for RCS makeup in the CWRT will be maintained at least 80,000 gallons or greater at a boron concentration between 2600 and 2800 ppm boron. The BWST is a safety-related, stainless steel tank that is protected from all applicable external hazards except for high winds or tornados. The BWST is located outside on the West side of the Auxiliary Building. The BWST will have available borated water for RCS makeup between 500,100 gallons and 550,000 gallons at a boron concentration between 2600 and 2800 ppm boron in accordance with Davis Besse Technical Specification 3.5.4. The licensee FLEX RCS makeup strategy allows for both the CWRT and BWST to be used by either RCS FLEX charging pump.

During the audit, the NRC staff reviewed the locations of both the CWRT and BWST as well as the proposed locations for the RCS FLEX charging pumps to confirm that the RCS makeup strategy will have at least one fully protected pathway for all applicable external events. Based on the location and the availability of RCS FLEX charging pumps and the available borated water sources, the staff finds the licensee's strategy should be available to support RCS inventory control during an ELAP caused by a BDBEE, consistent with Condition 3 of NEI 12-06, Section 3.2.1.3.

3.2.3.1.2 Plant Instrumentation

Per Section 2.3.6 of the FIP, the following instrumentation credited for FLEX is expected to be available following the stripping of non-essential loads:

- in-core thermocouple temperature
- RCS temperatures (hot leg and cold leg)
- SG level (both)
- pressurizer level
- RCS pressure
- BWST level
- source range nuclear instrumentation
- EFW flow
- EFWST level

This list of instruments assumes that Station Battery 2P is in service with Instrument Bus Y2 energized, which the licensee states is the expected condition. If one of the other Station Batteries (1P, 1N, or 2N) is in service, supporting a different Instrument Bus (Y1, Y3, or Y4, respectively) then this list may vary. However, in any case, the minimum set of parameters recommended to be available per Section 3.2.1.10 of NEI 12-06 will be available, with the following partial exceptions:

(1) SG pressure is not credited to be available from any Station Battery. Procedure DB-OP-02707, "Loss of DC Power," directs operators to estimate SG pressure, if necessary, based on local AFW steam pressure indicators. Attachment 2 of this procedure also provides guidance for operators to obtain this parameter from the appropriate local penetration.

(2) Instrument Buses Y3 and Y4 do not support SG level indication. However, procedure DB-OP-02704, "Extended Loss of AC Power DC Load Management," states that operators could use jumpers to power SG level instrumentation from Y3/Y4 power. The procedure instructs operators to consult the TSC for guidance in the event that it must be used. Attachment 3 of DB-OP-2707 also provides guidance for operators to obtain this parameter from the appropriate local penetration.

As recommended by Section 5.3.3 of NEI 12-06, the licensee has developed procedural guidance with instructions and information to obtain readings locally (e.g., at containment penetrations and instrument racks) for the majority of the plant instrumentation listed above. These instructions are contained in DB-OP-02707. Exceptions to this statement are the source range nuclear instruments, as well as indications for EFW flow and EFWST level, which are not included as required instrumentation in NEI 12-06.

3.2.3.2 Thermal-Hydraulic Analyses

In the analysis of the ELAP event performed by the PWR Owners Group (PWROG) in WCAP-17601-P, "Reactor Coolant System Response to the Extended Loss of AC Power Event for Westinghouse, Combustion Engineering and Babcock & Wilcox NSSS Designs," the RELAP5/MOD2-B&W code was chosen for the evaluation of B&W-designed plants such as Davis-Besse. The RELAP5/MOD2-B&W code, as described in AREVA topical report BAW-10164-PA, "RELAP5/MOD2-B&W - An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analysis," Revision 6 (proprietary), is a general purpose thermal-hydraulic code that is capable of modeling accident scenarios including large- and small-break loss-of-coolant accidents (LOCAs), as well as a range of operational transients. The RELAP5/MOD2-B&W code is an adaption of the two-fluid, non-equilibrium RELAP5/MOD2 code developed at the Idaho National Engineering Laboratory. Although RELAP5/MOD2-B&W has been approved for performing certain design-basis transient and accident analyses, the NRC staff had not previously examined its technical adequacy for performing best-estimate simulations of the ELAP event. Therefore, in support of mitigating strategy reviews to assess compliance with Order EA-12-049, the NRC staff evaluated licensees' thermal-hydraulic analyses, including a limited review of the significant assumptions and modeling capabilities of the RELAP5/MOD2-B&W code and other thermal-hydraulic codes used for these analyses.

Based upon this review, the NRC staff questioned whether RELAP5/MOD2-B&W and other codes used to analyze ELAP scenarios for PWRs would provide reliable coping time predictions in the reflux or boiler-condenser cooling phase of the event because of challenges associated with modeling complex phenomena that could occur in this phase, including boric acid dilution in the intermediate leg loop seals, two-phase leakage through RCP seals, and primary-to-secondary heat transfer with two-phase flow in the RCS. In particular, for B&W PWRs with once-through SGs, the boiler-condenser cooling mode is said to exist when vapor boiled off from the reactor core flows up through the saturated, stratified hot legs, around the hot leg bends, and then down into the once-through SG tubes, where it is condensed by EFW sprayed onto the SG tubes. Unlike PWRs with inverted U-tube SGs that undergo reflux cooling (i.e., wherein the majority of condensation occurs on the uphill side of the SG tubes, with the resulting condensate flowing back downhill into the reactor vessel via the hot legs), for B&W reactors in the boiler-condenser cooling mode, the condensate continues to drain downward through the once-through SGs and into the intermediate legs.

Due to the B&W RCS design configuration, at the time natural circulation ceases in the RCS (i.e., hot leg bends are sufficiently voided), the once-through SG tubes remain full of water. The presence of this stagnant liquid precludes effective heat transfer via boiler-condenser cooling, since it prevents vapor from penetrating down into the SG tubes being sprayed by EFW flow. In this condition, degraded primary-to-secondary heat transfer conditions may occur, persisting until either: (1) sufficient RCS volume is restored to restart natural circulation, or (2) sufficient RCS volume is lost such that steam from the hot legs can enter the once-through SG tubes to permit adequate, continuous condensation heat transfer via boiler-condenser cooling. Owing to the relatively low RCS leakage rate considered during the analyzed ELAP event, if this situation occurs prior to the establishment of FLEX RCS makeup, a significant period of time may elapse, during which primary-to-secondary heat transfer may be significantly degraded, as illustrated in simulations conducted for B&W reactors in both WCAP-17601-P and WCAP-17792-P, "Emergency Procedure Development Strategies for the Extended Loss of AC Power Event for all Domestic Pressurized Water Reactor Designs" (proprietary). These simulations show the potential for RCS re-pressurization in excess of 2000 psia after RCS loop flow stagnates, with the RCS pressure in some cases remaining in this vicinity for many hours. Extensive re-pressurization of the RCS following a loss of natural circulation should be avoided for a number of reasons, including the potential to lift a safety or relief valve on the pressurizer and the potential for elevated RCS temperatures induced by the re-pressurization to result in RCP seal degradation and increased RCS leakage.

Furthermore, the NRC staff observed that the modeling capability of the RELAP5/MOD2-B&W code with respect to two-phase primary-to-secondary heat transfer for B&W reactors had not been sufficiently benchmarked to support best-estimate calculations for the ELAP event. As noted in BAW-10164-PA, limited benchmarking of the models for two-phase heat transfer across the SG was undertaken because the RCS pressure response during a LOCA tends to be dominated by the mass and energy loss from the break effluent, even down into the size range of the most limiting small break. However, considering the much lower RCS leakage rates associated with the analyzed ELAP event, heat transfer to the once-through SGs becomes the primary means of energy removal from the RCS. Furthermore, the analytical modeling techniques used in the calculations in WCAP-17601-P and WCAP-17792-P for B&W reactors were not adequately documented (e.g., modeling of SG tube wetting by auxiliary feedwater), and in some cases, the calculated results did not appear to match ostensible descriptions (e.g., the B&W simulations apparently did not use the 75°F per hour cooldown rate described in

Section 4.2.1 of WCAP-17601-P). As a result, the NRC staff could not credit the generic B&W coping time results from WCAP-17601-P and WCAP-17792-P beyond the point at which natural circulation ceases and RCS loop flow stagnates.

Likewise, the licensee did not credit boiler-condenser cooling to extend its credited coping time, but instead performed analysis intended to demonstrate that the Davis-Besse strategy will be successful by taking actions to maintain natural circulation in all RCS loops and establish FLEX RCS makeup early in the event. In particular, for the B&W reactor design, prudent objectives for plant operators to prolong the duration of natural circulation flow in the RCS include:

- Maintaining adequate pressurizer level, which suppresses void formation in the RCS loop piping and the potential for an associated increase in flow resistance to interrupt natural circulation. Initiating RCS makeup early in the ELAP event prevents RCS leakage from draining the pressurizer. Delaying the RCS cooldown until RCS makeup is restored, and thereafter conducting a slow cooldown within the volumetric capacity of the FLEX RCS makeup source prevents thermally induced contraction of the RCS from draining the pressurizer.

- Maintaining adequate subcooling in the RCS loops, which similarly suppresses void formation in the RCS loops and the associated potential to interrupt natural circulation. Using the SGs to cool down the RCS with normal plant equipment unavailable would substantially degrade the RCS subcooling margin, potentially beneath minimum values considered desirable or necessary to support natural circulation. By delaying the RCS cooldown until critical steps within the FLEX strategy can be accomplished (e.g., restoration of pressurizer heaters, establishing FLEX RCS makeup), adequate subcooling margin to support natural circulation can be preserved during the RCS cooldown. If at any time adequate subcooling margin (SCM) is lost (i.e. is less than 20 °F), the licensee's Station Blackout procedure directs operators to perform an asymmetric cooldown with a slower cooldown rate (between 5 and 10 °F/hr), in order to restore and maintain SCM between 20 and 30 °F in the active loop.

- Maximization of the elevation at which primary-to-secondary heat transfer occurs, since increasing the height of the heat sink relative to the heat source promotes natural circulation flow. In the B&W reactor design, upon demand, the AFW system sprays feedwater onto the once-through SG tubes at their upper elevation near the upper tubesheet. This elevation is significantly higher than the water level maintained by the main feedwater system during normal operation. Per the Davis-Besse FLEX strategy, the EFW pump and FLEX pumps used for SG makeup would discharge into AFW system piping and hence accrue a similar benefit. In the event that adequate primary to secondary heat transfer were lost, the licensee's procedures would also direct raising the SG water level, which has a similar objective.

The calculations documented in Section C.6 of WCAP-17792-P, which assumed an RCS leakage rate of 9 gpm, concluded that commencing RCS makeup by 6 hours after event initiation would be adequate to maintain natural circulation and subcriticality for a B&W Raised

Loop (RL) plant such as Davis-Besse. The B&W analysis in WCAP-17792-P recommended a slow (5-10 °F/hr) asymmetric cooldown, in order to promote long-term natural circulation and extend the time available to align a source of RCS makeup. In an asymmetric cooldown, the idle loop would act as a source of RCS inventory for the active loop, and the slow cooldown rate would limit the RCS inventory shrinkage rate and delay the formation of voids in the active RCS hot leg.

The primary FLEX strategy at Davis-Besse is to perform a symmetric RCS cooldown at a rate of 30 °F/hr, which the licensee acknowledges deviates from the sequence of events assumed in WCAP-17792-P. The licensee states that the Davis-Besse FLEX strategy is based on aligning RCS makeup as early as possible, and has validated that this can be achieved within 2.5 hours of the start of the event. Therefore, the licensee does not consider a slow asymmetric cooldown such as that recommended by WCAP-17792-P to be necessary to maintain natural circulation. However, as a contingency, the licensee's Station Blackout procedure contains guidance to perform an asymmetric cooldown at 5-10 °F/hr if any of the following conditions are observed at any time during the FLEX response:

(1) Pressurizer level rate of change > 1.5 inches/minute, with RCS charging not in service

(2) Pressurizer level lowering due to leakage only (not contraction) with RCS charging in service

(3) Subcooling margin < 20 °F in either loop

(4) RCS makeup cannot be placed in service within 6 hours

Conceptually, the NRC staff did not consider the B&W analysis from WCAP-17792-P to be entirely satisfactory. However, the staff accepts the validated time of 2.5 hours by which the licensee will be able to commence active RCS injection, and agrees that pressurizer level will be maintained and natural circulation in all loops will be assured throughout the event. The staff further noted that the thermal-hydraulic analysis performed in WCAP-17792-P did not explicitly credit isolation of the controlled bleed-off (CBO) flow from the Flowserve N-9000 RCP seals installed at Davis-Besse. As discussed further in Section 3.2.3.3 of this safety evaluation (SE), for at least the 6-7 hour duration over which the N-Seal design was tested, CBO isolation would be expected to decrease leakage well below the flow rate considered in the calculations. The licensee's FLEX strategy directs isolating CBO flow (referred to as the RCP seal return flowpath) from the control room, or locally, within the first 10 minutes of the event. Also, an RCS injection rate of 50 gpm was assumed for the raised-loop case in WCAP-17792-P, which is conservative relative to the 60-gpm capacity of the RCS FLEX charging pumps at Davis-Besse. Thus, despite differences in the analytical results, the NRC staff's audit review supports the licensee's strategy for initiating RCS makeup for Davis-Besse by 2.5 hours into the ELAP event.

Therefore, based on the evaluation above, the NRC staff concludes that the licensee's analytical approach should appropriately determine the sequence of events for reactor core cooling, including time-sensitive operator actions, and evaluate the required equipment to mitigate the analyzed ELAP event, including pump sizing and cooling water capacity.

3.2.3.3 Reactor Coolant Pump (RCP) Seals

Leakage from RCP seals is among the most significant factors in determining the duration that a PWR can cope with an ELAP event prior to initiating RCS makeup. An ELAP event would interrupt cooling to the RCP seals, potentially resulting in increased leakage and the failure of elastomeric o-rings and other components, which could further increase the leakage rate.

As discussed above, as long as adequate inventory is maintained in the RCS, natural circulation can effectively transfer residual heat from the reactor core to the SGs and limit local variations in boric acid concentration. Along with cooldown-induced contraction of the RCS inventory, cumulative leakage from RCP seals governs the duration over which natural circulation can be maintained in the RCS. Furthermore, the seal leakage rate at the depressurized condition can be a controlling factor in determining the flow capacity requirement for FLEX pumps to offset ongoing RCS leakage and recover adequate system inventory.

As noted above, Flowserve N-9000 3-stage seals are installed on the RCPs at Davis-Besse. The N-9000 seal is a product in Flowserve's N-seal line of hydrodynamic seals that was developed by Flowserve in the 1980s. One of the design objectives for the N-9000 seal was to provide low-leakage performance under loss-of-seal-cooling conditions during events such as a station blackout. On August 5, 2015, in support of licensees using Flowserve RCP seals, the PWROG submitted a white paper to the NRC staff describing the response of the Flowserve N-Seal RCP Seal Package to a postulated ELAP (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15222A366).

The N-Seal white paper contains information regarding the expected leakage rates over the course of an ELAP event for each PWR at which Flowserve N-Seals are currently installed. Leakage rates as a function of time were assigned based upon a comparison of plant-specific thermal profiles relative to the thermal margin demonstrated in a test of N-Seal performance under simulated station blackout conditions that was conducted by Flowserve in 1988. The white paper gives an initial leakage rate of 1.5 gpm/RCP for Davis-Besse and other plants where their respective FLEX scenarios were found to not thermally exceed the 1988 test data. According to measured data from this test, following CBO isolation at 0.5 hours, over the course of the succeeding period of 6 to 7 hours during which CBO isolation was maintained, the average seal leakage rate was slightly less than 0.05 gpm. Although the NRC staff agreed that it is appropriate to allow credit for demonstrated performance, during its review of the Flowserve white paper, the staff questioned the extrapolation of evidence from a limited test period of 6 to 7 hours to the indefinite coping period associated with the ELAP event. While the NRC staff ultimately agreed with the credit Flowserve's N-Seal white paper allowed for CBO isolation in determining the short-term thermal exposure profile of seal elastomers, the staff did not endorse direct application of the average leakage rate measured with the CBO isolated in the 1988 test for an indefinite period in the absence of demonstrated long-term seal performance. In a letter dated November 12, 2015 (ADAMS Accession No. ML15310A094), the staff endorsed the leakage rates described in the white paper for the beyond-design-basis ELAP event, subject to certain limitations and conditions.

During the audit, the licensee addressed the status of its conformance with the Flowserve N-Seal white paper and the limitations and conditions in the NRC staff's endorsement letter. The licensee's FIP states that the plant design and planned mitigation strategy of Davis-Besse are consistent with the calculation performed by Flowserve, as summarized in Table 1 of the

white paper, and that the peak cold-leg temperature is based on the lowest main steam safety valve lift pressure. The NRC staff audited the applicable information from the Flowserve white paper against the Davis-Besse plant design and the mitigating strategy and determined that they were generally consistent.

One issue identified by the licensee with conformance to the limitations of the NRC's Flowserve endorsement letter was that their EFW analysis indicated that for a short period of time, cold leg temperature (T-cold) in the #1 loop would reach approximately 580 °F, and cold leg temperature in the #2 loop would reach approximately 600 °F. At 10 minutes into the event, EFW flow is established to the #1 SG, and loop 1 T-cold begins to decrease from a peak of approximately 580 °F to approximately 555 °F, the saturation temperature corresponding to the lowest-set MSSV. Operators will take up to 90 minutes to align EFW flow to the #2 SG, which the licensee calculates will dry out at approximately 12 minutes into the event. T-cold in loop 2 reaches approximately 600 °F at around 15 minutes into the event, and remains at that level until EFW is aligned to the #2 SG, after which point loop 2 T-cold would decrease to approximately 555 °F. The licensee contacted Flowserve and requested that they formally address the response of the N-9000 RCP seals to these short-term temperature spikes.

In its response, Flowserve noted that the licensee will isolate CBO within 10 minutes of the initiating event, which will prevent the rapid introduction of hot RCS fluid into the mechanical seals. The evaluation documented in the N-seal white paper demonstrated that CBO isolation by 20 minutes into the ELAP event would delay the heatup of the N-seal to RCS cold-leg temperature until 120 minutes into the event, past the point (90 minutes) at which EFW flow would be established to both SGs. Flowserve concluded that the N-9000 seals at Davis-Besse would not be exposed to temperatures higher than those bounded by the 1988 test data. Their response to the licensee further noted that the Davis-Besse ELAP scenario in particular shows significant margin to the 1988 test data.

The thermal-hydraulic analysis in WCAP-17792-P, as discussed in the previous section, assumed a leakage rate of 2 gpm from each of the four RCPs at Davis-Besse. This is conservative relative to the leakage rate of 1.5 gpm/RCP which the N-seal white paper demonstrates is bounding for Davis-Besse throughout the ELAP scenario. Based upon the discussion above, the NRC staff concludes that the RCP seal leakage rates assumed in the licensee's thermal-hydraulic analysis may be applied to the beyond-design basis ELAP event for the site.

3.2.3.4 Shutdown Margin Analyses

In an analyzed ELAP event, the loss of electrical power to control rod drive mechanisms is assumed to result in an immediate reactor trip with the full insertion of all control rods into the core. The insertion of the control rods provides sufficient negative reactivity to achieve subcriticality at post-trip conditions. However, as the ELAP event progresses, the shutdown margin for PWRs is typically affected by several primary factors:

- the cooldown of the RCS and fuel rods adds positive reactivity

- the concentration of xenon-135, which (according to the core operating history assumed in NEI 12-06) would

  - initially increase above its equilibrium value following reactor trip, thereby adding negative reactivity
  - peak at roughly 12 hours post-trip and subsequently decay away gradually, thereby adding positive reactivity

- the passive injection of borated makeup from nitrogen-pressurized accumulators due to the depressurization of the RCS, which adds negative reactivity

At some point following the cooldown of the RCS, PWR licensees' mitigating strategies generally require active injection of borated coolant via FLEX equipment. In many cases, boration would become necessary to offset the gradual positive reactivity addition associated with the decay of xenon-135; but, in any event, borated makeup would eventually be required to offset ongoing RCS leakage. The necessary timing and volume of borated makeup depend on the particular magnitudes of the above factors for individual reactors.

The specific values for these and other factors that could influence the core reactivity balance that are assumed in the licensee's current calculations could be affected by future changes to the core design. However, NEI 12-06, Section 11.8 states that "[e]xisting plant configuration control procedures will be modified to ensure that changes to the plant design ... will not adversely impact the approved FLEX strategies." Inasmuch as changes to the core design are changes to the plant design, the staff expects that any core design changes, such as those considered in a core reload analysis, will be evaluated to determine that they do not adversely impact the approved FLEX strategies, especially the analyses which demonstrate that re-criticality will not occur during a FLEX RCS cooldown.

During the audit, the NRC staff reviewed the licensee's shutdown margin calculation for Davis-Besse. The licensee concluded that adequate shutdown margin could be achieved without crediting the boron injected via the CFTs. Based upon the licensee's planned mitigating strategy and procedural guidance for CFT isolation, the NRC staff considers the lack of credit appropriate. The assumptions in the licensee's analysis are appropriately conservative, including the most limiting initial core conditions and injected boron concentration at the minimum allowed by technical specifications (2600 ppm). Per NEI 12-06, there is no requirement to consider further random failures besides the initial ELAP/loss of normal access to the UHS; hence, all rods are assumed to insert into the core. The licensee's calculations conservatively assume zero RCS leakage or letdown after the plant trip.

Case 1 of the shutdown margin analysis, which was based on the licensee's credited FLEX cooldown strategy, modeled the Phase 2 FLEX scenario as repeated alternating evolutions of (1) RCS injection to raise pressurizer level to 250 inches, followed by (2) symmetrically cooling down the RCS until thermal contraction of the RCS inventory had caused pressurizer level to decrease to 100 inches. The cooldown was assumed to pause at that point, while the charging pump again raised pressurizer level to 250 inches. The RCS boron concentration at each point (which rises with every injection from the BWST or CWRT) was compared with the minimum RCS boron concentration required to maintain 1 percent shutdown margin at the appropriate temperature "plateau". This analysis demonstrated that the RCS boron concentration at all times was sufficient to maintain at least 1 percent shutdown margin, even as the RCS temperature was lowered to well below the licensee's actual target cooldown temperature band

of 320-350 °F. This conclusion was shown to be valid for all points in the core operating cycle for the Davis-Besse Cycle 20 core. Conservatively, no credit for negative reactivity from xenon was assumed in this case.

The calculation did not specifically address the potential for CFT injection. However, the staff notes that the analyzed range of RCS leakage rates should result in the RCS pressure remaining sufficiently high to prevent CFT discharge prior to the injection of sufficient inventory from the BWST or CWRT to provide the required shutdown margin. The NRC staff observed that the licensee's thermal-hydraulic calculations further support this conclusion.

Case 2 of the shutdown margin analysis was based on the contingency strategy of performing an asymmetric cooldown (described in Section 3.2.3.2 of this SE), with no on-site RCS makeup available. This analysis did take credit for negative reactivity from core xenon. With no active boration, the analysis concluded that, for the most limiting core time-in-life (604 effective full power days, or EFPD) a shutdown margin of 1 percent could only be maintained for 27 hours if the RCS was cooled to 450 °F or lower. The staff notes that the asymmetric cooldown procedure is only included by the licensee as a contingency, as borated makeup is fully credited to be available from either of two FLEX RCS charging pumps and two tanks of borated water, one of which (#1 CWRT) is fully robust to all applicable external hazards.

Toward the end of an operating cycle, when RCS boron concentration reaches its minimum value, some PWR licensees may need to vent the RCS to ensure that their FLEX strategies can inject a volume of borated coolant that is sufficient to satisfy shutdown margin requirements in cases where minimal RCS leakage occurs. Understanding the need for RCS venting is necessary because completion of this action can extend the time required to complete RCS boration to the required concentration. The licensee's calculations adequately demonstrate that RCS venting would not be required. One assumption in the shutdown margin calculation is that pressurizer level is maintained at 250 inches, and the high boron concentration of the injected water ensures that the makeup volume required to maintain 250 inches in the pressurizer is itself enough to keep the reactor subcritical.

The NRC staff's audit review of the licensee's shutdown margin calculation determined that credit was taken for uniform mixing of boric acid during the ELAP event. The NRC staff had previously requested that the industry provide additional information to justify that borated makeup would adequately mix with the RCS volume under natural circulation conditions potentially involving two-phase flow. In response, the PWROG submitted a proprietary position paper, dated August 15, 2013, which provided test data regarding boric acid mixing under single-phase natural circulation conditions and outlined applicability conditions intended to ensure that boric acid addition and mixing during an ELAP would occur under conditions similar to those for which boric acid mixing data is available. By letter dated January 8, 2014, the NRC staff endorsed the above position paper with three conditions:

- The required timing and quantity of borated makeup should consider conditions with no RCS leakage and with the highest applicable leakage rate.

- Adequate borated makeup should be provided either (1) prior to the RCS natural circulation flow decreasing below the flow rate corresponding to single-phase natural circulation, or (2) if provided later, then the negative reactivity from the injected boric acid should not be credited until one hour after the flow rate in the RCS has been restored and maintained above the flow rate corresponding to single-phase natural circulation.

- A delay period adequate to allow the injected boric acid solution to mix with the RCS inventory should be accounted for when determining the required timing for borated makeup. Provided that the flow in all loops is greater than or equal to the corresponding single-phase natural circulation flow rate, a mixing delay period of one hour is considered appropriate.

Because credit is taken for uniform boric acid mixing under natural circulation flow, the NRC staff determined that the boric acid mixing position paper, including the conditions in the endorsement letter, is applicable to Davis-Besse. The licensee's shutdown margin analysis appropriately makes the most conservative assumptions regarding RCS leakage rate, and incorporates a 1-hour delay to account for boron mixing. The NRC staff concurs with the licensee that natural circulation in the active loop(s) will be maintained throughout the event, and further notes that the licensee's strategy credits initiating RCS makeup relatively early in the event (at or before 2.5 hours), well before the time at which positive reactivity introduced by xenon decay or RCS cooldown would threaten shutdown margin.

Therefore, based on the evaluation above, the NRC staff concludes that the sequence of events in the proposed mitigating strategy should result in acceptable shutdown margin for the analyzed ELAP event.

3.2.3.5 FLEX Pumps and Water Supplies

The FIP states that the two alternate LP EFW Pumps (N and N+1) are used with connections to the EFW system to support SG makeup in the addition to the EFW pump. Both alternate LP EFW pumps are capable of providing water flow of 495 gpm (at 405.7 psid [per square inch diameter]) from the EFWST and are trailer-mounted, diesel driven, centrifugal pumps. The "N" alternate LP EFW pump is pre-staged and protected in the EFW Facility, which is fully protected from all applicable external hazards. The "N+1" alternate LP EFP pump is stored in Service Building 7 and towed to the staging location outside the EFW Facility as required. The "N+1" alternate LP EFW pump serves as the backup pump for the "N" alternate LP EFW pump, as described by Section 3.2.2 of NEI 12-06. The licensee stated that the pumps will be staged as directed by FSG DB-OP-02705, "Initial Assessment and FLEX Staging," after ELAP is declared. The FLEX procedure FSG DB-OP-02703, "Alternate LP Emergency Feedwater," provides direction on establishing the primary and alternate connections involving the "N" or "N+1" alternate LP EFW pump for SG makeup in place of the EFW pump.

In regards to makeup water to the EFWST, the FIP describes two FLEX replenishment pumps, with associated hoses and fittings, that are stored respectively with the "N" and "N+1" alternate EFW pumps. The FLEX replenishment pumps are trailer-mounted Godwin HL100M with a John

Deere Diesel Driver, 920 gpm at 165 psi and 5 gph fuel consumption, and a 100 gallon tank maintained greater than half-full when stored in the respective storage locations. The licensee stated that EFWST replenishment would be needed 16 hours after the ELAP is declared and the preferred water sources, as indicated in Table 1 of Section 3.2.6 and as directed in FLEX procedure FSG DB-OP-02706, "EFW Storage Tank Makeup, Attachment 1," would be the suction sources used by one of the FLEX replenishment pumps to connect to refill the EFWST or directly supply the alternate LP EFW pump in service. The FLEX replenishment pumps can also be used to aid in SFP makeup as directed by FLEX procedure FSG DB-OP-02711, "Alternate SFP Makeup."

The FIP states that one of two FLEX RCS charging pumps will be used to provide RCS makeup, as directed by FLEX procedure FSG DB-OP-02701, "Long Term RCS Inventory Control." Two FLEX RCS charging pumps and associated booster pumps are stored and pre-staged in the Auxiliary Building and are associated with the respective borated water source (CWRT FLEX RCS charging pump and BWST FLEX RCS charging pump). Each FLEX RCS charging pump with its booster pump is capable of delivering 60 gpm at approximately full RCS system pressure. The Auxiliary Building is protected from all applicable external hazards, which protects the FLEX RCS charging and booster pumps. Each FLEX RCS charging pump can be aligned to take suction from the other borated water source as directed by FLEX procedure FSG DB-OP-02701.

During the audit review, the licensee provided for the NRC staff's review FLEX hydraulic calculations C-ME-050.05-001, "EFW Storage Tank Capacity for Decay Heat and Sensible Heat Removal," and C-NSA-050.05-001, "Emergency Feedwater System Assessment." The calculations provided evaluations of the EFW system providing water for SG makeup and EFWST replenishment, as well as the EFW pump and both "N" and "N+1" alternate LP EFW pumps' capabilities in meeting the flow requirements. The latter calculation also accounted for the alternate connections in using the FLEX pumps for direct connection to the EFW or supplying water from alternate sources on site. For RCS makeup, the licensee provided calculation C-ME-064.02-263, "Reactor Coolant System Makeup Requirements," which provided the evaluation of the FLEX RCS charging pumps and associated booster pumps for providing flow from the CWRT or BWST for RCS makeup. The NRC staff was able to confirm that flow rates and pressures evaluated in the hydraulic calculations were reflected in the FIP for the respective SG and RCS makeup strategies based upon the above FLEX pumps being deployed and implemented as described in the FSGs. The NRC staff conducted a walkdown of the hose deployment routes for the above FLEX pumps deployment locations during the audit to confirm the evaluation of the hose distance runs in the above hydraulic analyses. The NRC staff also confirmed that the FLEX pumps and associated hoses and fittings were stored in locations that were protected from all applicable external hazards. Based on the staff's review of the FLEX pumping capabilities at Davis Besse, as described in the above hydraulic analyses and the FIP, the NRC staff concludes that the portable FLEX pumps should perform as intended to support core cooling, EFW makeup, and RCS inventory control during an ELAP event, consistent with NEI 12-06, Section 11.2.

3.2.3.6 Electrical Analyses

The licensee's electrical strategies provide power to the equipment and instrumentation used to mitigate the ELAP and LUHS. The electrical strategies described in the FIP are practically identical for maintaining or restoring core cooling, containment, and SFP cooling, except as noted in Sections 3.3.4.4 and 3.4.4.4 of this SE.

The NRC staff reviewed the licensee's FIP, conceptual electrical single-line diagrams, and the summary of calculations for sizing the FLEX generators and station batteries. The staff also reviewed the licensee's evaluations that addressed the effects of temperature on the electrical equipment credited in the FIP as a result of the loss of heating, ventilation, and air conditioning (HVAC) caused by the event.

According to the licensee's FIP, operators would declare an ELAP following a loss of offsite power, emergency diesel generators (EDGs), and any ac source, but not the loss of ac power to buses fed by station batteries through inverters with a simultaneous loss of access to the UHS. The plants indefinite coping capability is attained through the implementation of pre-determined FLEX strategies that are focused on maintaining or restoring key plant safety functions. A safety function-based approach provides consistency with, and allows coordination with, existing plant EOPs. The FLEX strategies are implemented in support of EOPs using FSGs.

During the first phase of the ELAP event, DBNPS would rely on the Class 1E station batteries to provide power to key instrumentation for monitoring parameters and power to controls for SSCs used to maintain the key safety functions (Reactor core cooling, RCS inventory control, and Containment integrity). The DBNPS Class 1E station batteries and associated dc distribution systems are located in the auxiliary building which is safety-related structure designed to meet all applicable design basis external hazards. The licensee's procedure DB-OP-02704, "Extended Loss of AC Power DC Load Management," directs operators to conserve dc power during the event by stripping non-essential loads. Operators will strip or shed unnecessary loads to extend battery life until backup power is available. The plant operators would commence load shedding within 15 minutes and complete load shedding within 60 minutes from the onset of an ELAP/LUHS event.

Davis-Besse has four Class 1E 125 Vdc station batteries (1P, 1N, 2P, 2N) configured as two 125/250 Vdc batteries. Station batteries 1P and 2P are credited for FLEX. The station batteries were manufactured by Exide Technologies. The station batteries are model NCN-21 with a capacity of 1500 ampere-hours at an 8-hour discharge rate to 1.75 V per cell. The licensee noted and the staff confirmed that the Battery 2P capacity could be extended up to 14.6 hours. Battery 1P would be available to provide an additional 15.4 hours of coping if station battery chargers are not returned to service, or Battery 2P is lost or depleted for any reason.

The NEI White Paper, "EA-12-049 Mitigating Strategies Resolution of Extended Battery Duty Cycles Generic Concern," (ADAMS Accession No. ML13241A186) provides guidance for calculating extended duty cycles of batteries (i.e., beyond 8 hours) and was endorsed by the NRC (ADAMS Accession No. ML13241A188). In addition to the White Paper, the NRC sponsored testing at Brookhaven National Laboratory that resulted in the issuance of NUREG/CR-7188, "Testing to Evaluate Extended battery Operation in Nuclear Power Plants," in

May of 2015. The testing provided additional validation that the NEI White Paper method was technically acceptable. The NRC staff reviewed the licensee's battery calculations and confirmed that they had followed the guidance in the NEI White Paper.

The NRC staff reviewed the licensee's dc coping calculation C-EE-002.01-016, "Station Battery Discharge Analysis for Beyond Design Basis Events," Revision 1, which verified the capability of the dc system to supply power to the required loads during the first phase of the Davis-Besse FLEX mitigation strategy plan for an ELAP as a result of a BDBEE. The licensee's evaluation identified the required loads and their associated ratings (ampere (A) and minimum required voltage) and the non-essential loads that would be shed within 60 minutes to ensure battery operation for at least 14.6 hours.

Based on the staff's review of the licensee's analysis and procedures, the battery vendor's capacity and discharge rates for the Class 1E station batteries, the NRC staff finds that the DBNPS, dc systems have adequate capacity and capability to power the loads required to mitigate the consequences during Phase 1 of an ELAP as a result of a BDBEE provided that necessary load shedding is completed within the times assumed in the licensee's analysis, and backup power is supplied as described for Phase 2.

The licensee's Phase 2 strategy includes repowering 480 Vac buses within 2.5 hours after initiation of an ELAP event. The licensee's strategy relies on a pre-staged 850 kW 480 Vac FLEX DG located inside the EFWF. The licensee has a second portable 480 Vac FLEX DG stored in the "N+1" storage building (SB-7). The FLEX DG would supply power to the DBNPS vital 480 Vac vital bus (E1 and/or F1) circuits providing continuity of key parameter monitoring and other required loads. The FLEX DG would provide power to loads such as the vital battery chargers, a bank of essential pressurizer heaters, and battery room exhaust fans.

The NRC staff reviewed the licensee's engineering evaluation request (EER) notification 600990890, "FLEX/EFW Establish 480V & 4160V Load List," dated 9/11/2015, conceptual single line diagrams, and the separation and isolation of the FLEX DGs from the EDGs. Based on the NRC staff's review, the required loads for the Phase 2, 850 kW, FLEX DGs is a total of 526.81 kW (E1 – 247.11 kW, F1 – 279.70 kW). Therefore, one 850 kW FLEX DG is adequate to support the electrical loads required for the licensee's Phase 2 strategy.

If the "N" FLEX DG becomes unavailable or is out of service for maintenance, the other ("N+1") FLEX DG would be deployed to continue to support the required loads. The "N+1" FLEX DG is identical to the "N" FLEX DG, thus ensuring electrical compatibility and sufficient electrical capacity in an instance where substitution is required. Since the "N+1" FLEX DG is identical and interchangeable with the "N" FLEX DG, the NRC staff finds that the licensee has met the provisions of NEI 12-06, for spare equipment capability regarding the Phase 2 FLEX DGs.

For Phase 3, the licensee plans to continue the Phase 2 coping strategy with additional assistance provided from offsite equipment/resources. The offsite resources that will be provided by an NSRC includes two 1-megawatt (MW) 4160 Vac CTGs, one 1100 kW 480 Vac CTG, and distribution panels (including cables and connectors). Restoration of the 4160 Vac Essential Buses C1 or D1 will be accomplished using one NSRC 4160 Vac CTG per bus. The Phase 3 4160 Vac CTGs would provide power to operate the CCW and DHR systems to provide long-term core cooling. The NRC staff reviewed the licensee's EER 600990890, which

addressed loading for the NSRC Phase 3 4160 Vac CTGs. Based on the NRC staff's review, the required loads for the Phase 3 4160 Vac CTGs totals approximately 618.5 kW. Based on the additional margin available for the 4160 Vac CTGs and the availability of the 1100 kW 480 Vac CTG to back up the Phase 2 FLEX DG, the NRC staff finds that the 4160 Vac and 480 Vac CTGs being supplied from an NSRC have sufficient capacity and capability to supply the required loads.

Based on its review, the NRC staff finds that the plant batteries used in the strategy should have sufficient capacity to support the licensee's strategy, and that the FLEX DGs and turbine generators that the licensee plans to use should have sufficient capacity and capability to supply the necessary loads during an ELAP event.

3.2.4 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that should maintain or restore core cooling and RCS inventory during an ELAP event consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.3 Spent Fuel Pool Cooling Strategies

In NEI 12-06, Table 3-2 and Appendix D, summarize an approach consisting of two separate capabilities for the SFP cooling strategies. This approach uses a portable injection source to provide the capability for 1) makeup via hoses on the refueling floor capable of exceeding the boil-off rate for the design-basis heat load; and 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. However, in JLD-ISG-2012-01, Revision 1, the NRC staff did not fully accept this approach, and added another requirement to either have the capability to provide spray flow to the SFP, or complete an SFP integrity evaluation which demonstrates that a seismic event would have a very low probability of inducing a crack in the SFP or its piping systems so that spray would not be needed to cool the spent fuel. The evaluation must use the reevaluated seismic hazard described in Section 3.5.1 below if it is higher than the site's current safe shutdown earthquake (SSE) . During the event, the licensee selects the SFP makeup method to use based on plant conditions. This approach also requires a strategy to mitigate the effects of steam from the SFP, such as venting.

As described in NEI 12-06, Section 3.2.1.7, and JLD-ISG-2012-01, Section 2.1, strategies that must be completed within a certain period of time should be identified and a basis that the time can be reasonably met should be provided. In 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 beyond-design-basis, the analysis used to provide the technical basis for time constraints for the mitigation strategies may use nominal initial values (without uncertainties) for plant parameters, and best-estimate physics data. All equipment used for consequence mitigation may be assumed to operate at nominal setpoints and capacities. In NEI 12-06, Section 3.2.1.2 describes the initial plant conditions for the at-power mode of operation; Section 3.2.1.3 describes the initial conditions; and Section 3.2.1.6 describes SFP initial conditions.

NEI 12-06, Section 3.2.1.1 provides the acceptance criterion for the analyses serving as the technical basis for establishing the time constraints for the baseline coping capabilities to maintain SFP cooling. This criterion is keeping the fuel in the SFP covered with water.

The ELAP causes a loss of cooling in the SFP. As a result, the pool water will heat up and eventually boil off. The licensee's response is to provide makeup water. The timing of operator actions and the required makeup rates depend on the decay heat level of the fuel assemblies in the SFP. The sections below address the response during operating, pre-fuel transfer or post-fuel transfer operations. The effects of an ELAP with full core offload to the SFP is addressed in Section 3.11. The licensee has decided to provide the spray flow described in JLD-ISG-2012-01.

3.3.1 Phase 1

The FIP states that a vent path will be created from the SFP area to the environment prior the SFP inventory reaching the boiling point. The licensee also indicated that hoses to aid in SFP makeup would be pre-staged. If the BWST is available at the beginning of the ELAP event, the SFP makeup can be supported by gravity-feed from the BWST using the SFP cooling system. However, the FLEX SFP makeup strategy accounts for FLEX equipment being required for Phase 2, which supports when SFP makeup would be required (within 49 hours) under normal operating conditions. The licensee will monitor SFP water level using reliable SFP level instrumentation installed per Order EA-12-051.

3.3.2 Phase 2

The licensee stated that for Phase 2, the SFP makeup can be provided from the EFWST using the EFW pump, through mechanical connections described below in SE Section 3.7.3.1, to supply the newly installed FLEX SFP makeup header. Two diesel-driven FLEX Spray pumps will also be available to support SFP makeup from variable water sources as described in Table 1 of FIP Section 3.2.6 and as directed by FSG DB-OP-02711, "Alternate SFP Makeup, Attachment 7, SFP Makeup Water Sources." The licensee also stated that portable (Blitzfire) spray nozzles are staged on the SFP deck as part of a contingency capability required by NEI 12-06.

3.3.3 Phase 3

The licensee stated that Phase 2 SFP makeup strategy is continued until NSRC equipment arrives on site and SFP makeup will be supplied from the SW system. The SW system will be restored by NSRC generators along with the 4160 volt ac power to supply CCW and the DHR systems. This will allow the SFP cooling to be establish using SW as the suction source to provide indefinite makeup to the SFP.

3.3.4 Staff Evaluations

3.3.4.1 Availability of Structures, Systems, and Components

3.3.4.1.1 Plant SSCs

Condition 6 of NEI 12-06, Section 3.2.1.3, states that permanent plant equipment contained in structures with designs that are robust with respect to seismic events, floods, and high winds, and associated missiles, are available. In addition, Section 3.2.1.6 states that the initial SFP conditions are: 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 and 3) SFP cooling system is intact, including attached piping.

During the audit review, the licensee provided calculation CN-SEE-II-12-41, "Determination of the time to Boil in the Davis-Besse Spent Fuel Pool after an Earthquake," for the staff's review. The purpose of the calculation is to determine the SFP time to boil after an ELAP event. The calculation and the FIP indicate that boiling begins at approximately 8 hours after ELAP is declared and another 41 hours before the inventory in the SFP is boiled off to about 10 ft. above the top of the fuel racks.

As described in its FIP, the licensee's Phase 1 SFP cooling strategy does not require any anticipated actions outside of pre-staging of hoses needed for Phase 2. However, the licensee does establish a ventilation path to cope with temperature, humidity and condensation from evaporation and/or boiling of the SFP. The operators are directed by FSG DB-OP-02711, "Alternate SFP Makeup," to prop open doors in the SFP area to allow a steam path through the Auxiliary Building. The licensee also indicated that floor drains in the SFP area are covered in Phase 1 to prevent condensing steam or any water leakage from draining into the Emergency Core Cooling Room sump.

The licensee's Phase 2 SFP cooling strategy involves the use of the EFW and alternate LP EFW "N" and "N+1" pumps and associated hoses and fittings with suction from the EWFST or other available water sources, including Lake Erie. The staff's evaluation of the robustness and availability of FLEX connections points for the above pumps is discussed in Section 3.7.3.1 below. Furthermore, the staff's evaluation of the robustness and availability of the BWST, EFWST, variable water sources, and Lake Erie for an ELAP event is discussed in Section 3.10.3.

3.3.4.1.2 Plant Instrumentation

In its FIP, the licensee stated that the instrumentation for SFP level will meet the requirements of Order EA-12-051. Furthermore, the licensee stated that these instruments will have initial local battery power with the capability to be powered from the FLEX DGs. The NRC staff's review of the SFP level instrumentation, including the primary and back-up channels, the display to monitor the SFP water level and environmental qualifications to operate reliably for an extended period are discussed in Section 4 of this SE.

3.3.4.2 Thermal-Hydraulic Analyses

Section 11.2 of NEI 12-06 states, in part, that 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. In addition, NEI 12-06, Section 3.2.1.6, Condition 4 states that SFP heat load assumes the maximum design-basis heat load for the site. In accordance with NEI 12-06, the licensee performed a thermal-hydraulic

analysis of the SFP as a basis for the inputs and assumption used in its FLEX equipment design requirements analysis. During the audit, the licensee referenced calculation CN-SEE-II-12-41, "Determination of the time to Boil in the Davis-Besse Spent Fuel Pool after an Earthquake," to provide the thermal-hydraulic analysis for the SFP. The calculation concluded that the normal expected SFP heat load will reach maximum boiling temperature in approximately 8 hours and boil off to the top of the active fuel in approximately 41 hours. The calculation also concluded that a SFP makeup flowrate of 70 gpm would be needed within 49 hours of the ELAP event to replenish the SFP to 10 ft. above the top of the fuel racks. The worst case scenario would call for 12.7 hours before SFP makeup would be needed. The licensee referenced in calculation C-ME-067.01-002, "FLEX Spent Fuel Cooling and Makeup Hydraulics," that the EFW pump and the respective alternate LP EFW pumps will provide for adequate makeup to restore the SFP level.

The staff reviewed both calculations to confirm that the implementation and performance of the EFW and FLEX pumps will meet the makeup requirements for the SFP in accordance with the time to boil and evaporation rate of the SFP. The NRC staff provided an inquiry regarding the preparatory conditions for the worse case SFP inventory boiling scenario. In response, as documented in ADAMS Accession No. ML16349A633, dated December 14, 2016, the licensee stated that the initial calculation prior to the finalization of the FIP estimated that 12.7 hours would be needed for the worst case scenario (full-core offload with no fuel in the reactor vessel). The licensee conducted an additional SFP evaluation that indicated that 18.34 hours would be needed for operator action to setup SFP makeup for the worst case scenario with additional resources available. The calculation was referenced in NORM-LP-7204, "Davis-Besse FLEX Strategy Design & Equipment Bases Detail, Appendix 1." For normal operating conditions, the licensee concluded that 37 hours would be needed for SFP makeup to be setup based on prioritization of other FLEX strategies and allowance for additional resources to reach the Davis Besse site. The operator actions for aligning SFP makeup are described in DB-OP-02711, "Alternate Spent Fuel Pool Makeup," as conducting continuous SFP level monitoring and connecting a 3 in. hose from the EFW system in Mechanical Penetration Room 3 to the makeup header in the SFP area. The licensee also stated that the SFP makeup task can be utilized at any time, which provides flexibility to the operational staff to align SFP based on completion of other FLEX strategies and SFP level indications. The licensee is processing a change request to revise the FIP and procedure DB-OP-02711 to include the information from the NORM-LP-7204 evaluation for operational clarity.

The NRC staff reviewed the additional evaluation to confirm that the time frame to align SFP makeup would be achievable even in the worst case scenario. The NRC staff also concurs that the inclusion of the revised 18.34 hour time frame in procedure DB-OP-02711 for initiation and completion of the SFP makeup would allow the operators to complete other FLEX strategies as indicated in the sequence of events in Section 3.1 of the FIP. Based on the information contained in the FIP, the hydraulic calculation, and supplementary evaluation of the SFP for heat loads, the staff finds that the licensee has provided an analysis that considered maximum design-basis SFP heat load during operating, pre-fuel transfer or post-fuel transfer operations. The basis for assumptions and inputs used in determining the design requirements for FLEX equipment used in SFP cooling are consistent with NEI 12-06 Section 3.2.1.6, Condition 4 and Section 11.2.

3.3.4.3 FLEX Pumps and Water Supplies

During the audit, the licensee referenced hydraulic calculation C-ME-067.01-002, "FLEX Spent Fuel Cooling and Makeup Hydraulics," to provide the hydraulic calculation for the SFP makeup. One alternate LP EFW pump is capable of delivering 495 gpm of flow to provide the SFP (only 70 gpm is required for the SFP makeup strategy). The FLEX spray pumps are also capable of providing 920 gpm of flow from the alternate water sources on site. The spray nozzles are to be set up on the deck next to the SFP. The spray nozzles are connected to the fire hoses on the 603 ft. elevation of the Auxiliary Building. The Alternate LP EFW pumps and the FLEX spray pumps are stored in the EFW Facility and Service Building 7, respectively. The spray nozzles are already pre-staged in the Auxiliary Building. The NRC staff reviewed the hydraulic calculation and technical specifications of the alternate LP EFW pumps and FLEX spray pumps to confirm that the pumps can meet the makeup requirements for the SFP. Based on the staff's review of the SFP makeup requirements, the licensee has demonstrated that the alternate LP EFW pumps and the FLEX spray pumps, if aligned and operated as described in the FSGs and the FIP, should perform as intended to support SFP cooling during an ELAP caused by a BDBEE, consistent with NEI 12-06, Section 11.2.

3.3.4.4 Electrical Analyses

The licensee's FIP defines strategies capable of mitigating a simultaneous loss of all ac power and loss of normal access to the UHS resulting from a BDBEE, by providing the capability to maintain or restore core cooling, containment, and SFP cooling at the DBNPS site. The staff performed a comprehensive review of the licensee's electrical strategies, which includes the SFP cooling strategy.

The licensee's Phase 1 strategy is to monitor SFP level using installed instrumentation (the capability of this instrumentation is described in other areas of this SE). In its FIP, the licensee stated that SFP level instrumentation has a battery backup that will provide power to the instrumentation for 72 hours.

The licensee's Phase 2 strategy is to continue monitoring SFP level using installed instrumentation. If necessary, a portable 120 Vac generator can be used to provide power to either or both SFP Level indicators as directed by FSG DB-OP-02705, "Initial Assessment and FLEX Equipment Staging."

The licensee's Phase 3 strategy is continue with the Phase 2 strategy and provide alternative power within 72 hours to the SFP level instrumentation as directed by FSG DB-OP-02705. The Phase 3 strategy also includes restoring power to the CCW and DHR systems to provide SFP cooling. The staff reviewed licensee EER 600990890 and determined that the 4160 Vac CTGs have sufficient capacity and capability to supply SFP instrumentation and cooling systems.

Based on its review, the NRC staff finds that the licensee's strategy is acceptable to restore or maintain SFP cooling indefinitely during an ELAP as a result of a BDBEE.

3.3.5 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should maintain or restore SFP cooling following an ELAP consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.4 Containment Function Strategies

The industry guidance document, NEI 12-06, Table 3-2, provides some examples of acceptable approaches for demonstrating the baseline capability of the containment strategies to effectively maintain containment functions during all phases of an ELAP event. One such approach is for a licensee to perform an analysis demonstrating that containment pressure control is not challenged. DBNPS has a dry ambient pressure containment.

The licensee performed a containment evaluation, C-NSA-060.05-018, "FLEX Mode 1 Containment Response Analyses Due to 10 GPM RCS Leak," which was based on the boundary conditions described in Section 2 of NEI 12-06. The calculation analyzed the strategy of containment isolation and monitoring key containment parameters and concluded that the containment parameters of pressure and temperature remain well below the respective Updated Final Safety Analysis Report (UFSAR) Section 6.2.1.2.1 design limits of 36 psig (design)/40 psig (maximum) and 264 °F for more than 100 hours. From its review of the evaluation, the NRC staff noted that the required actions to maintain containment integrity and required instrumentation functions have been developed, and are summarized below.

3.4.1 Phase 1

Operators will ensure Containment integrity is established and maintained. Guidance is provided by FSG DB-OP-02715, "Containment Isolation and Closure". Containment temperature and pressure will be monitored.

3.4.2 Phase 2

The licensee will continue the Phase 1 strategy of monitoring containment temperature and pressure.

3.4.3 Phase 3

The licensee will continue the Phase 1 strategy of monitoring containment temperature and pressure.

Phase 3 deployments of a large pumps from the NSRC capable of providing an alternate motive force to use the inventory in the UHS will be connected to the SW system as directed by FSG DBOP-02722, "Restore Service Water during an ELAP." In addition, restoration of power to E1 and/or F1 electrical buses as directed by FSG DB-OP-02721, "Restore Power to E1 and F1," will allow operation of the Containment Air Cooler (CAC) fans. Restoration of SW flow and electrical power for fan operations will provide heat rejection capability for the CAC to establish Containment cooling as directed by FSG DB-OP-02712, "Alternate Containment Cooling".

3.4.4 Staff Evaluations

3.4.4.1 Availability of Structures, Systems, and Components

Guidance document NEI 12-06 baseline assumptions have been established on the presumption that other than the loss of the ac power sources and normal access to the UHS, installed equipment that is designed to be robust with respect to design-basis external events is assumed to be fully available. Installed equipment that is not robust is assumed to be unavailable. Below are the baseline assumptions for the availability of SSCs for maintaining containment functions during an ELAP.

3.4.4.1.1 Plant SSCs

Containment Vessel

The containment system for DBNPS, as described in UFSAR Section 6.2.1, consists of three basic structures: a steel containment vessel, a reinforced concrete Shield Building, and the internal structures. The Containment Vessel is a free standing cylindrical steel pressure vessel with hemispherical dome and ellipsoidal bottom, which houses the reactor vessel, the reactor cooling system, and other support systems. The containment vessel is completely enclosed by a reinforced concrete Shield Building having a cylindrical shape with a shallow dome roof. An annular space is provided between the wall of the Containment Vessel and the Shield Building, and clearance is also provided between the Containment Vessel and the dome of the Shield Building. The containment system is a seismic Category I structure designed to withstand a Maximum Possible Earthquake

As provided in UFSAR Section 6.2.1.2.1 Design Parameters, the Containment Vessel design internal pressure, temperature, and free volume are:

- 36 psig (design) /40 psig (max)
- 264°F
- 2,834,000 ft3

The Shield Building is a Seismic Category I structure completely enclosing the Containment Vessel. It has been analyzed to withstand of tornado wind loads along with impact from tornado missiles.

Service Water System

In the UFSAR, Section 3 classifies SW system portions which service Class I systems as Seismic Category I.

In the UFSAR, Section 9.2 indicates the portion of the system required for emergency operation, including the intake structure, is designed to the American Society of Mechanical Engineers Code, Section III, Nuclear Class and Seismic Class I, as applicable. This includes protection from a tornado and tornado missiles. The associated containment penetrations are Nuclear Class 2. All Class I piping which passes through the turbine building is enclosed in a Class I tunnel.

Containment Air Coolers

The CAC system is composed of three air cooler units located within the Containment Vessel. Two of the three units are used for both normal and emergency cooling. Each unit consists of finned tube cooling coils and a direct driven fan. The fans are designed to operate under normal conditions at full speed, and at half speed during LOCA conditions. Cooling water for the air cooler units is supplied by the SW system. In the UFSAR, Section 3 indicates that all equipment, piping, valves, and instrumentation associated with this systems' safety functions are designed to withstand the temperature and pressure transient conditions resulting from a LOCA and the seismic forces resulting from the applicable earthquake. The CACs are within the Shield Building and are therefore protected from the effects of a tornado.

3.4.4.1.2 Plant Instrumentation

In NEI 12-06, Table 3-2, specifies that containment pressure is a key containment parameter which should be monitored by repowering the appropriate instruments. The licensee's FIP states that control room instrumentation would be available due to the coping capability of the station batteries and associated inverters in Phase 1, or the portable DGs deployed in Phase 2. If no ac or dc power was available, the FIP states that key credited plant parameters, including containment pressure, would be available using alternate methods.
Instrumentation providing the following key parameters is credited for all phases of the Containment Integrity strategy:

- Each of the 4 Safety Features Actuation System (SFAS) Channels provides Containment Pressure. Normally, only SFAS Channel 2 would be in service at the conclusion of DC Load Shed actions previously described.
- Post-Accident Monitoring Cabinet Channel 2 provides Containment Pressure.

The above instrumentation will remain available during an ELAP, following load shedding of the dc and ac buses, during Phase 1. Availability during Phases 2 and 3 is dependent on the strategy to re-power the essential 480 volt ac buses including the Class 1E battery chargers and associated instrument ac buses, however, instrumentation is available depending on which station battery and associated Instrument ac bus is in service. Procedure FSG DB-OP- 02704, "ELAP DC Load Management," provides direction to transition from one battery in service to an alternate battery in the event that restoration of power is delayed. Procedure FSG DB-OP-02707, "Loss of DC Power" provides directions for obtaining alternate readings for containment parameters in the event all instrument power is lost.

3.4.4.2 Thermal-Hydraulic Analyses

Calculation C-NSA-060.05-018, "FLEX Mode 1 Containment Response Analysis Due to 10 gpm RCS Leak," Revision 0, evaluated the response of Containment pressure and temperature in an ELAP event. The calculation determined the resulting Containment conditions, 100 hours after event initiation, would be 8.4 psig and 179°F. Ten gpm RCS leakage is based on the assumption of 2-gpm per RCS pump seal (4 pumps) plus 1-gpm unidentified RCS leakage and rounding up to 10-gpm to be conservative.

The calculation used the Bechtel computer code COPATTA Version G1-14 to evaluate the containment temperature and pressure response. The computer code is controlled under the FENOC quality assurance program for use for design basis calculations.

Calculations conservatively assume no heat transfer to the exterior environment. All heat from the RCS is transferred to internal containment heat sinks. The calculation also assumes RCS heat loss to containment at 100 percent power for duration of evaluation.

3.4.4.3 FLEX Pumps and Water Supplies

Section 3.2.3.5, "FLEX Pumps and Water Supplies" above, addresses the use of FLEX pumps and water supplies. Guidance document, FSG DB-OP-02722, "Restore Service Water during an ELAP," provides direction to use equipment provided by the NSRC to restore the SW system allowing use of the inventory in the ultimate heat sink which for DBNPS is Lake Erie.

The SW is not required until later in the ELAP event. Containment temperatures and pressures increase slow enough that the use of SW to cool containment can be coordinated with other SW demands.

3.4.4.4 Electrical Analyses

The licensee performed a containment evaluation based on the boundary conditions described in Section 2 of NEI 12-06. Based on the results of its evaluation, the licensee developed required actions to ensure maintenance of containment integrity and required instrumentation continues to function. With an ELAP initiated, while DBNPS is in Modes 1-4, containment cooling would be lost for an extended period of time. Therefore, containment temperature and pressure will slowly increase. Structural integrity of the reactor containment building due to increasing containment pressure will not be challenged during the first several weeks of an ELAP event. However, with no cooling in the containment, temperatures in the containment are expected to rise and could reach a point where continued reliable operation of key instrumentation and components might be challenged.

The licensee's Phase 1 coping strategy for containment involves initiating and verifying containment isolation per procedure FSG DB-OP-02715, "Containment Isolation and Closure," following an ELAP/LUHS. Phase 1 also includes monitoring containment temperature and pressure using installed equipment. The licensee's strategy to repower instrumentation using the Class 1E station batteries is identical to what was described in Section 3.2.3.6 of this SE and is adequate to ensure continued containment monitoring.

The licensee's Phase 2 coping strategy is to continue the Phase 1 coping strategy and monitoring containment temperature and pressure using installed instrumentation. The licensee's strategy to repower instrumentation using the 480 Vac, 800 kW, FLEX DGs is identical to what was described in Section 3.2.3.6 of this SE and is adequately sized to ensure continued containment monitoring.

The licensee's Phase 3 coping strategy includes actions to reduce containment temperature and pressure utilizing existing plant systems restored by off-site equipment and resources, if needed. The licensee's strategy is to use the 4160 Vac CTGs to repower the CAC fans to

restore and maintain containment cooling. The staff reviewed licensee EER 600990890 and determined that the 4160 Vac CTGs have sufficient capacity and capability to supply the CAC fans, required instruments, and additional loads.

Based on its review, the NRC staff determined that the electrical equipment available onsite (e.g., 480 Vac FLEX DGs) supplemented with the equipment that will be supplied from an NSRC (e.g., 4160 Vac CTG), provides sufficient capacity and capability to supply the required loads to reduce containment temperature and pressure, if necessary, to ensure that the key components including required instruments remain functional.

3.4.5 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should maintain or restore containment functions following an ELAP event consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.5 Characterization of External Hazards

Sections 4 through 9 of NEI 12-06 provide the methodology to identify and characterize the applicable BDBEEs for each site. In addition, NEI 12-06 provides a process to identify potential complicating factors for the protection and deployment of equipment needed for mitigation of applicable site-specific external hazards leading to an ELAP and loss of normal access to the UHS.

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.

The licensee reviewed the plant site against NEI 12-06 and determined that FLEX equipment should be protected from the following hazards: seismic; external flooding; severe storms with high winds; snow, ice and extreme cold; and extreme high temperatures.

References to external hazards within the licensee's mitigating strategies and this SE are consistent with the guidance in NEI-12-06 and the related NRC endorsement of NEI 12-06 in JLD-ISG-2012-01. Guidance Document NEI 12-06 directed licensees to proceed with evaluating external hazards based on currently available information. For most licensees, this meant that the OIP used the current design basis information for hazard evaluation. Coincident with the issuance of Order EA-12-049, on March 12, 2012, the NRC staff issued a Request for Information pursuant to Title 10 of the *Code of Federal Regulations* Part 50, Section 50.54(f) [Reference 19] (hereafter referred to as the 50.54(f) letter), which requested that licensees reevaluate the seismic and flooding hazards at their sites using updated hazard information and current regulatory guidance and methodologies. Due to the time needed to reevaluate the hazards, and for the NRC to review and approve them, the reevaluated hazards were generally not available until after the mitigation strategies had been developed. The NRC staff has developed a proposed rule, titled "Mitigation of Beyond-Design-Basis Events," hereafter called the MBDBE rule, which was published for comment in the Federal Register on November 13, 2015 [Reference 39]. The proposed MBDBE rule would make the intent of Orders EA-12-049

and EA-12-051 generically applicable to all present and future power reactor licensees, while also requiring that licensees consider the reevaluated hazard information developed in response to the 50.54(f) letter.

The NRC staff requested Commission guidance related to the relationship between the reevaluated flooding hazards provided in response to the 50.54(f) letter and the requirements for Order EA-12-049 and the MBDBE rulemaking (see COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards" [Reference 38].) The Commission provided guidance in an SRM to COMSECY-14-0037 [Reference 20]. The Commission approved the staff's recommendations that licensees would need to address the reevaluated flooding hazards within their mitigating strategies for BDBEEs, and that licensees may need to address some specific flooding scenarios that could significantly impact the power plant site by developing scenario-specific mitigating strategies, possibly including unconventional measures, to prevent fuel damage in reactor cores or SFPs. The NRC staff did not request that the Commission consider making a requirement for mitigating strategies capable of addressing the reevaluated flooding hazards be immediately imposed, and the Commission did not require immediate imposition. In a letter to licensees dated September 1, 2015 [Reference 37], the NRC staff informed the licensees that the implementation of mitigation strategies should continue as described in licensee's OIPs, and that the NRC safety evaluations and inspections related to Order EA-12-049 will rely on the guidance provided in JLD-ISG-2012-01, Rev. 0, and the related industry guidance in NEI 12-06, Rev. 0. The hazard reevaluations may also identify issues to be entered into the licensee's corrective action program consistent with the OIPs submitted in accordance with Order EA-12-049.

As discussed above, licensees are reevaluating the site seismic and flood hazards as requested in the NRC's 50.54(f) letter. After the NRC staff approves the reevaluated hazards, licensees will use this information to perform flood and seismic mitigating strategies assessments (MSAs) per the guidance in NEI 12-06, Rev. 2, Appendices G and H [Reference 6]. The NRC staff endorsed Rev. 2 of NEI 12-06 in JLD-ISG-2012-01, Rev. 1 [Reference 7]. The licensee's MSAs will evaluate the mitigating strategies described in this safety evaluation using the revised seismic hazard information and, if necessary, make changes to the strategies or equipment. Licensees will submit the MSAs for NRC staff review.

The licensee developed its OIP for mitigation strategies by considering the guidance in NEI 12-06 and the site's design-basis hazards. Therefore, this safety evaluation makes a determination based on the licensee's OIP and FIP. The characterization of the applicable external hazards for the plant site is discussed below.

3.5.1 Seismic

In its FIP, the licensee described the current design-basis seismic hazard for which structures, systems, and components important to safety are designed to remain functional as the maximum possible earthquake. The maximum possible earthquake, in current NRC terminology, is the SSE. As described in UFSAR Section 3.8.1.4.3, Earthquake Loads, the SSE seismic criteria for the site is 0.15 of the acceleration due to gravity (0.15g) peak horizontal ground acceleration and 0.10g peak ground acceleration acting vertically. It should be noted

that the actual seismic hazard involves a spectral graph of the acceleration versus the frequency of the motion. Peak acceleration in a certain frequency range, such as the numbers above, is often used as a shortened way to describe the hazard.

As the licensee's seismic reevaluation activities are completed, the licensee is expected to assess the mitigation strategies to ensure they can be implemented under the reevaluated hazard conditions as will potentially be required by the proposed MBDBE rulemaking. The licensee has appropriately screened in this external hazard and identified the hazard levels to be evaluated.

3.5.2 Flooding

In its FIP, the licensee described the current design bases for each event at the site. The FIP described that the limiting site flooding event is the Local Intense Precipitation (LIP) event, which is of limited duration and water level. As described in UFSAR Section 2.4.2.3, the current design-basis is that the Seismic Category I structures are not susceptible to external flooding from the LIP. The licensee also stated in its FIP, that there is no groundwater in-leakage that could affect the FLEX strategy.

As the licensee's flooding reevaluation activities are completed, the licensee is expected to assess the mitigation strategies to ensure they can be implemented under the reevaluated hazard conditions as will potentially be required by the proposed MBDBE rulemaking. The licensee has appropriately screened in this external hazard and identified the hazard levels to be evaluated.

3.5.3 High Winds

In 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); if the resulting frequency of recurrence of hurricanes with wind speeds in excess of 130 miles per hour (mph) exceeds 1E-6 per year, the site should address hazards due to extreme high winds associated with hurricanes using the current licensing basis for hurricanes.

The screening for high wind hazard associated with tornadoes should be accomplished by comparing the site location to NEI 12-06, Figure 7-2, from U.S. NRC, "Tornado Climatology of the Contiguous United States," NUREG/CR-4461, Rev. 2, February 2007; if the recommended tornado design wind speed for a 1E-6/year probability exceeds 130 mph, the site should address hazards due to extreme high winds associated with tornadoes using the current licensing basis for tornados or Regulatory Guide 1.76, Rev. 1.

In its FIP, regarding the determination of applicable extreme external hazards, the licensee stated that the site is located at 41° 35' 49" North latitude and 83° 05' 16" West longitude. In NEI 12-06 Figure 7-2, Recommended Tornado Design Wind Speeds for the 1E-6/year Probability Level indicates the site is in a region where the tornado design wind speed exceeds

130 mph. Therefore, the plant screens in for an assessment for high winds and tornados, including missiles produced by these events. In its FIP, the licensee described that DBNPS would not be susceptible to hurricanes so the hazard is screened out, since the site is beyond the range of high winds from a hurricane per NEI 12-06 Figure 7-1. The NRC staff concludes that a hurricane hazard is not applicable and need not be addressed.

In its FIP, the licensee described that Figure 7-2 of NEI 12-06 provided a 200 mph wind hazard (Region 1) for DBNPS, the UFSAR defines a design-basis tornado for DBNPS of being 300 mph winds. Therefore, the design-basis tornado attributes have been used in analysis for DBNPS's FLEX strategies.

Therefore, high-wind hazards are applicable to the plant site. The licensee has appropriately screened in the high wind hazard and characterized the hazard in terms of wind velocities and wind-borne missiles.

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

In its FIP, regarding the determination of applicable extreme external hazards, the licensee stated that the site is located north of the 35th parallel (41° 35' 49" North latitude and 83° 05' 16" West longitude); therefore, the FLEX strategies must consider the impedances caused by extreme snowfall with snow removal equipment, as well as the challenges that extreme cold temperatures may present. On Figure 8-1 of NEI 12-06, the DBNPS site is located in the area identified as purple and pink, so three day snowfalls up to 36 inches should be anticipated. In its FIP, the licensee described that the minimum recorded temperature in the area around the DBNPS site between 1870 and 1970 was -20°F.

In addition, the site is located within the region characterized by Electric Power Research Institute (EPRI) as ice severity level 3 (NEI 12-06, Figure 8-2, Maximum Ice Storm Severity Maps). Consequently, the site is subject to low to medium damage to power lines and/or existence of considerable amount of ice. The licensee concludes that the plant screens in for an assessment for snow, ice, and extreme cold hazard.

In summary, based on the available local data and Figures 8-1 and 8-2 of NEI 12-06, the plant site does experience significant amounts of snow, ice, and extreme cold temperatures; therefore, the hazard is screened in. The licensee has appropriately screened in the hazard and characterized the hazard in terms of expected temperatures.

3.5.5 Extreme Heat

In the section of its FIP regarding the determination of applicable extreme external hazards, the licensee stated that, as per NEI 12-06 Section 9.2, all sites are required to consider the impact of extreme high temperatures. In its FIP, the licensee described that the monthly temperature averages for DBNPS indicate that July and August are the hottest months and January the coldest month. The hottest average daily maximum is 83°F with a record maximum temperature of 105°F in Toledo in July 1936. The plant site screens in for an assessment for extreme high temperature hazard.

In summary, based on the available local data and the guidance in Section 9 of NEI 12-06, the plant site does experience extreme high temperatures. The licensee has appropriately screened in the high temperature hazard and characterized the hazard in terms of expected temperatures.

3.5.6 Conclusions

Based on the evaluation above, the NRC staff concludes that the licensee has developed a characterization of external hazards that is consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order in regard to the characterization of external hazards.

3.6 Planned Protection of FLEX Equipment

3.6.1 Protection from External Hazards

As described in the FIP, the FLEX equipment is primarily storage in the EFWF and service building 7 (SB7). Some FLEX equipment is stored inside the auxiliary building generally near locations where the equipment will be used. The EFWF and the auxiliary building locations provide protection from all hazards, while SB7 is climate controlled and provides protection from flooding, but not for seismic or storms with high winds.

Below are additional details on how FLEX equipment is protected from each of the applicable external hazards.

3.6.1.1 Seismic

As described in the FIP, the EFWF is a seismic Class II building, but designed for Seismic Class 1 loads. As described in engineering change package (ECP) 13-0195, "Emergency Feedwater Facility (EFWF)," Rev. 3, the EFWF is a reinforced concrete building with a reinforced concrete tank, which is called the EFWST. The EFWST has a stainless steel liner to maintain water quality. Although the EFWF and EFWST are designed as non-safety related, the facility is designed to meet SSE requirements.

As described in the FIP, the auxiliary building is a seismic Class 1 building.

In its FIP, the licensee described that for both the EFWF and the auxiliary building; the FLEX equipment stored or staged inside those buildings are seismically restrained.

In its FIP, the licensee described that SB7 is not seismically rated. The SB7 is the storage location for some N+1 equipment.

3.6.1.2 Flooding

In its FIP, the licensee described that site safety-related structures are protected against high water levels up to an elevation of 585 feet (ft) - International Great Lakes Datum of 1955 (IGLD55). The auxiliary building is a safety-related structure. During a LIP, water could build up to elevation of 584.5 ft-IGLD55 or 584 ft - 6 inches (in) - IGLD55.

As described in ECP 13-0195, the finish floor elevation of the EFWF is set at 586 ft-IGLD55, and is therefore above the maximum flood elevation.

As described in the FIP, SB7 has a floor that is elevated above the maximum evaluated flood level. In addition, the FIP describes SB7 of having a finish floor elevation of 584 ft - 7 in.
In addition, the UFSAR indicates that there are no dams or other regulating hydraulic structures on the Toussaint River which would affect the flow hydrograph at DBNPS.

3.6.1.3 High Winds

The auxiliary building is a safety-related structure built to withstand the site's design-basis tornado loading of 300 mph.

As described in ECP 13-0195, the EFWF is designed for a tornado loading of a maximum wind speed of 300 mph along with a maximum differential pressure of 3 pounds per square inch (psi).

As described in the FIP, SB7 is not capable of withstanding high winds. The SB7 is a commercial building. One debris removal truck is stored inside SB7 and the other is stored inside the protected area on the north side of the plant. The second truck is separated by distance that provides reasonable assurance that both trucks would not be disabled by a tornado. Based on tornado widths from the National Oceanic and Atmospheric Administration's Storm Prevention Center for 1950-2011, 1,200 ft should be considered as the minimum separation distance for which further analysis is not required since DBNPS is located within Region 1 based on NEI 12-06 Figure 7-2. The diverse location should also consider the "typical" tornado path for the site. The prevailing tornado path for DBNPS is west to east/southwest to northeast. The second truck position was selected based on a distance from SB7 of approximately 1,450 ft in a north/south orientation, and its open space and distance from structures

3.6.1.4 Snow, Ice, Extreme Cold and Extreme Heat

In its FIP, the licensee described that EFWF building ventilation systems are designed to maintain temperature required to support equipment operation. As described in ECP 13-0195, the HVAC system for the EFWF will be installed to provide cooling and heating to maintain indoor temperature for EFW service area equipment and to provide ventilation to maintain the air quality during normal plant conditions and during FLEX coping activities. The HVAC system will be sized and designed for the following outdoor conditions: summer temperature of 105°F/76°F dry/wet bulb; and a winter temperature of -10°F dry bulb. The HVAC system is

designed to provide the following indoor conditions: summer temperature of 120°F dry bulb; and winter temperature: 60°F dry bulb. In addition, the snow load used for the EFWF roof design is 40 pounds per square foot (psf), which includes ice-on-snow.

In its FIP, the licensee described that the auxiliary building is a seismic Class 1, safety-related building. It is temperature controlled including post BDBEE heatup calculations.

In its FIP, the licensee described that SB7 is climate controlled. In addition, it described the structural design of SB7 was in accordance with the 2011 Ohio Building Code. The 2011 Ohio Building Code used ASCE 7-05, Minimum Design Loads for Buildings and Other Structures, as the basis for design loads.

In its FIP, the licensee described that in selecting FLEX equipment, FENOC considered the site maximum expected temperatures in their specification, storage, and deployment requirements, including ensuring adequate ventilation or supplementary cooling, as required.

3.6.1.5 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should protect the FLEX equipment during a BDBEE consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.6.2 Availability of FLEX Equipment

Section 3.2.2.16 of NEI 12-06 states, in part, that in order to assure reliability and availability of the FLEX equipment, 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). 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, in which case the equipment associated with each strategy does not require an additional spare.

In its FIP, the licensee described that sufficient equipment has been purchased 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 equipment required by FLEX strategies for all units onsite. In addition, the FIP describes that in the case of hoses and cables associated with FLEX equipment required for FLEX strategies, the method documented in NEI 12-06 Rev. 2 was chosen. These hoses and cables are passive components being stored in a protected facility (EFWF or auxiliary building). It is postulated the most probable cause for degradation/damage of these components would occur during deployment of the equipment. Therefore the N+1 capability is accomplished by having sufficient hoses and cables to satisfy the N capability plus ten percent spares or at least one length of hose and cable. This ten percent margin capability ensures that failure of any one of these passive components would not prevent the successful deployment of a FLEX strategy.

The N+1 requirement does not apply to the beyond-design-basis (BDB) FLEX support equipment, vehicles, and tools. However, these items are covered by a fleet administrative procedure and are subject to inventory checks, requirements, and any maintenance and testing that are needed to ensure they can perform their required functions.

In its FIP, the licensee described that the following Phase 2 FLEX equipment are stored and/or staged in the EFWF building and seismically restrained:

- EFW system
- "N" FLEX 480 Vac DG (operated from stored location)
- "N" FLEX alternate low pressure EFWP (operated from stored location)
- "N" FLEX SFP spray pump (deployed as contingency to surviving water source)
- "N" FLEX replenishment pump (deployed to refill EFWST)
- "N" and "N+1" hoses for alternate low pressure EFWP, SFP spray, replenishment
- "N" and "N+1" cables for FLEX 480 Vac DG

In its FIP, the licensee described that the following Phase 2 FLEX equipment are stored and/or staged in the auxiliary building and seismically restrained:

- "N" FLEX CWRT RCS charging pump
- "N+1" FLEX BWST RCS charging pump
- "N" and "N+1" hoses for FLEX charging pumps
- "N" and "N+1" cables for FLEX charging pumps

In its FIP, the licensee described that the following Phase 2 FLEX equipment are stored in SB7:

- "N+1" FLEX SFP/replenishment pump
- "N+1" FLEX alternate low pressure EFWP
- "N+1" FLEX 480 Vac DG
- "N+1" FLEX Debris Removal Truck

In addition, a listing of the portable equipment and their storage location is provided in Table 2 of the FIP.

Based on the number of portable FLEX pumps, FLEX DGs, and support equipment identified in the FIP and during the audit review, the NRC staff finds that, if implemented appropriately, the licensee's FLEX strategies include a sufficient number of portable FLEX pumps, FLEX DGs, and equipment for RCS makeup and boration, SFP makeup, and maintaining containment consistent with the N+1 recommendation in Section 3.2.2.16 of NEI 12-06.

3.7 Planned Deployment of FLEX Equipment

In its FIP, the licensee described that the storage for FLEX equipment on the Davis Besse site is designed to minimize the deployment routes to the operations areas (designated areas where FLEX equipment is operated). The use of two storage areas (EFW Facility and SB7) on opposite sides of the plant provides for avoidance of site hazards while allowing deployment during the event. In addition, the FLEX strategies are intended to minimize the impact of debris by installing equipment in robust locations such as inside the Auxiliary Building or the EFW Facility that minimize the number of activities the operators must perform outside.

3.7.1 Means of Deployment

In its FIP, the licensee described that FLEX equipment haul paths to the various deployment locations have been identified and designated in FSG DB-OP-02705, "Initial Assessment and FLEX Equipment Staging." Soil liquefaction evaluations have been performed for the preselected haul paths and determined that the haul paths are stable following a seismic event. The FLEX equipment haul paths have also been assessed for potential debris such as trees and power lines and debris-prone locations such as narrow passages. Two heavy duty pickup trucks will be used as debris removal and towing vehicles. The trucks are stored in diverse locations such that at least one of the trucks can be reasonably expected to be available following a tornado event. The heavy duty pickup trucks are equipped for debris removal. This equipment includes snow plows to remove snow and ice from travel paths as necessary.

In addition, the EFWF stores ice augers and chop saws to create openings in the ice to access water during cold weather events if necessary.

3.7.2 Deployment Strategies

In its FIP, the licensee described that primary and alternate haul paths into the protected area have been identified as shown on Figure 2 of the FIP. The preferred haul path is via the normal vehicle entrance into the protected area located adjacent to the personnel access facility. An alternate haul path into the protected area has also been designated that is located at the north east corner of the protected area. This access point includes security features and barriers that can be manually opened and provides a pathway that is adequate for the FLEX equipment deployment.

In its FIP, the licensee described that ac power is not required to open EFWF Doors. In addition, the operators have methods to open all required auxiliary building doors in the event that ac power is lost.

In its FIP, the licensee described that a site liquefaction evaluation was completed. The results of that evaluation concluded that the subsurface soils and man-made fill deposits encountered below the anticipated haul paths are not considered to be susceptible to liquefaction during seismic events.

3.7.3 Connection Points

3.7.3.1 Mechanical Connection Points

Core Cooling (SG) Primary and Alternate Connections

The FIP describes the primary connections to support the SG makeup function as the installed EFW pumps in the EFW facility. Two LP EFW pumps are available to take suction from the EFWST in the event that the EFW pump is no longer available. The "N" alternate LP EFW pump is stored inside the EFW facility and uses a flexible hose to connect from a suction valve of the EFWST to a discharge valve on the EFW system inside the EFW facility. The "N+1" alternate LP EFW pump is deployed from SB7 and staged outside the EFW facility. A flexible hose is connected from an alternate suction valve on the EFWST to an alternate discharge valve to the EFW system. Both discharge valves to the EFW system will inject the water from

either LP EFW pump into an EFW control valve for SG injection. The connections from the EFWST to the EFW system are all located inside the EFW facility, which is protected from all applicable external hazards. The licensee also described in the FIP alternate flowpaths for both LP EFW pumps. A branch connection from the EFW system is located in the Auxiliary Building Mechanical Penetration Room 3, which allows for SFP makeup from the EFW system. The licensee stated that an isolation valve was installed to allow for train separation for SG injection at the existing SFP makeup connection. The "N" or N+1" alternate LP EFW pump can be deployed to a blowout panel outside of the Mechanical Penetration Room 3, with 100 feet of discharge hose connecting to the respective alternate LP EFW pump and taking suction from one of two replenishment FLEX pumps. The replenishment pump is deployed to a surviving water source other that the EFWST. A Y-Manifold is used to prime and control the pressure to the alternate LP EFW pump in use. The other alternate LP EFW pump will serve as the backup for this alternate connection.

RCS Inventory Control Primary and Alternate Connections

The FIP states that the primary connection for RCS makeup is to use the RCS FLEX charging and booster pumps. The CWRT RCS FLEX charging pump and associated booster pump are deployed and presaged in the CWRT room in the Auxiliary Building. A flexible hose is connected from a suction line from the CWRT to the booster pump and then into the CWRT RCS FLEX charging pump. Borated water from the CWRT is distributed from the discharge of the CWRT RCS FLEX charging pump through a flexible hose into the RCS through the High Pressure Injection system Train 2 as directed by FSG DB-OP-02701, "Long Term RCS Inventory Control." As an alternative approach, the CWRT RCS FLEX can also be manually aligned with flexible hoses to take suction from the BWST and discharge to the RCS through High Pressure Injection Train 1. The BWST RCS FLEX charging pump and associated booster pump are deployed to a location on the 545' elevation in the Auxiliary Building. A flexible hose is connected from a suction line from the BWST to the booster pump and then into the BWST RCS FLEX charging pump. Borated water from the BWST is distributed from the discharge of the BWST RCS FLEX charging pump through a flexible hose into the RCS through the High Pressure Injection system Train 1 as directed by FSG DB-OP-02701, "Long Term RCS Inventory Control." As an alternative approach, the BWST RCS FLEX can also be manually aligned with flexible hoses to take suction from the CWRT and discharge to the RCS through High Pressure Injection Train 2. The CWRT and BWST RCS FLEX pumps, associated booster pumps, and flexible hoses are stored in the Auxiliary Building, which is protected from all applicable external hazards. The CWRT is located inside the Auxiliary Building, which indicates that the CWRT suction connections for the CWRT and BWST RCS charging pumps are both located inside a structure that is protected from all applicable external hazards. The BWST is located outside Containment and the Auxiliary Building. The BWST is protected from all applicable external hazards, with the exception of the high winds or tornados hazard. The licensee indicated in the FIP that the BWST would be the preferred source for RCS makeup for all external hazards excluding high winds or tornados, whereas the CWRT would be available as the fully protected source for all applicable external events.

SFP Makeup Primary and Alternate Connections

The FIP describes the primary connection for SFP makeup as a hose connection to a new FLEX SFP makeup header, which is then connected to the permanent, seismically designed primary emergency SFP makeup connection located on the inside wall of the Fuel Handling

area. The new FLEX makeup header allows for connection of flexible hoses from the EFW system (using the EFW pump or alternate LP EFW pump) or from the FLEX SW connection. Flexible hoses are routed from the EFW throttle valve to the SFP makeup header (SFP Train Bay SE corner 585 ft. elevation level). The makeup flow and pressure is then maintained as directed by FLEX procedure FSG DB-OP-02711, "Alternate Spent Fuel Pool Makeup." The alternate connections for SFP makeup will involve direct connection to the EFW system or SW system, as directed by FLEX procedure FSG DB-OP-02711. Flexible hoses are connected from the EFW system (through the EFW pump or alternate LP EFW pump) or from the FLEX SW connection and are connected to fire hoses located on the 603 ft. elevation level of the SFP area. The hoses are routed from the EFW throttle valve to the top of the SFP on the 603 ft. elevation level. Additionally, the NSRC SW pump can be used for SFP makeup, in which the SW is aligned to the SFP makeup header (SFP Train Bay SE corner 585 ft. elevation level) through SW Loop 1. The SFP makeup header is located in the Auxiliary Building, which is protected from all applicable external hazards except near one rollup door in the SFP area. However, the licensee has indicated alternative means to provide makeup water to the SFP if the SFP makeup header is not available. The licensee also indicated that FLEX procedure FSG DB-OP-02711 allows operators to use makeup water from other water sources such as the Circulating Water Canal, the UHS, or the Training Center Pond as prioritized in the procedure. The replenishment pumps are used to draw suction from these sources and feed to the SFP makeup header as available.

3.7.3.2 Electrical Connection Points

Electrical connection points are only needed for Phases 2 and 3 of the licensee's mitigation strategies for a BDBEE.

During Phase 2, the licensee's strategy is to supply power to equipment required to maintain or restore core cooling, containment, and SFP cooling using a combination of permanently installed and portable components. The strategy is to use the pre-staged "N" 480 Vac FLEX DG located inside the EFWF. The "N+1" FLEX DG, if required, would be towed to just outside the EFWF (FLEX Staging Area 1) or to just outside the Auxiliary Building High Voltage Switchgear (HVSG) Rooms (FLEX Staging Area 2). Procedure DB-OP-02721, "Restore 480V Power to E1 and F1," provide guidance for connecting the 480 Vac FLEX DG to restore power to E1 and F1. The licensee verified proper phase rotation as part of its post installation testing.

The "N" FLEX DG Connection Strategy – the 480 Vac bus (E1 and/or F1) is powered by connecting the FLEX DG to the EFWF FLEX 480V Generator Receptacle Enclosure (ZSR5005) via temporary cables. Enclosure ZSR5005 is connected to EFWF MCC BYS07 via permanent cables and breaker BYS0702. Breaker BYS0702 is Kirk Key interlocked with the normal power supply breaker for the EFW facility breaker BYS0701. The MCC BYS07 distributes power from the generator to the EFWF and various FLEX loads (charging pumps and its associated booster pumps, MCC E1 and F1).

The "N+1" FLEX DG Connection Strategy (FLEX Staging Area 1) – the connection strategy for the N+1 FLEX DG while it is staged in FLEX staging area 1 is the same as the N FLEX DG connection strategy.

The "N+1" FLEX DG Connection Strategy (FLEX Staging Area 2) - the connection strategy for the N+1 FLEX DG when it is staged in the FLEX Area Staging 2 is to connect directly to E1 (preferred) or F1 via their respective 480 Vac receptacle enclosure. The preferred strategy is to connect the FLEX N+1 DG and the E1 480 Vac receptacle enclosure (ZSR3602) in the "A" HVSG via temporary power cables. The alternate strategy is to connect the FLEX N+1 DG and the F1 480 Vac receptacle enclosure (ZSR3603) in the "B" HVSG via temporary power cables.

For Phase 3, the licensee will receive two 1 MW 4160 Vac and one 1100 kW 480 Vac CTGs from an NSRC. The licensee plans to restore power to 4160 Vac essential buses C1 or D1 using the NSRC supplied 4160 Vac CTGs. Temporary power cables will be used to connect a breaker cart that will be installed in the place of the EDG output breakers (AC101 and AD101) to the NSRC CTGs. The NSRC supplied 4160 Vac CTGs will be staged outside the HVSG room on the north side of the auxiliary building. Procedure DB-OP-02723, "Restore 4160V Power to C1 and D1," provides guidance connecting the 4160 Vac CTGs to restore power to E1 and F1. Procedure DB-OP-02756, "FLEX 4160 Breaker Cart," provides guidance for performing phase rotation checks when connecting the 4160 Vac CTGs.

3.7.4 Accessibility and Lighting

In its FIP, the licensee identified that battery powered (Appendix "R") emergency lights are available to provide lighting. Appendix "R" emergency lights are designed to provide a minimum of eight hours of lighting without ac power. These emergency lights are tested periodically and located throughout the plant. In addition, operators responsible for implementing FLEX related tasks are required to carry flashlights.

The FIP described that additional FLEX lighting is also available including personal lighting, portable battery flood lighting. Generator powered flood lighting is staged in the auxiliary building and the EFWF (both robust). Procedure FSG DB-OP-2705, Initial Assessment and FLEX Equipment Staging, provides the necessary instructions to deploy the FLEX lighting. Attachments 12 and 13 have been created to provide the instructions for portable lighting options and storage locations to be implemented as required based on the initial assessments. Attachment 12 is specific to non-radiologically controlled areas and Attachment 13 is specific to radiologically controlled areas.

3.7.5 Access to Protected and Vital Areas

During the audit process, the licensee provided information describing that access to protected areas will not be hindered. The licensee has contingencies in place to provide access to areas required for the ELAP response if the normal access control systems are without power.

3.7.6 Fueling of FLEX Equipment

In its FIP, the licensee described that diesel fuel is required to support the FLEX equipment for the FLEX strategies. The general coping strategy for supplying fuel oil to diesel-driven portable equipment is to draw fuel oil out from any of the available existing diesel fuel oil tanks on the DBNPS site. Diesel fuel is provided from a 6,000 gallon diesel fuel tank that is located in the EFWF.

The FIP describes that at full load, the EFW pump diesel would use 51.3 gallons per hour (gph). The 480 Vac, 850 kW FLEX DG would use 110 gph. As a result, without considering the EFWP day tank and assuming maximum fuel consumption rates, a minimum of 37 hours is available to move fuel to replenish the EFWF fuel oil storage tank. As inventory in the EFW Facility fuel oil storage tank is depleted, fuel will be transferred from the EDG day tanks located inside the auxiliary building to fuel transfer equipment, or directly to equipment using a small electric powered transfer pump. A connection will be made to a drain line located on the supply line to the EDG from the associated EDG day tank. The installed 480 Vac fuel transfer pumps will be repowered by the FLEX 480Vac DG and will transfer inventory from the EDG week tanks (located underground, west of the Auxiliary Building) to the EDG day tanks as needed. Procedure DB-OP-02705, "Initial Assessment and FLEX Staging," provides direction for monitoring usage and transferring diesel fuel oil as necessary. Procedure DB-OP-02759, "FLEX Portable Fuel Oil Pumps," provides detailed transfer direction. Fuel oil for portable equipment will also be available from the EDG day tank. These two diesel tanks contain a minimum of 4,000 gallons of diesel fuel each as required by technical specifications (a total of 8,000 gallons) and are seismically mounted and housed in the tornado protected EDG rooms. The preferred fueling strategy is to cross-tie the EDG day tanks, then connect one fuel hose to EDG day tank No. 2 drain with a manual trigger nozzle for filling smaller items such as portable DGs, and to connect one fuel hose to EDG day tank No. 1 drain to supply a portable ac pump with a manual trigger nozzle for filling larger items such as fuel transfer cubes and the debris removal truck 110 gallon tanks.

The licensee provided information that described how the site accepts fuel oil from approved vendors for use onsite that includes fuel oil sampling by the Chemistry Department and is accepted per procedures DB-CH-06900, "Operational Chemical Control Limits," DB-CH-03044, "New EDG Diesel Fuel Oil Analysis," and/or DB-CH-04056, "New Diesel Fuel Oil Analysis." The FIP described that diesel fuel in the EDG fuel oil storage tanks is routinely sampled and tested to assure fuel oil quality is maintained to American Society for Testing and Materials standards. This sampling and testing surveillance program also assures that fuel oil quality is maintained for operation of the station EDGs. In addition, the licensee provided information that the 6,000 gallon EFW Facility fuel oil storage tank has been added to the chemistry monitoring program and is periodically sampled following the requirements of procedure DB-CH-06900.

In addition, the FIP described that FLEX equipment that use fuel oil will have an onboard fuel tank (maintained normally greater than 1/2 filled). These onboard fuel tanks will provide the fuel necessary for initial implementation of the strategies. In addition, the licensee described during the audit process that the portable 850 kW, 480 Vac DGs do not have fuel oil storage tanks, but rather receive their fuel oil directly through an attachment hose from the EFW Facility fuel oil storage tank or a 1,200 gallon fuel storage trailer. The 1,200 gallon fuel oil storage trailer, portable FLEX pumps and small portable 6 kW DGs, which are stored in indoor temperature controlled facilities, are initially filled with fuel oil that was sampled and accepted by the licensee. These portable units are drained and refilled annually to assure fuel oil quality, which is controlled by preventive maintenance tasks.

3.7.7 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should allow deploying the FLEX equipment following a BDBEE consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.8 Considerations in Using Offsite Resources

3.8.1 Davis-Besse Nuclear Power Station SAFER Plan

The industry has collectively established the needed off-site capabilities to support FLEX Phase 3 equipment needs via the SAFER Team. The SAFER team consists of the Pooled Equipment Inventory Company (PEICo) and AREVA Inc. and provides FLEX Phase 3 management and deployment plans through contractual agreements with every commercial nuclear operating company in the United States.

There are two NSRCs, located near Memphis, Tennessee and Phoenix, Arizona, established to support nuclear power plants in the event of a BDBEE. Each NSRC holds five sets of equipment, four of which will be able to be fully deployed to the plant when requested.

The fifth set allows removal of equipment from availability to conduct maintenance cycles. In addition, the plant's FLEX equipment hose and cable end fittings are standardized with the equipment supplied from the NSRC.

By letter dated September 26, 2014 [Reference 21], the NRC staff issued its assessment of the NSRCs established in response to Order EA-12-049. In its assessment, the staff concluded that SAFER has procured equipment, implemented appropriate processes to maintain the equipment, and developed plans to deliver the equipment needed to support site responses to BDBEEs, consistent with NEI 12-06 guidance; therefore, the staff concluded in its assessment that licensees can reference the SAFER program and implement their SAFER response plans to meet the Phase 3 requirements of Order EA-12-049.

The NRC staff noted that the licensee's SAFER Response Plan contains (1) SAFER control center procedures, (2) NSRC procedures, (3) logistics and transportation procedures, (4) staging area procedures, which include travel routes between staging areas to the site, (5) guidance for site interface procedure development, and (6) a listing of site-specific equipment (generic and non-generic) to be deployed for FLEX Phase 3.

3.8.2 Staging Areas

In general, up to four staging areas for NSRC supplied Phase 3 equipment are identified in the SAFER Plans for each reactor site. These are a Primary (Area C) and an Alternate (Area D), if available, which are offsite areas (within about 25 miles of the plant) utilized for receipt of ground transported or airlifted equipment from the NSRCs. From Staging Areas C and/or D, the SAFER team will transport the Phase 3 equipment to the on-site Staging Area B for interim staging prior to it being transported to the final location in the plant (Staging Area A) for use in

Phase 3. For DBNPS, Alternate Staging Area D is Wood County Regional Airport. Staging Area C is the Freemont Airport. Staging Area B is northwest contractor parking lot. Staging Area A is the point-of-use for the FLEX response equipment.

Use of helicopters to transport equipment from Staging Areas C and/or D to Staging Area B is recognized as a potential need within the Davis-Besse Nuclear Power Station SAFER Plan and is provided for.

3.8.3 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should allow utilization of offsite resources following a BDBEE consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.9 Habitability and Operations

3.9.1 Equipment Operating Conditions

3.9.1.1 Loss of Ventilation and Cooling

Following a BDBEE and subsequent ELAP event at Davis-Besse, ventilation that provides cooling to occupied areas and areas containing required equipment will be lost. The primary concern with regard to ventilation is the heat buildup, which occurs with the loss of forced ventilation in areas that continue to have heat loads. A heat balance calculation was performed by the licensee to quantify the maximum steady state temperatures expected in specific areas related to FLEX implementation to ensure the environmental conditions remain acceptable and within equipment limits. The licensee did not perform time-dependent heat-up calculations. The licensee confirmed that the maximum operating temperatures of the equipment in the room were greater than the maximum equilibrium temperature determined by the heat balance calculation. The NRC staff reviewed the heat balance calculation and concluded that it is conservative and structured appropriately. The key areas identified for all phases of execution of the FLEX strategy activities are the Control Room, HVSG Rooms, low voltage switchgear (LVSG) Rooms (station inverters, battery chargers, battery rooms), and Containment.

Control Room

The licensee performed heat balance calculation C-ME-099.25-001, "Auxiliary Building Room Temperatures During an ELAP," Revision 0, which modeled the temperature response in the control room following an ELAP event. The calculation determined that the expected control temperature will remain below 110.3°F. The calculation also determined that portable ventilation providing 9,800 standard cubic feet per minute (scfm) and opening doors could maintain control room temperature below 100°F if normal ventilation is not able to be established. Procedure DB-OP-02725, "Control Room and Miscellaneous Habitability Actions," provides guidance for restoring normal control room ventilation, and establishing portable ventilation and opening room doors to minimize control room temperature increases after a loss of ventilation and cooling due to ELAP.

Based on temperatures remaining below 120°F (the temperature limit identified in NUMARC-87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," Revision 1, for electronic equipment to be able to survive indefinitely), the NRC staff finds that the electrical equipment in the control room will not be adversely impacted by the loss of ventilation as a result of an ELAP event.

HVSG Rooms

The licensee performed heat balance calculation C-ME-099.25-001, which modeled the temperature response in the HVSG rooms following an ELAP event. The calculation determined that the expected HVSG room temperature will remain below 115.5°F. The calculation also determined that portable ventilation providing 2,900 scfm and opening doors could maintain HVSG room temperature below 104°F if normal ventilation is not able to be established. Procedure DB-OP-02721, provides guidance to establish portable ventilation in the LVSG rooms for cooling to the instrumentation and components.

Based on temperatures remaining below 120°F, the NRC staff finds that the electrical equipment in the HVSG room will not be adversely impacted by the loss of ventilation as a result of an ELAP event.

LVSG Rooms (station inverters, battery chargers, battery rooms)

The licensee performed heat balance calculation C-ME-099.25-001, which modeled the temperature response in the LVSG rooms following an ELAP event. The calculation determined that the expected LVSG room temperature will remain below 114.4°F. The calculation also determined that portable ventilation providing 3,300 scfm and opening doors could maintain LVSG room temperature below 104°F if normal ventilation is not able to be established. Procedure DB-OP-02721, provides guidance to restore battery room ventilation when the 480 Vac FLEX DGs are repowering 480 Vac buses E1 and F1. Procedure DB-OP-02725, provides guidance to establish portable ventilation in the LVSG rooms for providing cooling to the instrumentation and components. Although the licensee plans to restore normal battery room ventilation or provide portable ventilation and open doors in the LVSG and battery rooms if normal battery ventilation can't be restored, periodic monitoring of electrolyte level may be necessary to protect the battery since the battery may gas more at higher temperatures.

Based on temperatures remaining below 120°F (the temperature limit for indefinite survival of electrical equipment, as identified in NUMARC-87-00, Revision 1, and the maximum temperature for the station batteries), the NRC staff finds that the electrical equipment in the LVSG room, including the batteries, will not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Based on the above, the NRC staff finds that the if the licensee can maintain LVSG room temperature below 114.4°F, which is below the maximum temperature limit (120°F) of the station batteries, as specified by the battery manufacturer (Exide Technologies), the loss of ventilation as a result of an ELAP event should not adversely impacted the station batteries.

Containment

The licensee performed calculation C-NSA-060.05-018 "CS14-001, "FLEX Mode 1 Containment Response Analysis Due to 10 GPM RCS Leak," Revision 0, which modeled the transient temperature response in the containment following an ELAP event. The calculation analyzed the containment pressure and temperature response for 100 hours following an ELAP. The results of this analysis determined that without any mitigating actions taken, the equipment limits for pressure and temperature are not challenged during this period. Therefore, there is adequate time for the licensee to establish containment cooling during Phase 3 by either venting containment or using the CACs to ensure that temperature and pressure limits are not exceeded and necessary equipment, including credited instruments and components, located inside containment remains functional throughout the ELAP event. Procedure DB-OP-02712, "Alternate Containment Cooling," provides guidance to restore containment cooling and venting the containment.

Based on containment temperature and pressure remaining below their respective design limit, the NRC staff expects that the electrical equipment in the containment should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

3.9.1.2 Loss of Heating

The licensee indicated in the FIP that the Auxiliary Building, the EFW Facility, and the Service Building 7 are used for storing FLEX equipment and to protect from extreme cold weather. The Auxiliary Building and the EFW Facility include heating and ventilation systems to maintain building temperatures required to prevent freezing of FLEX equipment. The licensee stated that Service Building 7 is also heated to provide protection for FLEX equipment stored in the building. Although, heat trace systems are used on site to maintain the concentrated boric acid stored in the Boric Acid Addition System, the Boric Acid Addition System is not credited in the FLEX strategies. The licensee credits the existing heating features in the Auxiliary Building and EFW Facility to protect the FLEX and installed equipment used for FLEX during extreme cold temperatures in lieu of heat tracing systems.

The DBNPS Class 1E station battery rooms are located inside the auxiliary building and would not be exposed to extreme low temperatures. At the onset of the event, the battery rooms would be at their normal operating temperature and the temperature of the electrolyte in the cells would build up due to the heat generated by the batteries discharging and during re-charging. In its compliance letter, the licensee stated that HVAC systems are sized to maintain the station battery rooms between 60°F and 104°F year round during all modes of operation. The licensee also stated that due to the relatively small size of the station battery rooms, low normal mode room heat loads, and the comparatively large outside wall area, a continuous supply of ventilation air from the LVSG rooms may be required to maintain the battery rooms above 60°F during severe winter weather. Procedure DB-OP-02725, provides guidance for setting up a portable heater in the LVSG room to maintain temperature in the battery rooms above 60°F. Therefore, the NRC staff finds that DBNPS station batteries should perform their required functions as a result of loss of normal heating during an ELAP event.

3.9.1.3 Hydrogen Gas Control in Vital Battery Rooms

An additional ventilation concern that is applicable to Phases 2 and 3, is the potential buildup of hydrogen in the battery rooms as a result of loss of ventilation during an ELAP event. Off-gassing of hydrogen from batteries is only a concern when the batteries are charging. In the FIP, the licensee stated that they plan to restore battery room ventilation once the 480 Vac FLEX DG repowers the 480 Vac bus. Procedure DB-OP-02721, provides guidance to repower battery room exhaust fans when the 480 Vac FLEX DGs are repowering the 480 Vac bus and the station batteries are charging, thus maintaining hydrogen below 2 percent. Furthermore, procedure DB-OP-02725, provides guidance for opening battery room doors and setting up portable ventilation, if necessary.

Based on its review of the licensee's battery room ventilation strategy, the NRC staff finds that hydrogen accumulation in the DBNPS vital battery rooms should not reach the combustibility limit for hydrogen (4 percent) during an ELAP as a result of a BDBEE.

3.9.2 Personnel Habitability

A loss of ventilation analyses, calculation C-ME-099.25-001, "Auxiliary Building Room Temperature during an ELAP," determined the temperatures expected in specific areas related to FLEX implementation to ensure the environmental conditions remain acceptable for personnel habitability and equipment functionality. It evaluated key areas identified for all phases of execution of the FLEX strategy activities, including the Control Room, the HVSG rooms, the LVSG rooms (includes station inverters, battery chargers, and battery rooms), Mechanical Penetration Room 3 (MPR3), Fan Alley, and the SFP Area. Calculation C-ME-050.05-007 analyzed the post-ELAP environmental conditions in the Emergency Feedwater Facility (EFWF). Procedure FSG DB-OP-02725, "Control Room and Miscellaneous Habitability Actions," provides direction to establish ventilation as required using portable equipment.

In the FIP, Section 2.11.1 concludes that the worst case temperature in each room is low enough to allow Operators to safely complete the mitigation task, or evaluated the effectiveness of the alternate ventilation plans (e.g., portable fans). For the alternate ventilation, the licensee's evaluation shows that the calculated flow rates for removing the heat load are within portable alternative ventilation capability, and implementation of the alternative ventilation is within the allotted time for room entry as defined in the mitigation strategy. Portable FLEX fans will provide ventilation as needed for the Control Room and the HVSG rooms. Supplemental ventilation is based on worst case ambient temperatures (105°F) and equipment heat loads. Fans will be powered by FLEX diesel generators located in the EFWF and will be directly vented to the outdoors. However, the FIP did not provide information regarding the timeframe for operator actions.

The licensee provided additional information on January 16, 2017 [Reference 42], to clarify the evaluation that provides the basis for FIP Section 2.11.1. The licensee confirmed that those rooms and areas that required continuous or extended occupation by plant personnel would reach a maximum temperature of approximately 110°F or below. This is consistent with NUMARC-87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," Revision 1, which identifies a maximum temperature limit for extended personnel occupancy of 110°F. For those rooms and areas with maximum temperatures above 110°F, the additional information [Reference 42] confirmed that the

personnel stay times were of relatively short duration or intermittent (i.e. monitoring). Therefore, the licensee clarified that while portable ventilation would be available, it was not required and the NRC staff concludes that personnel habitability should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

3.9.2.1 Main Control Room

The licensee performed calculation C-ME-099.25-001, "Auxiliary Building Room Temperatures During an ELAP," Revision 0, which modeled the temperature response in the control room following an ELAP event. The calculation used input from other calculations to determine alternative ventilation requirements to maintain the Control Room at or below 100°F when the outdoor temperature is 95°F. Input calculation 57.003, "Control Room Temperature (2-Hour Blackout) for Loss of Power" determined the Control Room temperature during a SBO is 103.3°F. Calculation 57.005, "Control Room Heatup During 2 Hr. Station Blackout," determined the Control Room temperature would be 97.7°F at the end of 2-hours. Calculation 57.001 Revision 3, "Extent of Temperature Rise in Essential Areas With Loss of Ventilation," determined the steady-state temperature for the Control Room is 118°F with the assumption that the rooms adjacent to the Control Room are at 110°F. Calculation C-ME-099.25-001 used the same methodology used in calculation 57.005 along with heat loads based on the equipment that is expected to remain in operation during an ELAP. This analysis determined that the expected main control room temperature will remain below 110.3°F.

Calculation C-ME-099.25-001 also determined that portable ventilation providing 9,800 scfm and opening doors could maintain control temperature below 100°F if normal ventilation is not able to be established. Procedure DB-OP-02725, "Control Room and Miscellaneous Habitability Actions," provides guidance for restoring normal control room ventilation using the Emergency Ventilation System (EVS) in the Air-Cooled Mode (guidance in DB-OP-02000, "RPS, SFAS, SFRCS Trip, or SG Tube Rupture") once E1 or F1 power is restored from a FLEX 480v generator, and establishing portable ventilation and opening room doors to minimize control room temperature increases after a loss of ventilation and cooling due to ELAP. Procedure DB-OP-02705, "Initial Assessment and FLEX Equipment Staging," Attachment 24 provides guidance for the location of portable ventilation equipment.

Based on temperatures remaining below approximately 110°F without establishing portable ventilation in the main control room, the NRC staff finds that personnel habitability should not be adversely impacted by the loss of ventilation as a result of an ELAP event, per NUMARC-87-00.

3.9.2.2 Spent Fuel Pool Area

The licensee performed calculation C-ME-099.25-001, which modeled the temperature response in the SFP area following an ELAP event. The calculation determined that there would be no significant heat load from the fuel in the SFP. The expected SFP area temperature will remain below 104°F.

During the audit, NRC staff requested clarification regarding no significant heat load from the spent fuel following a loss of cooling. The licensee responded that the calculation is for SFP areas below the operating floor. Calculation CN-SEE-II-12-41, "Determination of the Time to Boil in the Davis Besse Spent Fuel Pools after an Earthquake," determined the time to boil

during an ELAP following an earthquake. The licensee determined that there is sufficient time to install any equipment required to monitor the SFP and to cool and maintain water inventory prior to SFP boiling.

Ventilation for the SFP area will be provided by opening the large overhead door. Staff noted during the audit that the top of the overhead door is above the spent fuel pool operating floor such that natural draft heat removal is expected to limit temperature rise in areas below the operating floor. Guidance for establishing ventilation is provided in DB-OP-02711, "Alternate Spent Fuel Pool Makeup," and DB-OP-02547, "Spent Fuel Pool Cooling Malfunctions."

3.9.2.3 Other Plant Areas

HVSG Rooms
The licensee performed calculation C-ME-099.25-001, which modeled the temperature response in the HVSG rooms following an ELAP event. The calculation determined that the expected HVSG room temperature will remain below 115.5°F. The calculation also determined that portable ventilation providing 2,900 scfm and opening doors could maintain HVSG room temperature below 104°F if normal ventilation is not able to be established. Procedure DB-OP-02725, provides guidance to establish portable ventilation in the LVSG rooms for cooling to the instrumentation and components.

LVSG Rooms (station inverters, battery chargers, battery rooms)
The licensee performed calculation C-ME-099.25-001, which modeled the temperature response in the LVSG rooms following an ELAP event. The calculation determined that the expected LVSG room temperature will remain below 114.4°F. The calculation also determined that portable ventilation providing 3,300 scfm and opening doors could maintain LVSG room temperature below 104°F if normal ventilation is not able to be established. Procedure DB-OP-02721, provides guidance to restore battery room ventilation when the 480 Vac FLEX DGs are repowering 480 Vac buses E1 and F1. Procedure DB-OP-02725, provides guidance to establish portable ventilation in the LVSG rooms for cooling to the instrumentation and components.

The licensee provided additional information on January 16, 2017, to clarify FIP Section 2.11.1 [Reference 42]. The licensee confirmed that the personnel stay times to implement the mitigating strategies in the HVSG and LVSG rooms were of relatively short duration (i.e.,15 to 30 minutes). Therefore, the licensee clarified that while portable ventilation would be available, it was not required and the NRC staff concludes that personnel habitability should not be adversely impacted by the loss of ventilation in the HSVG and LSVG rooms as a result of an ELAP event.

3.9.3 Conclusions

The NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should maintain or restore equipment and personnel habitability conditions following a BDBEE consistent with NEI 12-06 guidance as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.10 Water Sources

3.10.1 Steam Generator Make-Up

As described in the FIP, the CSTs would be used if they are available. The CSTs are not seismically qualified or missile protected. If the CSTs are not available, the EFWST would be utilized. The EFWST can be refilled from any of the sources of water provided in Table 1 of the FIP. Lake Erie is included in Table 1 as it is the UHS for DBNPS. Lake Erie via FLEX pumps would provide water to the SGs either via the EFW system or the FLEX alternate low pressure EFWP.

3.10.2 Reactor Coolant System Make-Up

In its FIP, the licensee described that there are two primary water sources (two sources of borated water) evaluated for DBNPS. Each water source can be aligned to provide suction for either the CWRT or the BWST RCS FLEX charging pump. These sources are the CWRT 1 and the BWST. The CWRT 1 has been determined by the licensee to be seismically adequate for SSE loads and is located in the auxiliary building such that it is protected from all other hazards. During "at power" operations, the CWRT 1 borated volume is maintained greater than or equal to 80,000 gallons at a boron concentration between 2,600 and 2,800 ppm.

The BWST is located outside of the auxiliary building and is not protected from high wind/tornado generated missiles. During "at power" operations, the BWST borated volume is maintained between 500,100 gallons and 550,000 gallons at a boron concentration between 2,600 and 2,800 ppm,

3.10.3 Spent Fuel Pool Make-Up

In its FIP, the licensee described that the use of a borated source for the SFP is not required. However, makeup to the SFP can be gravity-fed from the BWST if available. If the BWST is not available, the preferred source of SFP make-up would be the EFWST using the EFWP, through connections, to supply the FLEX SFP make-up header. The EFWST can be refilled from any of the water sources listed in Table 1 of the FIP. Lake Erie is included in Table 1 as it is the UHS for DBNPS. The FLEX pumps would provide water from Lake Erie to the SFP either through the EFW system or the FLEX LP EFW pump.

3.10.4 Containment Cooling

In its FIP, the licensee described that no water sources were needed for containment cooling during phases 1 and 2. Containment function is not expected to be challenged even later in the event. However, during phase 3, large pumps from the NSRC, taking suction from the UHS (Lake Erie) would be connected to the SW system. Large DGs from the NSRC would repower CAC fans. Restoration of SW and electrical power for fan operations will provide heat rejection capability for the CACs to establish containment cooling.

3.10.5 Conclusions

Based on the evaluation above, the NRC staff concludes that the licensee has developed guidance that, if implemented appropriately, should maintain satisfactory water sources following a BDBEE consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.11 Shutdown and Refueling Analyses

Order EA-12-049 requires that licensees must be capable of implementing the mitigation strategies in all modes. In general, the discussion above focuses on an ELAP occurring during power operations. This is appropriate, as plants typically operate at power for 90 percent or more of the year. When the ELAP occurs with the plant at power, the mitigation strategy initially focuses on the use of the steam-driven TDAFW pump or the EFW pump to provide the water initially needed for decay heat removal. If the plant has been shut down and all or most of the fuel has been removed from the RPV and placed in the SFP, there may be a shorter timeline to implement the makeup of water to the SFP. However, this is balanced by the fact that if immediate cooling is not required for the fuel in the reactor vessel, the operators can concentrate on providing makeup to the SFP. The licensee's analysis shows that following a full core offload to the SFP, about 18 hours are available to implement makeup before boil-off results in the water level in the SFP dropping far enough to uncover fuel assemblies, and the licensee has stated that they have the ability to implement makeup to the SFP within that time [Reference 41].

When a plant is in a shutdown mode in which steam is not available to operate the TDAFW pump and allow operators to release steam from the SGs (which typically occurs when the RCS has been cooled below about 300 °F), another strategy must be used for decay heat removal. The NRC-endorsed strategy is described in NEI 12-06. Section 3.2.3 provides guidance to licensees for reducing shutdown risk by incorporating FLEX equipment in the shutdown risk process and procedures. Considerations in the shutdown risk assessment process include maintaining necessary FLEX equipment readily available and potentially pre-deploying or pre-staging equipment to support maintaining or restoring key safety functions in the event of a loss of shutdown cooling. In its FIP, the licensee stated that it would follow this guidance. During the audit process, the NRC staff observed that the licensee had made progress in implementing this guidance.

Based on the licensee's incorporation of the use of FLEX equipment in the shutdown risk process and procedures, the NRC staff concludes that the licensee has developed guidance that if implemented appropriately should maintain or restore core cooling, SFP cooling, and containment following a BDBEE in shutdown and refueling modes consistent with NEI 12-06 guidance, as endorsed by JLD-ISG-2012-01, and should adequately address the requirements of the order.

3.12 Procedures and Training

3.12.1 Procedures

The licensee's FIP described that FSGs have been developed to provide guidance for a variety of conditions since the actual plant conditions in a BDBEE are not predictable. In order to

ensure that FSGs are not entered and used inappropriately, clear entry criteria are established to indicate when an FSG should be used in lieu of an existing station procedure. Pre-planned FLEX strategies to accomplish specific tasks in the EOPs or abnormal operating procedures (AOPs) are described in the FSGs. The FSGs provide implementing instructions for the FLEX strategies and are used to supplement (not replace) the existing procedure structure that establishes command and control for the event.

The FIP described that FSG procedural Interfaces have been incorporated into the appropriate station procedures to reference the FSGs and provide command and control for the ELAP. In addition, DBNPS developed FLEX Support Operator Aids (FSOAs). The FSOAs provide operating instructions for equipment that is unique to implementing the FLEX strategies.

The FIP also stated that the FSGs have been reviewed and validated by the involved groups to the extent necessary to ensure that implementation of the associated FLEX strategy is feasible. Specific FSG validation was accomplished via table top evaluations and walk-throughs of the guidelines when appropriate.

3.12.2 Training

In its FIP, the licensee described that DBNPS's Nuclear Training Program has been revised in accordance with the Systematic Approach to Training (SAT) Process. Training programs and controls have been implemented to assure personnel proficiency in utilizing FSGs and associated BDBEE equipment is adequate and maintained.

The FIP also described that initial training was provided prior to order compliance and that routine, continuing training will be provided to site emergency response leaders regarding the BDBEE emergency response strategies and implementing guidelines. In addition, personnel assigned to direct the execution of the FLEX mitigation strategies for a BDBEE were provided with training to develop familiarity with the associated tasks, bearing in mind available job aids, instructions, and considering mitigation strategy time constraints.

The FIP described that certification of simulator fidelity is considered to be sufficient for the initial stages of the BDBEE scenario until the current capability of the simulator model is exceeded. Therefore, full scope simulator models will not be upgraded to accommodate FLEX training or drills. The DBNPS Simulator has been updated to include the EWF System equipment and indications available in the Control Room.

3.12.3 Conclusions

Based on the description above, the NRC staff finds that the licensee has adequately addressed the procedures and training associated with FLEX. The procedures have been issued in accordance with NEI 12-06, Section 11.4, and a training program has been established and will be maintained in accordance with NEI 12-06, Section 11.6.

3.13 Maintenance and Testing of FLEX Equipment

In its FIP, the licensee described that initial component level testing, consisting of factory acceptance testing and site acceptance testing, was conducted to ensure the portable FLEX equipment can perform its required FLEX strategy design functions. Factory acceptance testing

verified that the portable equipment performance conformed to the manufacturers rating for the equipment as specified in the purchase order. Verification of the vendor test documentation was performed as part of the receipt inspection process for each of the affected pieces of equipment and included in the applicable vendor technical manuals. Site acceptance testing confirmed factory acceptance testing to ensure portable FLEX equipment delivered to the site performed in accordance with the FLEX strategy functional design requirements.

The FIP also described that portable beyond-design-basis (BDB) equipment directly performing a FLEX mitigation strategy for the core cooling, containment, or SFP cooling is subject to periodic maintenance and testing in accordance with NEI 12-06, Rev. 2 and INPO AP 913, Equipment Reliability Process, to verify proper function. Additional FLEX support equipment that requires maintenance and testing will have preventive maintenance (PM) to ensure it will perform its required functions during a BDBEE.

In addition, the FIP described that EPRI has completed and has issued Preventive Maintenance Basis for FLEX Equipment - Project Overview Report. Preventative Maintenance Templates for the major FLEX equipment including the portable diesel pumps and generators have also been issued.

In its FIP, the licensee described that the PM Templates include activities such as:

- Periodic static inspections - monthly walkdown
- Fluid analysis - Annually
- Periodic operational verifications
- Periodic performance tests

In addition, the PM procedures and test procedures are based on the templates contained within the EPRI Preventive Maintenance Basis Database, or from manufacturer provided information/recommendations when templates were not available from EPRI [Reference 40]. The corresponding maintenance strategies were developed and documented. The performance of the PMs and test procedures are controlled through the site work order process. FLEX support equipment not falling under the scope of INPO AP 913 will be maintained, as necessary, to ensure continued reliability. Performance verification testing of FLEX equipment is scheduled and performed as part of the DBNPS PM process.

In its FIP, the licensee described that procedure NORM-LP-7202, Davis-Besse Specifications for FLEX Equipment Out of Service, was established to ensure the unavailability of equipment and applicable connections that directly perform a FLEX mitigation strategy for core cooling, containment, and SFP cooling will be managed such that risk to mitigation strategy capability is minimized. Maintenance and risk guidance conforms to the guidance of NEI 12-06, Rev. 2, as follows:

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

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

- The N+1 alternate LP EFWP, N+1 Replenishment/Spray pump & Debris removal are not protected against all hazards, therefore maintenance on N equipment will be completed in 45 days OR N+1 equipment will be moved to robust storage.

The NRC staff finds that the licensee has adequately addressed equipment maintenance and testing activities associated with FLEX equipment because a maintenance and testing program has been established in accordance with NEI 12-06, Rev. 2, Section 11.5.

3.14 Alternatives to NEI 12-06, Rev. 2

The licensee did not describe or credit any alternatives to the guidance contained in NEI 12-06, Rev. 2.

3.15 Conclusions for Order EA-12-049

Based on the evaluations above, the NRC staff concludes that the licensee has developed guidance to maintain or restore core cooling, SFP cooling, and containment following a BDBEE which, if implemented appropriately, should adequately address the requirements of Order EA-12-049.

4.0 TECHNICAL EVALUATION OF ORDER EA-12-051

By letter dated February 27, 2013 [Reference 22], the licensee submitted its OIP for DBNPS in response to Order EA-12-051. By letter dated July 17, 2013 [Reference 23] the NRC staff sent a Request for Additional Information (RAI) to the licensee. The licensee provided a response by letters dated August 12 and August 26, 2013 [Reference 24] and [Reference 25] respectively. By letter dated December 11, 2013 [Reference 26], the NRC staff issued an Interim Staff Evaluation and RAI to the licensee.

By letters dated August 26, 2013 [Reference 25], February 27, 2014 [Reference 27], August 28, 2014 [Reference 28], February 26, 2015 [Reference 29], August 18, 2015 [Reference 30], and February 9, 2016 [Reference 31], the licensee submitted status reports for the Integrated Plan. The Integrated Plan describes the strategies and guidance to be implemented by the licensee for the installation of reliable SFP level instrumentation which will function following a BDBEE, including modifications necessary to support this implementation, pursuant to Order EA-12-051. By letter dated June 24, 2016 [Reference 33], the licensee reported that full compliance with the requirements of Order EA-12-051 was achieved.

The licensee has installed a SFP level instrumentation system designed by Westinghouse. The NRC staff reviewed the vendor's SFP level instrumentation system design specifications, calculations and analyses, test plans, and test reports. The staff issued an audit report on August 18, 2014 [Reference 32].

The staff performed an onsite audit to review the implementation of SFP level instrumentation related to Order EA-12-051. The scope of the audit included verification of (a) site's seismic and environmental conditions enveloped by the equipment qualifications, (b) equipment installation met the requirements and vendor's recommendations, and (c) program features met the requirements. By letter February 8, 2016 [Reference 17], the NRC issued an audit report on the licensee's progress. Refer to Section 2.2 above for the regulatory background for this section.

4.1 Levels of Required Monitoring

In a letter dated February 27, 2014, the licensee stated that Level 1, the level that is adequate to support operation on the normal fuel pool cooling system, is defined in NEI 12-02 as the higher of the following two points:

(1) The level at which reliable suction loss occurs due to uncovering of the coolant inlet pipe, weir or vacuum breaker (depending on the design) or

(2) The level at which the water height, assuming saturated conditions, above the centerline of the cooling pump suction provides the required net positive suction head (NPSH) specified by the pump manufacturer or engineering analysis.

Level 1 for DBNPS is designated to be elevation (El.) 597 feet (ft.) (19 ft. 2 inch (in.) above the top of the fuel racks). Once the water level drops below El. 597 ft., water will no longer be extracted from the pool to be sent to the SFP cooling equipment to provide heat removal from the SFP. At this level, the coolant inlet pipe is uncovered. This level is also above the level required to provide NPSH to SFP pumps at El. 585 ft.

In its OIP, the licensee also stated that the Level 2 is the indicated level on either primary or backup instrument channel greater than 587 ft. 8 in. plus the accuracy of the SFP level instrument channel. The Level 3 is the indicated level on either the primary or backup instrument channel greater than 577 ft. 8 in. (which is the top of the highest point on the spent fuel racks). In its compliance letter dated June 24, 2016 [Reference 33], the licensee stated that more refined measurements were obtained for the top of fuel rack and bottom of measurement range. The licensee also provided an updated sketch. In this sketch, the revised Level 2 is 588 ft. 6 in. which is 10 ft. (+/- 1 foot) above the top of fuel rack (El. 578 ft. 8-9/16 in.). The Level 3 is revised to 579 ft. 2-9/16 in. which is 6 in. above the top of the fuel rack.

The NRC staff found the licensee selection of the SFP measurement level adequate based on the following:

- Level 1 is the level at which reliable suction loss occurs due to uncovering of the coolant inlet pipe. The designated Level 1 would allow the licensee to identify a level in the SFP adequate to support operation of the normal SFP cooling system and represents the higher of the options described in NEI 12-02.

- Level 2 meets the first option described in NEI 12-02 for Level 2, which is 10 ft. (+/- 1 ft.) above the highest point of any fuel rack seated in the SFPs. The designed Level 2 represents the range of water level where any necessary operations in the vicinity of the SFP can be completed without significant dose consequences from direct gamma radiation from the SFP consistent with NEI 12-02.

- Level 3 is 6 in. above the highest point of any fuel storage rack seated in the SFP. This level allows the licensee to initiate water make-up with no delay meeting the NEI 12-02 specifications of the highest point of the fuel racks seated in the SFP. Meeting the NEI 12-02 specifications of the highest point of the fuel racks conservatively meets the Order EA-12-051 requirement of a level where the fuel remains covered.

Based on the evaluation above, the NRC staff finds that the licensee's proposed Levels 1, 2 and 3 appear to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2 Evaluation of Design Features

Order EA-12-051 required that the SFP level instrumentation shall include specific design features, including specifications on the instruments, arrangement, mounting, qualification, independence, power supplies, accuracy, testing, and display. Refer to Section 2.2 above for the requirements of the order in regards to the design features. Below is the staff's assessment of the design features of the SFP level instrumentation.

4.2.1 Design Features: Instruments

In its OIP, the licensee stated that the instrumentation will consist of permanent, fixed primary and backup instrument channels and that the measured range will be continuous from the top of the SFP to the fop of the spent fuel racks. In the compliance letter dated June 24, 2016 [Reference 33], the licensee provided an updated sketch. In this sketch, the measurement range (22 ft. 7.5 in.) is continuous from the normal pool level elevation of 601 ft. 9-1/8 in. to El. 579 ft. 1-5/8 in.

The NRC staff noted that the specified measurement range will cover Level 1, 2, and 3 as described in Section 4.1 above.

Based on the evaluation above, the NRC staff finds that the licensee's design, with respect to the number of channels and measurement range for its SFP, appears to be consistent with NEI 12-02 guidance as endorsed by JLD-ISG-2012-03 and should adequately address the requirements of the order.

4.2.2 Design Features: Arrangement

In the compliance letter dated June 24, 2016 [Reference 33], the licensee stated that the final location of the backup level sensor is on the south deck of the southwest corner of the SFP. The licensee also provided a sketch depicting the revised location of the backup sensor.

The staff noted, and verified during the walkdown, that there is sufficient channel separation within the SFP area between the primary and back-up level instruments, sensor electronics, and routing cables to provide reasonable protection against loss of indication of SFP level due to missiles that may result from damage to the structure over the SFP. The staff finds that the arrangements of SFP Level Instrumentation (SFPLI) channels at DBNPS appears to be consistent with those recommendation in NEI 12-02.

Based on the evaluation above, the NRC staff finds that, if implemented appropriately, the licensee's proposed arrangement for the SFP level instrumentation appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03 and should adequately address the requirements of the order.

4.2.3 Design Features: Mounting

In its letter dated June 24, 2016 [Reference 33], the licensee stated in part that:

> The attachment of the seismically qualified bracket to the pool deck will be through permanently installed anchors. With permanently installed anchors, the bracket pedestal will be secured to the poolside deck with adequate washers and bolts.
>
> The parameters used and analytical results are contained in Westinghouse calculation CN-PEUS-13-25, Revision 1, Seismic Analysis of the SFP Mounting Bracket at Davis-Besse and Beaver Valley Nuclear Stations. The results are obtained from the GTSTRUDL model and are in accordance with sire design requirements and [American Institute of Steel Construction] 7th Edition. Considering all of the loads and load combinations, all members of the bracket are acceptable. All welds and bolts are acceptable when compared to their applicable allowable values. The results of the analysis represent all of the applied loads and load combinations that were applied. The GTSTRUDL model and output considers self-weight, dead load of the instrumentation, hydrodynamic effects of the SFP water, and seismic load on the bracket. All members passed code check with interaction ratios below the allowable limit using the applicable requirements per AISC 7th Edition.
>
> Calculations are C-CSS-070.01-007, SFPLI Enclosure and Transmitter Mounting, and C-CSS-070.01-008, SFPLI Sensor Mounting. The vendor technical manual is M-024-00030, Davis-Besse Spent Fuel Pool Level Instrumentation. These documents demonstrate that the design for the mounting of electronic components and conduits was completed in accordance with the endorsed guidance in Institute of Electrical and Electronics Engineers, Inc. (IEEE) Standard 344-2004, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations."
>
> Because Beaver Valley Power Station and Davis-Besse Nuclear Power Station (DBNPS) share a bracket design and because DBNPS has a larger pool, the sloshing analysis performed in CN-PEUS-13-25 is bounded by DBNPS. The site specific seismic analysis of the DBNPS pool-side bracket documented in CN-PEUS-13-25, Section 4.8, shows that the height of the wave due to sloshing is

2.65 feet maximum, which is lower than the 5 feet considered in the generic analysis performed by Westinghouse (LTR-SEE-II-13-47). Therefore, the evaluation performed in LTR-SEE-II-13-47 remains bounding. The DBNPS specific distance from the nominal water level to the bracket is approximately 15.125 inches, which is greater than the 12 inches used in LTR-SEE-II-13-47. However, the freeboard assumed in the analysis for CN-PEUS-13-25 was approximately 15 inches. In Engineering Evaluation Request 601009784, FENOC engineering personnel have assessed the DBNPS specific parameters by estimating the change in postulated hydrodynamic load on the level sensor combined with the design loads resulting in an estimated maximum anchor tension of 531 pounds. Review of the postulated load has confirmed that it remains within the allowable limits for the 3/8 inch anchors, affirming the general conclusions of LTR-SEE-II-13-047 that the resulting loads on the level sensor probe will not result in probe ejection or potential impact of the instrument on the side walls.

During the onsite audit, the NRC staff reviewed the mounting specifications and seismic analyses for the SFPLI, including the methodology and design criteria used to estimate the total loading on the mounting devices. The staff also reviewed the design inputs and the methodology used to qualify the structural integrity of the affected structures for each of the SFPLI mounting attachments. Based on the review, the staff found that the criteria established by the licensee adequately account for the appropriate structural loading conditions, including seismic and hydrodynamic loads.

Based on the evaluation above, the NRC staff finds that the licensee's proposed mounting design appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.4 Design Features: Qualification

4.2.4.1 Augmented Quality Process

Appendix A-1 of the guidance in NEI 12 02 describes a quality assurance process for non-safety systems and equipment that are not already covered by existing quality assurance requirements. In JLD-ISG-2012-03, the NRC staff found the use of this quality assurance process to be an acceptable means of meeting the augmented quality requirements of Order EA 12 051.

By letter dated February 27, 2013 [Reference 22], the licensee stated that instrument channel reliability shall be established by use of an augmented quality assurance process similar to that described in NEI 12-02.

The NRC staff finds that, if implemented appropriately, this approach appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order

4.2.4.2 Instrument Channel Reliability

Section 3.4 of NEI 12-02 states, in part:

> The instrument channel reliability shall be demonstrated via an appropriate combination of design, analyses, operating experience, and/or testing of channel components for the following sets of parameters, as described in the paragraphs below:
>
> - conditions in the area of instrument channel component use for all instrument components,
> - effects of shock and vibration on instrument channel components used during any applicable event for only installed components, and
> - seismic effects on instrument channel components used during and following a potential seismic event for only installed components.

Equipment reliability performance testing was performed to (1) demonstrate that the SFP instrumentation will not experience failures during BDB conditions of temperature, humidity, emissions, surge, and radiation, and (2) to verify those tests envelope the plant-specific requirements.

The NRC staff reviewed the Westinghouse SFP level instrumentation's qualification and testing during the vendor audit for temperature, humidity, radiation, shock and vibration, and seismic [Reference 32]. The staff further reviewed the anticipated DBNPS's environmental conditions during the onsite audit [Reference 17].

The NRC staff performed an audit at Westinghouse facility for shock, vibration, and seismic testing of the electronic enclosure and transmitter and found them acceptable. The staff issued an audit report on August 18, 2014 [Reference 32]. During the onsite audit at DBNPS, the staff reviewed Calculations 57.001, "Extent of Temperature Rise in Essential Areas Loss of Ventilation," Rev. 0, and C-NSA-070.01-005, "Spent fuel Pool Instrumentation Dose Calculation," Rev. 0. The staff verified that the environment qualification of SFPLI components are bounded by those in Westinghouse test reports.

During the onsite audit, the NRC staff inquired about an assessment of potential susceptibilities of Electromagnetic Interferences (EMI) and Radio-Frequency Interference (RFI) in the areas where the SFP instruments are located and how to mitigate those susceptibilities. The licensee responded that the SFP Level Instrumentation system utilizes a tracer wire running along the coaxial cable from the bracket to the transmitter for both the primary and backup systems. Conduit is also used within the Fuel Handling Building as an added protection measure per Westinghouse, the tracer wire was a solution if no conduit was being used. Therefore, the cables are still protected once they leave the conduit to then travel in cable trays.

The licensee also stated that additional testing was performed at the factory acceptance test where portable radios were used in the vicinity of the equipment (transmitter, electronics enclosure, and probe). This testing determined that there was no impact to the equipment further than 10 feet away and that the signal always returned to normal after the radio transmission ended. The licensee also stated that an exclusion zone will be established around the SFP level probes and that signs will be posted in the SFP building prohibiting the use of

radios within 10 feet of the equipment. The transmitter and electronics displays are already within an exclusion zone and there are no large motors within the vicinity of the probes, transmitters or electronics enclosures.

The staff finds that the licensee has provided an ássessment of potential susceptibilities of EMF/RFI where the SFP instruments are located and will post signs and create exclusion zones where this system is susceptible to EMI/RFI.

Based on the evaluation above, the NRC staff finds that the licensee's proposed instrument qualification process appears to be with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately addresses the requirements of the order.

4.2.5 Design Features: Independence

In its letter dated February 27, 2014 [Reference 27], the licensee stated, in part, that:

> Power sources will be routed to the electronics enclosures from electrically separated sources ensuring the loss of one train or bus will not disable both channels;
>
> and,
>
> Primary and backup systems will be completely independent of each other, having no shared components.

During the onsite audit, the NRC staff reviewed Engineered Change Package (ECP) 13-0596-001, Rev. 1, "Spent Fuel Pool Level Indication – Supplement 001" and verified the layout of SFPLI during the walked down. The staff found that the licensee has adequately addressed the instrument channel independence, including the power sources. With the licensee's proposed power arrangement, the electrical functional performance of each level measurement channel would be considered independent of the other channel, and the loss of one power supply would not affect the operation of other independent channel under BDBEE conditions. The instrument channel physical separation is discussed in Section 4.2.2 of this SE.

Based on the evaluation above, the NRC staff finds that the licensee's proposed design, with respect to instrument channel independence, appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.6 Design Features: Power Supplies

In its letter dated February 27, 2014 [Reference 27], the licensee stated that:

> Each instrument channel is normally powered by non-class 1E 120 volts alternating current (VAC) distribution panels to support continuous monitoring of the SFP level. The 120VAC distribution panels for the primary and backup channels at each unit are powered by different 480V buses. Therefore, the loss of any one 480V bus will not result in the failure of both instrument channels.

> On loss of normal 120 VAC power, each channel's uninterruptible power supply (UPS) automatically transfers to a dedicated backup battery. If normal power is restored, then the channel will automatically transfer back to the normal alternating current (AC) power.

In its letter dated June 24, 2016 [Reference 33], the licensee stated that:

> The back-up battery is designed to last a minimum of 72 hours. The vendor's calculation has determined that the battery should last from a full charge for greater than 100 hours per Section 5.2.1 of Westinghouse calculation WNA-CN-00300-GEN, Revision 0, Spent Fuel Pool Instrumentation System Power Consumption.

During the onsite audit, the NRC staff reviewed drawings E4 Sheet 4, "480 V Unit Sub Station Lighting Distribution One Line Diagram," Revision 52, and E-6 Sheet 2, "480 VAC One Line Diagram," Revision 97. The staff verified that the ac power sources for the primary and backup channels are fed from independent ac sources such that loss of one source will not result in loss of power for both channels. The staff performed an audit at Westinghouse facility and finds that the 72 hours of battery duty cycle is acceptable and meets the recommended 3 days for backup battery in NEI 12-02.

Based on the evaluation above, the NRC staff finds that the licensee's proposed power supply design appears to be consistent with NEI 12-02 guidance as endorsed by JLD-ISG-2012-03 and should adequately address the requirements of the order.

4.2.7 Design Features: Accuracy

In its compliance letter dated June 24, 2016 [Reference 33], the licensee stated that:

> The design accuracy is 3 inches or less for both normal and BDB conditions. Westinghouse calculation WNA-CN-00301-GEN provides the channel accuracy of a wired system with a standard measurement span of 296 inches. The calculated accuracy of the standard system is 0.54 percent of span or 1.60 inches. The cable probe length for DBNPS is 287.5 inches, which is less than the assumed value in WNA-CN-00301 -GEN; therefore, the calculated accuracy of 0.54 percent of span or 1.60 inches is bounding for DBNPS and within the design range.

The NRC staff finds that the channel design accuracy of +/- 3 inches under normal and BDB conditions is consistent with the accuracy as specified in Westinghouse specifications. The channel accuracy of +/-3 inches is more conservative than the 1 ft. accuracy recommended in NEI 12-02. The channel design accuracy will be used in channel calibration procedures to flag operators and/or technicians that the channel requires adjustment to within the normal condition design accuracy.

Based on the evaluation above, the NRC staff finds that the licensee's proposed instrument accuracy appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.8 Design Features: Testing

In Attachment 2 of the compliance letter dated June 24, 2016 [Reference 33], the licensee described the SPLI periodic testing and calibration. The NRC staff reviewed this information and noted that by comparing the levels in the instrument channels and the maximum level allowed deviation, the operators could determine if recalibration or troubleshooting is needed. The staff also noted that the licensee's proposed design has the ability to be tested and calibrated in-situ, consistent with the provision of NEI 12-02.

Based on the evaluation above, the NRC staff finds that the licensee's proposed SFP instrumentation design allows for testing consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.9 Design Features: Display

In its OIP [Reference 22], the licensee stated that the SFPLI will provide for display of SFP level using an indicator located in the main control room.

The staff noted that the NEI guidance for "Display" specifically mentions the main control room as an acceptable location for SFPLI displays as it is occupied or promptly accessible, outside the area surrounding the SFP, inside a structure providing protection against adverse weather and outside of any very high radiation areas or locked high rad area during normal operation.

Based on the evaluation above, the NRC staff finds that the licensee's proposed location and design of the SFP instrumentation displays appear to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.3 Evaluation of Programmatic Controls

Order EA-12-051 specified that the spent fuel pool instrumentation shall be maintained available and reliable through appropriate development and implementation programmatic controls, including training, procedures, and testing and calibration. Below is the NRC staff's assessment of the programmatic controls for the spent fuel pool instrumentation.

4.3.1 Programmatic Controls: Training

In its OIP, the licensee stated that:

> The System Approach to Training [SAT] will be utilized when developing and implementing training. Training for maintenance and operation personnel will be developed and provided. Training will be provided for the personnel in the use of alternate power to primary and backup instrument channels in compliance with the NRC Order EA-12-051 Attachment 2, Section 2.1.

Guidance document NEI 12-02 specifies that the SAT process can be used to identify the population to be trained, and also to determine both the initial and continuing elements of the required training. Based on the licensee's OIP statement above, the NRC staff finds that the licensee's plan to train personnel in the operation, maintenance, calibration, and surveillance of

the SFP level instrumentation, including the approach to identify the population to be trained, appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.3.2 Programmatic Controls: Procedures

In its letter dated June 24, 2016 [Reference 33], the licensee stated that:

> The modification review process will be used to ensure all necessary procedures are developed for maintaining and operating the spent fuel level instruments upon installation. These procedures will be developed in accordance with the FENOC procedural control process.
>
> The objectives of each procedural area are described below:
>
> Inspection Calibration and Testing - Guidance on the performance of periodic visual inspections, as well as calibration and testing, to ensure that each SFP channel is operating and indicating level within its design accuracy.
>
> Preventative Maintenance - Guidance on scheduling of, and performing, appropriate preventative maintenance activities necessary to maintain the instruments in a reliable condition.
>
> Maintenance - To specify troubleshooting and repair activities necessary to address system malfunctions.
>
> Programmatic controls - Guidance on actions to be taken if one or more channels is out of service.
>
> System Operations - To provide instructions for operation and use of the system by plant staff.
>
> Response to inadequate levels - Action to be taken on observations of levels below normal level will be addressed in site off normal procedures and/or FLEX [Diverse and Flexible Coping Strategies] Support Guidelines (FSGs).
>
> The following procedures have been identified:
>
> - DB-MI-05340, Calibration of Fuel Pool Level Transmitter Model ABB/K-TEK MT5000
> - DB-OP-02547, Spent Fuel Pool Cooling Malfunctions
> - DB-OP-02600, Operational Contingency Response Action Plan
> - DB-OP-06021, Spent Fuel Pool Operating Procedure

During the onsite audit, the NRC staff reviewed a sample of procedures and noted that they were developed using the guidelines and vendor instructions to address the testing, calibration, maintenance, operation and abnormal response, in accordance with the provisions of NEI 12-

02. The NRC staff finds that the licensee's procedure development appears to be consistent with NEI 12-02 guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.4 Conclusions for Order EA-12-051

In its letter dated June 24, 2016 [Reference 33], the licensee stated that they would meet the requirements of Order EA-12-051 by following the guidelines of NEI 12-02, as endorsed by JLD-ISG-2012-03. In the evaluation above, the NRC staff finds that, if implemented appropriately, the licensee has conformed to the guidance in NEI 12-02, as endorsed by JLD-ISG-2012-03. In addition, the NRC staff concludes that if the SFP level instrumentation is installed at DBNPS according to the licensee's proposed design, it should adequately address the requirements of Order EA-12-051.

5.0 CONCLUSION

In August 2013 the NRC staff started audits of the licensee's progress on Orders EA-12-049 and EA-12-051. The staff conducted an onsite audit in November 2015 [Reference 17]. The licensee reached its final compliance date on August 2, 2017, and has declared that the DBNPS reactor is in compliance with the orders. The purpose of this safety evaluation is to document the strategies and implementation features that the licensee has committed to. Based on the evaluations above, the NRC staff concludes that the licensee has developed guidance and proposed designs that, if implemented appropriately ,should adequately address the requirements of Orders EA-12-049 and EA-12-051. The NRC staff will conduct an onsite inspection to verify that the licensee has implemented the strategies and equipment to demonstrate compliance with the orders.

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Date: January 31. 2017

DAVIS-BESSE NUCLEAR POWER STATION, UNIT NO. 1 – SAFETY EVALUATION REGARDING IMPLEMENTATION OF MITIGATING STRATEGIES AND RELIABLE SPENT FUEL POOL INSTRUMENTATION RELATED TO ORDERS EA-12-051 AND EA-12-049 DATED January 31, 2017

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