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

December 14, 2016

Mr. Ken J. Peters
Senior Vice President and Chief
Nuclear Officer
Attention: Regulatory Affairs
TEX Operations Company, LLC
P.O. Box 1002
Glen Rose, TX 76043

SUBJECT: COMANCHE PEAK NUCLEAR POWER PLANT, UNITS 1 AND 2 – SAFETY EVALUATION REGARDING IMPLEMENTATION OF MITIGATING STRATEGIES AND RELIABLE SPENT FUEL POOL INSTRUMENTATION RELATED TO ORDERS EA-12-049 AND EA-12-051 (CAC NOS. MF0860, MF0861, MF0862, AND MF0863)

Dear Mr. Peters:

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued Order EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design-Basis External Events" and Order EA-12-051, "Issuance of 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 28, 2013 (ADAMS Accession No. ML13071A617), submitted by Luminant Generation Company, LLC (now TEX Operations Company LLC, the licensee) submitted its OIP for Comanche Peak Nuclear Power Plant (Comanche Peak), Units 1 and 2 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 enclosed safety evaluation. By letter dated August 28, 2013 (ADAMS Accession No. ML13234A503), the NRC notified all operating power licensees and construction permit holders that the NRC 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 December 19, 2013 (ADAMS Accession No. ML13225A575), and August 5, 2015 (ADAMS Accession No. ML15180A261), the NRC issued an Interim Staff Evaluation (ISE) and audit report, respectively, on the licensee's progress. By letter dated July 28, 2016 (ADAMS Accession No. ML16214A251), the licensee submitted a compliance letter and Final Integrated Plan 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 28, 2013 (ADAMS Accession No. ML13071A344), the licensee submitted its OIP for Comanche Peak 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 enclosed safety evaluation. By letters dated November 4, 2013 (ADAMS Accession No. ML13295A674), and August 5, 2015 (ADAMS Accession No. ML15180A261), 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 December 16, 2014 (ADAMS Accession No. ML15016A188), the licensee 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 the licensee's strategies for Comanche Peak. The intent of the safety evaluation is to inform the licensee 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 NRC staff will evaluate implementation of the plans through inspection, using Temporary Instruction 2515/191, "Inspection of the Implementation of Mitigation Strategies and Spent Fuel Pool Instrumentation Orders and Emergency Preparedness Communications/Staffing/ Multi-Unit Dose Assessment Plans, Revision 1" (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 Stephen Monarque, Orders Management Branch, Comanche Peak Project Manager, at 301-415-1544 or at Stephen.Monarque@nrc.gov.

Sincerely,

Mandy K Halter

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

Docket Nos.: 50-445 and 50-446

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

TEX OPERATIONS COMPANY LLC

COMANCHE PEAK NUCLEAR POWER PLANT, UNITS 1 AND 2

DOCKET NOS. 50-445 AND 50-446

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, "Issuance of Order to Modify 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, "Issuance of Order to Modify 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 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 and install enhanced SFP instrumentation. 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 alternating current (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.

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

On August 21, 2012, following several submittals and discussions in public meetings with NRC staff, the Nuclear Energy Institute (NEI) submitted document NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0 [Reference 6] to the NRC to provide specifications for an industry-developed methodology for the development, implementation, and maintenance of guidance and strategies in response to the Order EA-12-049. The NRC staff reviewed NEI 12-06 [Reference 6] and on August 29, 2012, issued its final version of Japan Lessons-Learned Directorate (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" [Reference 7], endorsing NEI 12-06, Revision 0, with clarification, as an acceptable means of meeting the requirements of Order EA-12-049. On September 7, 2012, the NRC staff published a notice of the availability of JLD-ISG-2012-01 in the *Federal Register* (77 FR 55230).

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.
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> 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," Revision 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, Revision 1 [Reference 8], 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 TECHNICAL EVALUATION OF ORDER EA-12-049

By letter dated February 28, 2013 [Reference 10], submitted by Luminant Generating Company, LLC (now TEX Operations Company LLC (TEX OpCo), the licensee) submitted an Overall Integrated Plan (OIP) for Comanche Peak Nuclear Power Plant (Comanche Peak, CPNPP), Units 1 and 2 in response to Order EA-12-049. By letters dated August 28, 2013 [Reference 11], February 27, 2014 [Reference 12], August 28, 2014 [Reference 13], February 26, 2015 [Reference 14], August 27, 2015 [Reference 43], and February 24, 2016 [Reference 44], the licensee submitted six-month updates to the OIP. By letter dated August 28, 2013 [Reference 15], the NRC notified all operating power 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 31]. By letters dated December 19, 2013 [Reference 16] and August 5, 2015 [Reference 17], the NRC issued an Interim Staff Evaluation (ISE) and an audit report on the licensee's progress. By letter dated July 28, 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 Overall Mitigation Strategy

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 ultimate heat sink (LUHS). Thus, the ELAP with the LUHS is used as a surrogate for a BDBEE. The initial conditions and assumptions for the analyses are stated in NEI 12-06 [Reference 6], 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.

Comanche Peak is a Westinghouse pressurized-water reactor (PWR) with a dry ambient pressure containment. The FIP describes the licensee's three-phase approach to mitigate a postulated ELAP event.

As a result of an ELAP, the operators initiate reactor and turbine trip and isolate the reactor coolant system (RCS) to prevent inventory loss. The reactor coolant pumps (RCPs) coast down and flow in the RCS transitions to natural circulation. The licensee's cooling strategy involves a rapid cooldown and depressurization of the RCS by using the steam generators (SGs) atmospheric relief valves (ARVs). Decay heat is removed from the SGs through the ARVs. The SG ARVs can be operated from the control room and then locally, after the air supply from the accumulators is depleted. The condensate storage tank (CST) is the initial water source to the (TDAFW) pump. The SGs would be depressurized in a controlled manner to about 310 pounds per square inch gage (psig) and then maintained at this pressure while the operators borate the RCS. The licensee plans to complete this cooldown within 4 hours of the start of the event. The reduction in RCS temperature will result in inventory contraction in the RCS, with the result that the pressurizer would drain and a steam void would form in the reactor vessel upper head. The RCS leakage, particularly from the RCP seals, would also contribute to the decrease in RCS liquid volume. However, during the cooldown, RCS pressure should drop below the safety injection accumulator pressure and the injection of some quantity of borated water into the RCS from the accumulators would then occur.

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 its FIP, by approximately 72 hours into the event, the licensee expects to use FLEX equipment from offsite response centers. Prior to undertaking the additional cooling and depressurization of the RCS, operators would need to perform a number of supporting actions including injecting additional boric acid into the RCS to avoid the potential for recriticality and venting the accumulators using electrical power from FLEX generators to avoid the potential for injecting the nitrogen cover gas into the RCS.

Upon loss of all ac power, operators will complete an initial dc bus load stripping within 2 hours following the event. Once ELAP is declared operators perform a second dc bus load stripping within 5 hours following the event to ensure safety-related battery life is extended up to 12 hours. Following dc load stripping and prior to battery depletion, one 500-kilowatt (kW), 480 volt alternating current (Vac) generator will be deployed from the FLEX equipment storage building (FESB). The portable generators will be used to repower essential battery chargers within 12 hours of ELAP initiation.

The RCS makeup and boration will be initiated within 14 hours of the ELAP to ensure that natural circulation, reactivity control, and boron mixing is maintained in the RCS. Operators will provide reactor coolant makeup using portable FLEX high-pressure electric driven pumps, one per unit, to deliver water drawn initially from the boric acid storage tanks (BATs). After the BATs are depleted borated makeup water will be drawn from the refueling water storage tank (RWST). There is one RWST for each unit.

The water supply for the TDAFW pump is initially from the CST. The CST will provide approximately 16 hours of RCS decay heat removal, in addition to absorbing the latent heat associated with the planned RCS cooldown. Prior to emptying the CST the operators will cross tie the CST and the reactor makeup water storage tank (RMWST) thereby drawing simultaneously on both tanks for injecting makeup water into the SGs. Upon depletion of the RMWST, the operators will place in service a FLEX pump to refill the CST from the safe shutdown impoundment. Approximately 72 hours after the event, a mobile water purification unit from the National Strategic Alliance of FLEX Emergency Response (SAFER) Response Center (NSRC) will be available.

There are two connected SFPs housed in the fuel building (FB). Upon initiation of the ELAP event, the SFP will heat up due to the unavailability of the normal cooling system. The licensee has calculated that boiling could start as soon as 4 hours after the start of the event and that it would take approximately 16 hours for SFP water level to drop to a level 15 feet (') above the fuel storage racks. Makeup water would be provided using a diesel-driven FLEX pump with suction from the RWST and discharging through an overhead spray header to add water to the SFPs. Ventilation of the generated steam is accomplished by opening doors at various elevations, thus establishing a natural draft vent path.

For Phases 1 and 2, the licensee's calculations demonstrate that no actions are required to maintain containment pressure below design limits. During Phase 3, containment cooling and depressurization would be accomplished by restoring the containment ventilation chiller and the containment air cooling and recirculation system (CACRS) fans (on each unit) at 72 hours post-ELAP. Service water for cooling is supplied by an NSRC FLEX pump. The containment cooling fan would be powered by two 4160 Vac DG (one per unit) 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 guidance in NEI 12-06, Revision 0, [Reference 6].

3.2 Reactor Core Cooling Strategies

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 [Reference 6], Phase 1 of the licensee's core cooling strategy credits installed equipment (other than that presumed lost to the ELAP and LUHS) that is considered robust in accordance with the guidance in NEI 12-06 [Reference 6]. In Phase 2, robust installed equipment is supplemented by onsite FLEX equipment, which is used to cool the core either directly (e.g., with pumps and hoses) or indirectly (e.g., through the use of 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. 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 and LUHS event presumes that, as described in the guidance from NEI 12-06 [Reference 6], both units 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 and LUHS 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 and LUHS 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

As stated in the FIP [Reference 18], the heat sink for core cooling in Phase 1 is provided by the four SGs, which are fed simultaneously by the unit's TDAFW pump with inventory supplied from the CST, which is robust for all applicable hazards. The licensee calculated that the CST water volume of 269,700 gallons is sufficient to remove residual heat from the reactor for approximately 16 hours and to depressurize the system to 310 psig SG pressure. Prior to the depletion of the water in the CST, operators will crosstie the CST to the RMWST. The RMWST water volume of 73,900 gallons is sufficient to remove reactor decay heat for an additional 8 hours.

Following closure of the main steam isolation valves, steam release from the SGs to the atmosphere would be accomplished via the main steam safety valves or the SG ARVs. The SG ARVs would typically be operated by the instrument air system, which is expected to be lost following the ELAP. Following the loss of the instrument air system, air will continue to be supplied to the ARVs by local instrument air accumulators. The air accumulators are sized to last for four hours allowing for operation of the SG ARVs from the control room during the cooldown. The FIP states that after this means of ARV operation is lost, the RCS can be cooled through local manual operation of isolation valves upstream of the individual ARVs.

The licensee's Phase 1 strategy directs operators to complete a cooldown and depressurization of the RCS within 4 hours of the initiation of the ELAP and LUHS event. Over a period of approximately 3 hours, Comanche Peak will gradually cool down the RCS from post-trip conditions until achieving a SG pressure of 310 psig. A minimum SG pressure of 310 psig is set to avoid the injection of nitrogen gas from the safety injection accumulators into the RCS. The cooldown and depressurization of the RCS significantly extends the expected coping time under ELAP and LUHS conditions because it (1) reduces the potential for damage to RCP seals and

(2) allows coolant stored in the nitrogen-pressurized accumulators to inject into the RCS to offset system leakage and add negative reactivity.

3.2.1.1.2 Phase 2

In its FIP, the licensee states that the primary strategy for core cooling in Phase 2 would be to continue using the SGs as a heat sink, with SG secondary inventory being supplied by the TDAFW pump. Although functionality of the TDAFW pump is expected throughout Phase 2 as described in NEI 12-06 [Reference 6], the licensee will pre-stage a portable SG/AFW low pressure FLEX pump capable of backing up this essential function.

According to the licensee's calculations, the CST and RMWST together are capable of supplying SG makeup for approximately 24 hours. To provide an indefinite source of secondary makeup in Phase 2, the licensee stated that a multi purpose high flow FLEX pump would be deployed at the safe shutdown impoundment (SSI). This pump would draw suction from the SSI and refill the CST via hoses routed to the CST FLEX makeup connection in the CST valve room. The licensee has evaluated SSI water chemistry and calculated that raw water from the SSI could be used for 48 hours followed by the use of purified water from the SSI for another 216 hours prior to reaching SG corrosion and precipitate limits. Although exceeding these limits could affect SG performance, it would have an insignificant effect on the ability of the SGs to remove decay heat and maintain the RCS at the reduced temperature and pressure conditions.

The licensee's FIP states that its core cooling strategy for a seismic event is to rely initially on the TDAFW pump taking suction from the CST. However, in the unanticipated event that AFW flow from the TDAFW pump is interrupted early in the ELAP transient, a portable SG/AFW low pressure FLEX pump will be aligned at approximately 15 hours. The pumps are rated for 370 gallons per minute (gpm) at 1,021' total developed head (TDH). The pump can take suction from a connection located inside the CST valve room. The pump discharges to either a primary or secondary SG connection point. In the primary connection strategy, the SG/AFW low pressure FLEX pump discharges through a hose connected to a manifold. Four hoses are routed from the manifold to the individual AFW injection lines. In the alternate strategy, the SG/AFW low pressure FLEX pump discharges to a combination of hoses and installed piping to a connection point on the TDAFW pump discharge line.

3.2.1.1.3 Phase 3

According to its FIP, Comanche Peak's core cooling strategy for Phase 3 is a continuation of the Phase 2 strategy with additional offsite equipment and resources. The SGs will be supplied with purified water from the NSRC diesel powered mobile water treatment system. The NSRC provided pumps are capable of taking suction from the SSI and connecting to the FLEX connections to pump water into the SGs.

An NSRC supplied diesel powered air compressor will be used to restore instrument air in containment. Following the restoration of instrument air, the licensee will vent the nitrogen from the SI accumulators and initiate a second cooldown and depressurization to a target SG pressure of 170 psig. Comanche Peak will remain in this configuration until the restoration of power and does not have plans to align shutdown cooling.

3.2.1.2 RCS Makeup Strategy

3.2.1.2.1 Phase 1

Following the reactor trip at the start of the ELAP and LUHS event, operators will isolate RCS letdown pathways and confirm the existence of natural circulation flow in the RCS. A small amount of RCS leakage will occur through the low-leakage RCP seals, but its overall impact on the RCS behavior will be minor. Although the RCS cooldown planned for completion prior to 4 hours into the event would be expected to drain the pressurizer and create a vapor void in the upper head of the reactor vessel, ample RCS volume should remain to support natural circulation flow throughout Phase 1. Likewise, there is no need to initiate boration during this period, since the reactor operating history assumed in the guidance described in NEI 12-06 [Reference 6] implies that a substantial concentration of xenon-135 would be present in the reactor core. Nevertheless, as operators depressurize the RCS, some fraction of the borated inventory from the nitrogen-pressurized accumulators would be expected to passively inject. The licensee does not plan further SG depressurization until a Phase 3 air compressor is used to restore instrument air in containment and the SI accumulator nitrogen has been vented.

3.2.1.2.2 Phase 2

In Phase 2, RCS boration is accomplished using a portable electric pump stored in the FLEX equipment storage building. In the course of cooling and depressurizing the SGs to a target pressure of 310 psig, a significant fraction of the accumulator liquid inventory may inject into the RCS, filling volume vacated by the thermally induced contraction of RCS coolant and system leakage. However, crediting boration from the accumulators is challenging because actual RCS leakage may be quite small, and furthermore, dependent upon the rate of heat loss from the RCS (i.e., particularly from the reactor vessel upper head), RCS pressure may remain several hundred psi above the SG target pressure for multiple hours into the event. Thus, in order to ensure long-term subcriticality as positive reactivity is added from the RCS cooldown and xenon decay, RCS boration will commence using a portable high-pressure FLEX pump no later than 14 hours into the ELAP and LUHS event. With low-leakage Westinghouse Generation 3 SHIELD RCP seals installed on all RCPs, the licensee calculates that FLEX RCS makeup is not necessary to prevent the onset of reflux cooling for at least several days into the event. Therefore, the injection of borated RCS makeup water for reactivity control will be in progress long before entry into reflux cooling becomes a concern.

The primary method of boration and inventory control in Phase 2 is a portable high-pressure RCS injection FLEX pump with a capacity of 10 gpm at 3,602' TDH. The pump will initially be aligned to take suction from the BAT and then from the RWST. The BAT contains 23,000 gallons of water at a boron concentration of at least 7,000 parts per million (ppm). The RWST contains 473,700 gallons at a boron concentration of 2,400-2,600 ppm. Both the BATs and the RWST are robust for all applicable hazards. The portable high-pressure RCS injection FLEX pump will discharge into the RCS through hoses connected to either a primary connection on the SI header or an alternate connection on the normal charging header.

3.2.1.2.3 Phase 3

The Phase 3 strategy for indefinite RCS inventory control and subcriticality is simply a continuation of the Phase 2 strategy, with backup pumps and water treatment equipment supplied by the NSRC. The licensee does not anticipate the need to provide additional borated water beyond that available in the BATs and the RWST until the restoration of permanent plant equipment. The borated water available should provide around a months' worth of injection and allow for the plant to restore permanent plant equipment or procure other means of creating borated water.

3.2.2 Variations to Core Cooling Strategy for Flooding Event

In its FIP, the licensee stated that the Comanche Peak elevation is above the maximum plant site flood level. The FLEX storage building and deployment path would not be adversely affected by the external flooding events. The licensee's core cooling and makeup strategy implementation remains the same for a flooding event. Refer to Section 3.5.2 of this safety evaluation (SE) for further discussion on flooding.

Therefore, there are no significant variations necessary to support the core cooling and RCS inventory strategies for a flooding event.

3.2.3 Staff Evaluations

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

The NEI 12-06 [Reference 6] guidance includes the assumption that other than LUHS, installed equipment that is 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

Section 2.3.4.9 of the FIP described the following structures to be used for storage and implementation of FLEX equipment and strategies respectively. The structures are described as Seismic Category I buildings, which are protected from all applicable external hazards. The following structures contain permanent or portable equipment and connections to be used for FLEX strategies: Unit 1 and 2 Containments, Fuel Building, Auxiliary Building and Unit 1 and 2 Safeguards Buildings.

Core Cooling

The licensee provided descriptions in its FIP [Reference 18] for the permanent plant SSCs to be used to support core cooling for Phase 1 and 2. The licensee indicated that there are two TDAFW pumps, one for each unit, which have two air-operated steam supply valves that can fail open and initiate the TDAFW due to loss of air supply or loss of electrical power. These steam supply valves can also be opened manually to start the TDAFW pump. The TDAFW pumps are located in TDAFW pump rooms, which are located in the Seismic Category I Auxiliary Building. The SG ARVs are used to assist in reactor core cooling and decay heat removal by manually opening or throttling with the air accumulators. The SG ARVs are safety-related, missile protected, seismically-qualified valves. The SG ARV controllers in the Control Room (CR) will be powered by the station batteries in Phase 1 and by the portable 480 Vac DGs in Phases 2 and 3. The operation of the SG ARVs from the Control Room will continue for about 4 hours until air supply from the respective air accumulators is depleted at which point operators will manually control the SG ARVs through the use of local manual isolation valves.

The licensee also described in its FIP [Reference 18], that there are two CSTs, one for each unit, which supply SG makeup water through the TDAFW pumps. The CSTs are protected from all applicable external hazards and each CST can contain around 269,700 gallons of usable water for SG makeup. The RMWSTs are used after the depletion of the CSTs and are also protected from all applicable external hazards. The minimum usable water for SG makeup is 73,900 gallons for each RMWST. The SSI is the UHS and provides approximately 284 acre-feet of raw water for CST makeup following depletion of the initial contents of the CST and RMWST. The SSI dam is protected from all applicable external hazards.

Based on the design and location of the protected water sources and the permanent plant SSCs as described in the FIP, the NRC 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 [Reference 6], Section 3.2.1.3.

RCS Inventory Control

In its FIP [Reference 18], the licensee provided the borated water sources available to support RCS makeup for Phase 2 and Phase 3. The BAT, one for each unit, provide borated water for RCS makeup strategy with the use of the High Pressure RCS Injection FLEX pump. The BATs are located inside the Auxiliary Building, which is a Seismic Category I building that is protected from all applicable external hazards. Each BAT has an available borated water volume of 23,000 gallons at a boron concentration of at least 7,000 ppm. The licensee also indicated in its FIP, that the RWST, one for each unit, would be available to provide borated water for RCS makeup after the BATs are used. One RWST is located at grade level just outside of the respective unit's Safeguards Building. The RWSTs are Seismic Category I tanks and are protected from all applicable external events. Each RWST has a borated water volume of greater than 473,700 gallons at a boron concentration between 2,400 and 2,600 ppm.

Based on the location and the availability of High Pressure RCS Injection FLEX pumps, the available borated water sources, and permanent plant SSCs to support RCS cooldown, the NRC 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 [Reference 6], Section 3.2.1.3.

3.2.3.1.2 <u>Plant Instrumentation</u>

According to the FIP [Reference 18], the following instrumentation will be relied upon to support the licensee's core cooling and RCS inventory control strategy. The following instruments are monitored from the control room and will be available throughout the event.

- SG level (narrow range)

- SG pressure
- RCS temperature (hot-leg and cold-leg)
- Reactor vessel level indicating system (RVLIS)
- AFW pump flow rate
- Core exit thermocouples
- CST level
- Pressurizer level
- Source range count rate

All of these instruments are powered by installed safety-related station batteries. To prevent a loss of vital instrumentation, operators will extend battery life to a minimum of 12 hours for Units 1 and 2 by shedding unnecessary loads. Initial load shedding will be completed within 2 hours and a second load shed is completed within 5 hours from the initiation of the ELAP event. A FLEX 480 Vac DG will be deployed to repower the battery chargers within 12 hours from the ELAP event initiation.

The FIP [Reference 18] states that, as recommended by Section 5.3.3 of NEI 12-06 [Reference 6], procedures have been developed to read the above instrumentation locally using portable instruments, where applicable. Guidance has been provided in FLEX Support Instruction (FSI) Procedure, FSI-7, "Loss of Vital Instrumentation or Control Power," [Reference 51]. This document provides guidance for obtaining alternate monitoring for the following parameters:

- SG level (narrow and wide range)
- SG pressure
- RCS temperature
- RCS pressure (wide range)
- RVLIS
- Core exit thermocouples
- CST level
- Pressurizer level
- AFW flow indication

Furthermore, as described in its FIP [Reference 18], the licensee stated that portable FLEX equipment credited in the licensee's mitigating strategies is supplied with the instrumentation necessary to support local equipment operation.

The instrumentation available to support the licensee's strategies for core cooling and RCS inventory during the ELAP event is consistent with the recommendations specified in the endorsed guidance of NEI 12-06 [Reference 6]. Based on the information provided by the licensee, the NRC staff understands that indication for the above instruments would be available and accessible continuously throughout the ELAP event.

3.2.3.2 <u>Thermal-Hydraulic Analyses</u>

In the FIP [Reference 18], the strategy for reactor core cooling is adequate based, in part, on a generic thermal-hydraulic analysis performed for a reference Westinghouse four-loop reactor using the NOTRUMP computer code. The NOTRUMP code and corresponding evaluation model were originally submitted in the early 1980s as a method for performing licensing-basis safety analyses of small-break loss-of-coolant accidents (LOCAs) for Westinghouse PWRs. Although NOTRUMP has been approved for performing small-break LOCA analysis under the conservative Appendix K paradigm and constitutes the current evaluation model of record for many operating PWRs, 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 NOTRUMP and other thermal-hydraulic codes used for these analyses. The NRC staff's review included performing confirmatory analyses with the TRACE code to obtain an independent assessment of the duration that reference reactor designs could cope with an ELAP event prior to providing makeup to the RCS.

Based on its review, the NRC staff questioned whether NOTRUMP 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. Due to the challenge of resolving these issues within the compliance schedule specified in Order EA-12-049, the NRC staff requested that industry provide makeup to the RCS prior to entering the reflux or boiler-condenser cooling phase of an ELAP, such that reliance on thermal-hydraulic code predictions during this phase of the event would not be necessary.

Accordingly, the ELAP coping time prior to providing makeup to the RCS is limited to the duration over which the flow in the RCS remains in natural circulation, prior to the point where continued inventory loss results in a transition to the reflux or boiler-condenser cooling mode. In particular, for PWRs with inverted U-tube SGs, the reflux cooling mode is said to exist when vapor boiled off from the reactor core flows out the saturated, stratified hot leg and condenses on SG tubes, with the majority of the condensate subsequently draining back into the reactor vessel in countercurrent fashion. Quantitatively, as reflected in documents such as the PWR Owners Group (PWROG) report PWROG-14064-P, Revision 0, "Application of NOTRUMP Code Results for Westinghouse Designed PWRs in Extended Loss of AC Power Circumstances," industry has proposed defining this coping time as the point at which the 1-hour centered time-average of the flow quality passing over the SG tubes' U-bend exceeds one-tenth (0.1). As discussed further in Section 3.2.3.4 of this evaluation, a second metric for ensuring adequate coping time is associated with maintaining sufficient natural circulation flow in the RCS to support adequate mixing of boric acid.

With specific regard to NOTRUMP, preliminary results from the NRC staff's independent confirmatory analysis performed with the TRACE code indicated that the coping time for Westinghouse PWRs under ELAP conditions could be shorter than predicted 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." Subsequently, a series of additional simulations performed by the NRC staff and Westinghouse identified that the discrepancy in predicted coping time could be attributed largely to differences in the modeling of RCP seal leakage. (The topic of RCP seal leakage will be discussed in greater detail in Section 3.2.3.3 of this SE.) These comparative simulations showed that when similar RCP seal leakage boundary conditions were applied, the coping time predictions of TRACE and NOTRUMP were in adequate agreement. From these simulations, as supplemented by review of key code models, the NRC staff obtained sufficient confidence that the NOTRUMP code may be used in conjunction with the WCAP-17601-P evaluation model for performing best-estimate simulations of ELAP coping time prior to reaching the reflux cooling mode.

Although the NRC staff obtained confidence that the NOTRUMP code is capable of performing best-estimate ELAP simulations prior to the initiation of reflux cooling using the one-tenth flow-quality criterion discussed above, the NRC staff was unable to conclude that the generic analysis performed in WCAP-17601-P could be directly applied to all Westinghouse PWRs, as the vendor originally intended. In PWROG-14064-P, Revision 0, the industry subsequently recognized that the generic analysis would need to be scaled to account for plant-specific variation in RCP seal leakage. However, the NRC staff's review, supported by sensitivity analysis performed with the TRACE code, further identified that plant-to-plant variation in additional parameters, such as RCS cooldown terminus, accumulator pressure and liquid fraction, and initial RCS mass, could also result in substantial differences between the generically predicted reference coping time and the actual coping time that would exist for specific plants.

During the audit, the NRC staff evaluated a comparison of the generic analysis values from WCAP-17601-P and PWROG-14064-P to the Comanche Peak plant-specific values. The NRC staff concurred that the generic plant parameters were bounding for the analyzed event. Comanche Peak has installed low-leakage SHIELD shutdown seals; therefore, the seal leakage expected for Comanche Peak is significantly less than assumed in the generic NOTRUMP analysis case. The NRC staff concluded based on the licensee evaluation, that the licensee could maintain natural circulation flow in the RCS for approximately 43.8 hours for single-phase flow, and at least 65.2 hours for two-phase flow during the ELAP event without RCS makeup. The RCS makeup will be initiated in accordance with the licensee's mitigating strategy for shutdown margin at approximately 14 hours following initiation of ELAP, thus, the licensee's strategy for RCS makeup provides sufficient margin to the onset of reflux cooling.

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 the 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, resulting in increased leakage and the potential for 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 discussed in its FIP [Reference 18], the licensee credits Generation 3 SHIELD low leakage seals for FLEX strategies including RCS inventory control and boration. The low leakage seals limit the total RCS leak rate to no more than 5 gpm (1 gpm per RCP seal and 1 gpm of unidentified RCS leakage in accordance with Technical Specifications).

The SHIELD low leakage seals are credited in the FLEX strategies in accordance with the four conditions identified in the NRC's endorsement letter of TR-FSE-14-1-P, "Use of Westinghouse SHIELD Passive Shutdown Seal for FLEX Strategies," dated May 28, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14132A128). In its FIP [Reference 18], the licensee describes compliance with each condition of SHIELD seal use as follows:

(1) Credit for the SHIELD seals is only endorsed for Westinghouse RCP Models 93, 93A, and 93A-1.

This condition is satisfied because, as stated in the FIP, the RCPs for Comanche Peak Units 1 and 2 are Westinghouse Model 93A.

(2) The maximum steady-state RCS cold-leg temperature is limited to 571 °F [degrees Fahrenheit] during the ELAP (i.e., the applicable main steam safety valve setpoints results in an RCS cold-leg temperature of 571 °F or less after a brief post-trip transient).

As stated in the FIP, the maximum steady-state RCP seal temperature during an ELAP response is expected to be the RCS cold leg temperature corresponding to the lowest SG safety relief valve setting of 1,185 psig +3% due to uncertainty. This results in a RCS cold leg temperature of approximately 571 °F.

(3) The maximum RCS pressure during the ELAP (notwithstanding the brief pressure transient directly following the reactor trip comparable to that predicted in the applicable analysis case from WCAP-17601-P) is as follows: For Westinghouse Models 93 and 93A RCPs, RCS pressure is limited to 2,250 psia; for Westinghouse Model 93A RCPs, RCS pressure is to remain bounded by Figure 7.1-2 of TR-FSE-14-1-P, Revision 1.

Normal operating RCS pressure for Westinghouse PWR's is less than 2,250 psia. Allowing for the possibility of a brief pressure transient directly following the reactor trip, the NRC staff concludes that the licensee's mitigating strategy of cooling the reactor core via the main steam safety valves and SG ARVs will maintain reactor pressure within the limiting value for Model 93A.

(4) Nuclear power plants that credit the SHIELD seal in an ELAP analysis shall assume the normal seal leakage rate before SHIELD seal actuation and a constant seal leakage rate of 1.0 gpm for the leakage after SHIELD seal actuation.

The licensee's FIP [Reference 18], and supporting calculations assume a constant Westinghouse SHIELD RCP seal package leakage rate of 1 gpm per RCP, plus 1 gpm of unidentified RCS leakage, for a total RCS leakage of 5 gpm. As noted previously, the licensee's calculation indicates that departure from single phase natural circulation cooling would not be entered for a minimum of 43.8 hours into the event, even if FLEX RCS makeup flow were not provided as planned. In that Comanche Peak's mitigating strategy directs RCS makeup to begin approximately 14 hours after event initiation, ample margin exists to accommodate the small additional volume of leakage that is expected to occur before actuation of the SHIELD seal.

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 the 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 using the FLEX equipment. In many cases, boration would become necessary to offset the gradual positive reactivity addition associated with the decay of xenon-135, though 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 [Reference 6], 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 NRC 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 recriticality will not occur during a FLEX RCS cooldown.

During the audit, the NRC staff reviewed the licensee's shutdown margin calculation. The licensee intends to start the boration within 14 hours after the initiation of the ELAP event. The boration will use a portable high-pressure RCS injection FLEX pump with a capacity of 10 gpm at 3,602 TDH. The pump will initially be aligned to take suction from the BAT and later from the RWST. The licensee's shutdown margin calculation determined that the most restrictive end of life conditions would require a boration of 5,775 gallons from the BAT. The BAT contains 23,000 gallons of water at a boron concentration of at least 7,000 ppm. The RWST contains 473,700 gallons at a boron concentration of 2,400-2,600 ppm. The SDM analysis requires that the 10 hour boration (9 hours of injection plus 1 hour for mixing) be initiated no later than 14 hours into the event. The licensees calculations assume no xenon and a core inlet temperature as low as 350 °F.

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. The licensee's shutdown margin calculation concluded that the initial boration could be accomplished with no letdown from the upper head vent.

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 position paper, dated August 15, 2013 (withheld from public disclosure due to proprietary content), which provided test data regarding boric acid mixing under single-phase natural circulation conditions and outlined applicability limits 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 (ADAMS Accession No. ML13276A183), the NRC staff endorsed the above position paper with three conditions:

> Condition 1: The required timing and quantity of borated makeup should consider conditions with no RCS leakage and with the highest applicable leakage rate.

This condition is satisfied because the licensee's planned timing for establishing borated makeup acceptably considered both the maximum and minimum RCS leakage conditions expected for the analyzed ELAP event.

> Condition 2: 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.

This condition is satisfied because the licensee's planned timing for establishing borated makeup would be prior to RCS flow decreasing below the expected flow rate corresponding to single-phase natural circulation for the analyzed ELAP event.

Condition 3: 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 1 hour is considered appropriate.

This condition is satisfied because the licensee's planned timing for establishing borated makeup allows a 1-hour period to account for boric acid mixing; furthermore, during this 1-hour period, the RCS flow rate would exceed the single-phase natural circulation flow rate expected during the analyzed ELAP event.

During the audit review, the licensee confirmed that it will comply with the August 15, 2013, position paper on boric acid mixing, including the above conditions imposed in the NRC staff's corresponding endorsement letter. The NRC staff's audit review indicated that the licensee's shutdown margin calculations are generally consistent with the PWROG's position paper, including the three additional conditions imposed in the NRC staff's endorsement letter.

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 licensee described in its FIP [Reference 18], that the Multi-Purpose High Flow FLEX pump will provide makeup water from the several water sources throughout the site to the CSTs. The Multi-Purpose High Flow FLEX pump is deployed and staged within 24 hours after the licensee declares an ELAP. The pump is a trailer-mounted, diesel driven centrifugal pump and can take suction from variable water sources that are available before taking suction from the SSI, which is the protected water source for SG makeup. Three pumps are stored in the FLEX Equipment Storage Building to meet the "N+1" criteria of Section 3.2.2 of NEI 12-06 [Reference 6]. The licensee also described a backup portable pump, the SG/AFW Low Pressure FLEX pump, which can provide SG injection in the event that the TDAFW pump is not available. The SG/AFW Low Pressure FLEX pump is a trailer-mounted, diesel engine driven centrifugal pump that can be connected to primary and secondary FLEX connections for the SG. Three SG/AFW FLEX pumps are also stored and deployed from the FLEX Equipment Storage Building to meet the "N+1" criteria. The licensee indicated that the High Pressure RCS Injection FLEX Pump is responsible for RCS makeup from the BAT or RWST. The High Pressure RCS Injection FLEX pump is a positive displacement triplex type that is skid mounted on a mobile platform and can be transported by vehicle with a trailer hitch or by hand. Three pumps are stored in the FLEX Equipment Storage Building to satisfy the "N+1" requirement.

During the audit review, the licensee provided for the NRC staff's review FLEX hydraulic Calculations ME-CA-000-5510, "FLEX Yard Tank Deployment" Revision 0, [Reference 52], LTR-SEE-11-12-70-CP, "FLEX Alternate Cooling Source Evaluation Input Methodology," Revision 0, [Reference 53], and Calculation CN-LIS-12-74-REDACTED, "Comanche Peak Unit 1 and Unit 2 (TBX/TCX) Reactor Coolant System (RCS) Inventory, Shutdown Margin, and Mode 5/6 Boric Acid Precipitation Control (BAPC) Analyses to Support the Diverse and Flexible Coping Strategy (FLEX)," Revision 0, [Reference 54], which all evaluated the use of the above FLEX pumps respectively in providing makeup water to the CST, providing direct SG injection, and providing makeup water from the BAT and the RWST. 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 FSIs. The NRC staff also 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.

Based on the NRC staff's review of the FLEX pumping capabilities at Comanche Peak, as described in the above hydraulic analyses and the FIP [Reference 18], the NRC staff concludes that the portable FLEX pumps should perform as intended to support core cooling and RCS inventory control during an ELAP event, consistent with NEI 12-06 [Reference 6], 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 [Reference 18], conceptual electrical single-line diagrams, and summary of calculations for sizing the FLEX generators and station batteries. The NRC 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 [Reference 18], operators will respond to the event in accordance with emergency operating procedures to confirm RCS, secondary system, and containment conditions. A transition to ECA-0.0A/B, "Loss of All AC Power," Revision 9 [Reference 55], will be made upon the diagnosis of the total loss of ac power. This procedure directs isolation of RCS letdown pathways, confirmation of adequate RCS heat sink using the SGs, verification of containment isolation, reduction of dc loads on the station batteries, and establishment of electrical equipment alignment in preparation for eventual power restoration.

The Comanche Peak Phase 1 FLEX mitigation strategy involves relying on installed plant equipment and onsite resources, such as the use of installed Class 1E station batteries, vital inverters, and the Class 1E dc electrical distribution system. This equipment is considered robust and protected with respect to applicable site external hazards since they are located within safety-related, Category 1 structures. In its FIP [Reference 18], the licensee stated that initial load shedding of all non-essential loads will be initiated and completed within 2 hours after the initiation of an ELAP. Once the licensee declares ELAP, the licensee would complete a second load shed within 5 hours after the initiation of an ELAP. With load shedding, the licensee calculated the useable station battery capacity to be 12 hours for the Unit 1 and Unit 2 station batteries. The licensee would conduct the load shed using FSI-4.0A/B, "DC Bus Load Management and Phase 2 480 VAC Generator Alignment," Revision 0.

In its FIP [Reference 18], the licensee noted that it had followed the guidance in NEI White Paper, "EA-12-049 Mitigating Strategies Resolution of Extended Battery Duty Cycles Generic Concern," (ADAMS Accession No. ML13241A186) when calculating the duty cycle of the station batteries. This paper 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 calculations [References 56 through 63]. The NRC staff verified the capability of the dc system to supply the required loads during the first phase of the Comanche Peak FLEX mitigation strategy plan for an ELAP, as a result of a BDBEE.

Each of Comanche Peak unit's Class 1E 125 Volt (V) dc system consists of two independent batteries each having one main distribution bus with molded case circuit breakers, fusible switches, two static battery chargers (one spare), and local distribution panels. The BT1ED1 and BT1ED2 batteries were manufactured by Exide Technologies (NCN-27) and are rated at 1,950 Ampere-hours (Ah) at an 8-hour discharge rate to a final voltage of 1.75-V/cell. The BT1ED3 and BT1ED4 batteries were manufactured by Exide Technologies (NCN-17) and are rated at 1,200 Ah at an 8-hour discharge rate to a final voltage of 1.75- V/cell. The battery capacities for the Unit 2 Class 1E 125 Vdc batteries are similar. 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 to ensure battery operation for least 12 hours.

Based on the NRC 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 Comanche Peak 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 the portable 480 Vac, 500 kilowatt (kW) FLEX DG energizes the battery chargers prior to the batteries depleting to the minimum acceptable voltage (105 V) and the dc load shedding is completed within the times assumed in the licensee's analysis.

The licensee's Phase 2 strategy includes re-powering of battery chargers within 12 hours to maintain availability of instrumentation to monitor key parameters. Prior to depletion of the 125 Vdc Class 1E station batteries, operators would repower the safety-related battery chargers using one of the portable 480 Vac, 500 kW FLEX DGs stored on-site. The licensee would deploy the portable 480 Vac, 500 kW FLEX DGs using FSI-5.0, "Initial Assessment and FLEX Equipment Staging," Revision 0 [Reference 80].

The NRC staff reviewed Final Design Authorization (FDA)-2013-000008-27, "Final Design Authorization for the development of a specification for the procurement of two 480V FLEX diesel generators and the installation of a quick connection ground at the generator staging location," Revision 0 (this FDA did not include an official title), Attachment 6.28, "25 kV Loop Phase 2 Generator Connection," of ER-ME-133 dated April 30, 2015 [Reference 64], FSI-30.0, "Phase 3 Equipment Operation," Revision 0 [Reference 65], FSI-20.0A/B, "Loss of All AC Power While on Shutdown Cooling," Revision 0 [Reference 66], and FSA-24.0A/B, "MODE 5/6 DC Bus Load Management and Phase 2 480 VAC Generator Alignment," Revision 0 [Reference 67]. The licensee's 480 Vac (0.8 pf) FLEX DGs have a continuous rating of 500 kW. The rated output current is 753 Amperes (A), which translates to the minimum required ampacity of 866 A.

The three 4/0 cables per phase equates to a combined ampacity of 996 A. This is sufficient to carry a load of 866 A. According to the licensee's calculation, the maximum load on the FLEX DG is expected to be 365.31 kW. The licensee's calculations took the FLEX cable lengths into consideration, and ensured that the voltage drop did not exceed the minimum voltage required at the limiting component.

Based on its review of the licensee's calculation, conceptual single line electrical diagrams, and station procedures, the NRC staff finds that the licensee's approach is acceptable given the protection and diversity of the power supply pathways, the separation and isolation of the FLEX DGs from the Class 1E emergency diesel generators (EDGs), and availability of procedures to direct operators how to align, connect, and protect associated systems and components. The NRC staff also finds that the FLEX DGs have sufficient capacity and capability to supply the required loads.

For Phase 3, the licensee will receive four (two per unit) 1-megawatt (MW) 4160 Vac combustion turbine generators (CTGs), two (one per unit) 1100 kW 480 Vac CTGs, and distribution panels (including cables and connectors) from an NSRC. Each portable 4160 Vac CTG is capable of supplying approximately 1 MW, but two CTGs could be operated in parallel to provide a total of approximately 2 MW (per unit). The licensee plans to continue its Phase 2 electrical strategy but can replace the Phase 2 480 Vac, 500 kW FLEX DGs with the NSRC supplied 480 Vac CTGs to cope indefinitely, if necessary. The design rating of the NSRC supplied 480 Vac CTGs is greater than the Phase 2 FLEX DGs (1,100 kW vs 500 kW). The electrical connections for both the Phase 2 480 Vac, 500 kW FLEX DGs and the 480 Vac NSRC supplied CTGs are identical. Based on its review, the NRC staff finds that the equipment being supplied from either of the NSRCs has sufficient capacity and capability to supply the required loads during Phase 3.

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 [Reference 6] 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 [Reference 6], Table 3-2 and Appendix D, summarize an acceptable approach consisting of three 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; 2) makeup via connection to spent fuel pool cooling piping or other alternate location capable of exceeding the boil-off rate for the design-basis heat load; and 3) spray via portable monitor nozzles from the refueling floor using a portable pump capable of providing a minimum of 200 gpm per unit (250 gpm if overspray occurs). 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 [Reference 6], 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 [Reference 6], 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 [Reference 6], 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.

In NEI 12-06 [Reference 6], 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.

3.3.1 Phase 1

In its FIP [Reference 18], the licensee stated that no actions are required during ELAP Phase 1 for SFP makeup because the time to boil is sufficient to enable deployment of Phase 2 equipment. Adequate SFP inventory exists to provide radiation shielding for personnel well beyond the time of boiling. The licensee will monitor SFP water level using reliable SFP Instrumentation System (SFPIS) installed in accordance with Order EA-12-051.

3.3.2 Phase 2

The licensee described the Phase 2 SFP makeup strategy as using either an overhead spray header fed through redundant FLEX connections located on the outside of the Fuel Building or deployment of portable spray nozzles near the SFP deck fed from local Fire Protection hose stations. The overhead spray header will be pressurized using the Multi-Purpose High Flow FLEX pump drawing suction from the RWST. The licensee also indicated that a permanent plant diesel driven fire pump can be used to pressurize the fire main for feeding the portable spray nozzles.

3.3.3 Phase 3

The licensee indicated that the Phase 3 SFP makeup strategy would be a continuation of the Phase 2 coping strategy until additional electrical capability and off-site equipment is obtained from the NSRC, which will be used to restore the SFP cooling system. Two 1 MW 4160 V diesel turbine generators per unit will be brought in from the NSRC and will be used to re-energize one 6900 V safeguard ac bus on each unit.

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 [Reference 6], 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-12-36, "Determination of the Time to Boil in the Comanche Peak Units 1 and 2 Spent Fuel Pools after an Earthquake," Revision 0, [Reference 68], for the NRC 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 45 hours for both unit SFPs. The NRC staff noted that the licensee's sequence of events timeline in its FIP indicates that operators will deploy hoses and spray nozzles as a contingency for SFP makeup within 14 hours from event initiation to ensure the SFP area remains habitable for personnel entry.

As described in its FIP [Reference 18], the licensee's Phase 1 SFP cooling strategy does not require any anticipated actions. 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 the FSI Procedures to prop open doors at different elevations to the Fuel Building. The licensee indicated that opening the doors would create vent pathways to prevent excessive steam accumulation in the Fuel Building.

The licensee's Phase 2 and Phase 3 SFP cooling strategy involves the use of the Multi-Purpose High Flow FLEX pump and associated hoses and fittings with suction from the RWST or other available water sources, including the SSI. The NRC staff's evaluation of the robustness and availability of FLEX connections points for the Multi-Purpose High Flow FLEX pump is discussed in Section 3.7.3.1 below. Furthermore, the NRC staff's evaluation of the robustness and availability of the RWST and SSI for an ELAP event is discussed in Section 3.10.3.

3.3.4.1.2 Plant Instrumentation

In its FIP [Reference 18], 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 NSRC 4160 V generators prior to 72 hours. The NRC staff's review of the SFPIS, 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 safety evaluation.

3.3.4.2 Thermal-Hydraulic Analyses

Section 11.2 of NEI 12-06 [Reference 6] 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 [Reference 6], 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 [Reference 6], 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-12-36, "Determination of the Time to Boil in the Comanche Peak Units 1 and 2 Spent Fuel Pools After an Earthquake," Revision 0 [Reference 69] to provide the thermal-hydraulic analysis for the SFP of each unit. The calculation concluded that the maximum expected SFP heat load immediately following a full core off-load (applicable during refueling will reach a bulk boiling temperature of 212 °F in approximately 4 hours and boil off to the top of the active fuel in approximately 16 hours. The calculation also concluded that a flowrate of 110 gpm would be needed within 16 hours of the ELAP event to replenish the SFP to 15' above the top of the fuel racks. The licensee referenced in Calculation ME-CA-000-5507, "FLEX Spent Fuel Pool Make-up Pressure Drop," Revision 0 [Reference 70], that the Multi-Purpose High Flow FLEX pump will provide for adequate makeup to restore the SFP level for both Units. The NRC staff reviewed both calculations to confirm that the implementation and performance of the Multi-Purpose High Flow FLEX pump will meet the makeup requirements for the SFP in accordance to the time to boil and evaporation rate of the SFP.

Based on the information contained in the FIP and the above hydraulic calculation, the NRC 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 consistent with NEI 12-06 [Reference 6] Section 3.2.1.6, Condition 4 and Section 11.2.

3.3.4.3 FLEX Pumps and Water Supplies

As described in the FIP [Reference 18], the SFP cooling strategy relies on one of three Multi-Purpose High Flow FLEX pumps to provide SFP makeup for both units during Phases 2 and 3. During the audit, the licensee referenced hydraulic Calculation ME-CA-000-5507, "FLEX Spent Fuel Pool Make-up Pressure Drop," Revision 0 [Reference 71] to provide the hydraulic calculation for the SFP makeup. One Multi-Purpose High Flow FLEX pump is needed to deliver 500 gpm to provide to each SFP (250 gpm to each SFP). The spray option for SFP make-up specifies three portable spray nozzles to be set up on the deck next to the SFPs, each capable of flowing approximately 167 gpm. The spray nozzles are connected to the fire protection system through three local hose stations. Two spray nozzles will be aligned to the SFP with the highest decay heat load, if known, and one spray nozzle will be aligned to the other SFP. Three Multi-Purpose High Flow FLEX pumps with associated hoses and spray nozzles are stored in the FLEX Equipment Storage Building to meet the "N+1" criteria in NEI 12-06 [Reference 6]. The NRC staff reviewed the hydraulic calculation and technical specifications of the Multi-Purpose High Flow FLEX pump to confirm that the pump can meet the makeup requirements for the SFP.

Based on the NRC staff's review of the SFP makeup requirements for both units' SFP, the licensee has demonstrated that the Multi-Purpose High Flow FLEX pumps, if aligned and operated as described in the FSIs 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 [Reference 18] defines strategies capable of mitigating a simultaneous loss of all ac power and LUHS, resulting from a BDBEE, by providing the capability to maintain or restore core cooling, containment, and SFP cooling at all units on the Comanche Peak site. Furthermore, the electrical coping strategies are the same for all modes of operation.

The NRC staff performed a comprehensive analysis of the licensee's electrical strategies, which includes the SFP cooling strategy. In its FIP [Reference 18], the licensee stated that SFP levels will be monitored in all 3 Phases by instrumentation installed in response to NRC Order EA-12-051. The SFPIS has an independent power supply and an independent uninterruptable power supply with a 24 V battery backup. Instrument power for this equipment has backup battery capacity for 72 hours.

Beyond the SFPIS, no additional electrical components are needed as part of the licensee's Phase 2 strategy.

For Phase 3, the licensee would connect the NSRC supplied 4160 Vac CTGs to permit energizing one Class 1E 6900 Vac bus on each Unit within 72 hours. Once any Unit 1 or Unit 2 6900 Vac bus and associated 480 Vac buses are energized, alternate power will be provided through a lighting panel to the SFP level instrument cabinets to provide power to all four SFP level instruments and recharge the associated backup batteries.

Powering a Class 1E 6900 Vac bus will provide power to one Component Cooling Water (CCW) pump and one SFP cooling pump. At this point, the CCW system could be placed in service to provide cooling water to a SFP heat exchanger and the SFP cooling pump restored to service. During Phase 3, the Phase 2 FLEX DG would continue to provide power to the Unit 1 and Unit 2 battery chargers, battery room exhaust fan, and high pressure RCS injection pump to avoid interrupting power to these components. The NRC staff reviewed FSI-30.0 [Reference 65], which provides guidance for connecting and operating the Phase 3 CTGs. The NRC staff reviewed licensee Calculation ER-ME-133, "Beyond-Design-Basis External Event Mitigation Strategies," Revision 1 [Reference 72], which showed that the required loading on the CTGs, if sequenced appropriately, was within the design ratings (6.5 Mega Volt Ampere (MVA) starting and 3 MVA running) of two NSRC supplied CTGs operated in parallel. Specifically, the largest starting load would be the CCW pump which has a starting MVA of 5.36 MVA. The licensee's analysis showed that the total running loads for Comanche Peak, Units 1 and 2 would be 1.78 MVA and 1.81 MVA, respectively. Procedure FSI-30.0 [Reference 65], includes the licensee's assessment and guidance to ensure that the CTGs are not overloaded. Based on its review, the NRC staff determined that the 4160 Vac equipment being supplied from the NSRCs has sufficient capacity and capability to supply SFP cooling systems, if necessary.

Based on its review, the NRC staff finds that the licensee's electrical 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 a BDBEE consistent with NEI 12-06 [Reference 6] 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 [Reference 6], 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.

In accordance with NEI 12-06 [Reference 6], the licensee performed a containment Calculation CN-ISENG-14-3, "Containment Pressures and Temperatures for Comanche Peak Units 1 and 2 During an ELAP Calculated with MAAP [Modular Accident Analysis Program] 4.07," Revision 0 [Reference 73], which was based on the boundary conditions described in Section 2 of NEI 12-06 [Reference 6]. As describe in the Updated Final Safety Analysis Report (UFSAR) the calculation concludes that the containment pressure remains well below the respective design limit of 50 psig (UFSAR Section 3.8). 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

The licensee's containment analysis shows that there are no Phase 1 actions required for Modes 1-4 and Mode 5 with SGs available. The licensee indicated that containment pressure and temperature will be monitored from the CR using installed instrumentation. The containment intermediate range pressure instruments will be available for the duration of the ELAP for CR indication.

3.4.2 Phase 2

The licensee's containment analysis shows that there are no Phase 2 actions required. Containment pressure and temperature will continue to be monitored using installed instrumentation.

3.4.3 Phase 3

The licensee will utilize existing plant systems restored by off-site equipment and resources during Phase 3 in order to reduce containment temperature and pressure and to ensure continued functionality of the key parameters. Two high flow low pressure diesel driven pumps will be supplied by the NSRC to provide alternate Station Service Water (SSW) flow to one existing site CCW heat exchanger. The 4160 V generators from the NSRC will be aligned to power one Class IE 6900 V bus and associated 480 Vac buses on each unit, which will provide power to one CCW pump, one Ventilation chiller, and associated chilled water recirculation pumps, and CACRS fan motors on both units. The CCW system will be placed in service to provide cooling water to a ventilation chiller and the chiller unit restored to service. The Ventilation Chilled Water (CHN) system would then be established to both units' containments. Containment ventilation flow would be established by starting two CACRS fans per unit with airflow through the CACRS fan coil unit and recirculating within each unit's containment.

3.4.4 Staff Evaluations

3.4.4.1 Availability of Structures, Systems, and Components

In NEI 12-06 [Reference 6], baseline assumptions have been established on the presumption that other than the ELAP and LUHS event, 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

Comanche Peak UFSAR Section 3.8 describes Comanche Peak as having two containment structures, each with a fully continuous, steel-lined, reinforced concrete structure. The containments consist of a vertical cylinder and a hemispherical dome and are supported on an essentially flat foundation mat with a reactor cavity pit projection. The containment superstructure is independent of the adjacent interior and exterior structures. Sufficient space is provided between the Containment and the adjacent structures to prevent contact under all combinations of loadings.

The FIP [Reference 18] also described permanent SSCs that are used for containment function strategies. The CHN system is utilized for Phase 3 strategy and is located primarily within the Auxiliary, Safeguards and Containment Buildings; all Seismic Category I structures that fully protect the equipment from all applicable external hazards. A portion of the CHN system piping is exposed outside and may be susceptible to tornado or seismic hazards. The licensee indicated that the CHN system is not required for the first 72 hours following ELAP initiation, in which repairs or replacement of the affected piping can be made. The CACRS system is used for Phase 3 and is located within the Containment Buildings, which are Seismic Category I structures that fully protect the equipment from all applicable external hazards. The CACRS fans and cooling units are non-safety Seismic Category II SSCs and are fully protected for all applicable external events. Both systems satisfy the NEI 12-06 [Reference 6] criteria for robustness.

3.4.4.1.2 Plant Instrumentation

In NEI 12-06 [Reference 6], Table 3-2 specifies key containment parameters, which should be monitored by repowering the appropriate instruments. The licensee stated in its FIP [Reference 18] that the key parameter for the containment integrity function is containment pressure, which can be obtained from essential instrumentation.

The above essential instrumentation will be available prior to and after load stripping of the dc and ac buses during Phase 1. All indications will be in the Control Room. Should any of the signal cabling to the CR indicators be damaged or dc power lost, all process parameters can be obtained at remote locations with hand held devices. Procedure FSI-7.0A/B, "Loss of Vital

Instrumentation or Control Power," Revision 0 [Reference 51] provides location and termination information in the CR for all essential instrumentation. The hand held devices have built in power supplies, which can be used to provide loop power. The portable FLEX equipment is supplied with the local instrumentation needed to operate the equipment. The use of these instruments is detailed in the associated FSIs for use of the equipment. These procedures are based on inputs from the equipment suppliers, operation experience, and expected equipment function in an ELAP.

Based on this information, the licensee should have the ability to appropriately monitor the containment pressure as delineated in NEI 12-06 [Reference 6], Table 3-2.

3.4.4.2 Thermal-Hydraulic Analyses

During the audit process, the licensee provided the NRC staff access to calculation CN-ISENG-14-3, "Containment Pressures and Temperatures for Comanche Peak Units 1 and 2 During an ELAP Calculated with MAAP 4.07," Revision 0 [Reference 73], which was based on the boundary conditions described in Section 2 of NEI 12-06 [Reference 6]. This calculation concluded that the containment pressure and temperature for ELAP events would remain below the containment design parameters for 72 hours. The licensee also indicated that by restoring the two CACRS fans and ventilation chilled water flow at 72 hours after ELAP, this would also keep the containment temperature and pressure below the containment design limits for the duration of the event.

3.4.4.3 FLEX Pumps and Water Supplies

The NSRC is providing two high flow low pressure diesel driven pumps to provide SSW flow for cooling loads through one CCW heat exchanger. The SSI will be used to establish alternate SSW flow if needed.

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 this analysis, the licensee developed required actions to ensure maintenance of containment integrity and required instrumentation function. With an ELAP initiated, while either Comanche Peak unit is in Modes 1-4, containment cooling for that unit is also 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 an ELAP event. However, with no cooling in the containment, temperatures in the containment are expected to rise sufficient enough to challenge equipment capability if left unmitigated. The expected rate of containment temperature rise is low such that no immediate actions are required. However, restoration of containment cooling using two Containment Air Cooling and Recirculation (CACRS) fans (on each unit) at 72 hours post-ELAP initiation would ensure that temperature limits are not exceeded and necessary equipment, including credited instruments, located inside containment remains functional throughout the ELAP event.

The licensee's Phase 1 coping strategy for containment involves initiating and verifying containment isolation in accordance with ECA-0.0A/B [Reference 55], and monitoring containment pressure using installed instrumentation. Control room indication using containment intermediate range pressure instruments will be available for the duration of the ELAP. 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 monitoring containment pressure using installed instrumentation. The licensee's strategy to repower instrumentation using the 480 Vac, 500 kW FLEX DGs 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 3 coping strategy includes actions to reduce containment temperature and pressure utilizing existing plant systems restored by off-site equipment and resource during Phase 3.

The licensee evaluated several options to provide operators with the ability to reduce the containment temperature. Each of these options would require the restoration of multiple support systems to remove heat from the containment thus reducing containment temperature and pressure. The various containment cooling strategy options are discussed in Section 2.5.3 of the licensee's FIP. Those options require the powering of one 6900 Vac bus on each unit. The NRC staff reviewed the licensee's analysis and guidance included in FSI-30.0, and determined that the 4160 Vac equipment being supplied from an NSRC (and the 4160 Vac/6900 Vac transformer stored onsite) will provide adequate power to perform the noted strategies. Based on the above, the NRC staff determined that the electrical equipment available onsite (i.e., 480 Vac, 500 kW FLEX DGs and 4160 Vac/6900 Vac transformers) supplemented with the electrical equipment that will be supplied from the NSRCs (i.e., 480 Vac and 4160 Vac CTGs) have sufficient capacity and capability to supply the required loads to reduce containment temperature and pressure to ensure that key components and instrumentation 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 [Reference 6] 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 [Reference 6] provide the methodology to identify and characterize the applicable BDBEEs for each site. In addition, NEI 12-06 [Reference 6] 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 LUHS.

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 [Reference 6] 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 safety evaluation are consistent with the guidance in NEI-12-06 [Reference 6] and the related NRC endorsement of NEI 12-06 [Reference 6] 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 46]. 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 40]. 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 damage 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 32], 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, Revision 0, and the related industry guidance in NEI 12-06, Revision 0 [Reference 6]. 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) in accordance with the guidance in NEI 12-06, Revision 2, Appendices G and H [Reference 47]. The NRC staff endorsed Revision 2 of NEI 12-06 in JLD-ISG-2012-01, Revision 1 [Reference

55]. 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 SE 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 [Reference 18], the licensee described the current design-basis seismic hazard, the safe shutdown earthquake (SSE). As described in UFSAR Section 2.5.2.6, the SSE seismic criteria for the site is 0.12 g peak horizontal ground acceleration and 0.08 g 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 [Reference 18], the licensee stated that the current design-basis for the limiting site flooding event is the Probable Maximum Flood (PMF) event. As described in UFSAR Section 2.4.3.5, the current design-basis PMF is elevation 789.7' mean sea level (MSL) whereas the site grade is 810' MSL (UFSAR Section 2.4.1.1). Comanche Peak is considered a dry site.

In its FIP [Reference 18], the licensee also addressed the potential for local accumulation of water or ponding due to the local Probable Maximum Precipitation event. The licensee stated that the onsite drainage system is designed to adequately drain the governing rainfall event in such a way that runoff does not form ponds on the ground surrounding the safety-related structures nor be sufficient to back up into such structures. The licensee further stated that the CPNPP site is not expected to be subjected to the effects of ice, storm surge, seiche or tsunami flooding. Any such events are bounded by the PMF event due to river flooding.

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 [Reference 6], 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 [Reference 6], Figure 7-1 (Figure 3-1 of U.S. NRC NUREG/CR-7005, "Technical Basis for Regulatory Guidance on Design Basis Hurricane Wind Speeds for Nuclear Power Plants," December, 2009), if the resulting frequency of recurrence of hurricanes with wind speeds in excess of 130 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 NUREG/CR-4461, "Tornado Climatology of the Contiguous United States," Revision 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 tornadoes or Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants," Revision 1.

In its OIP [Reference 10], the licensee stated that Figures 7-1 and 7-2 from NEI 12-06 [Reference 6] were used for this assessment. The licensee concluded that CPNPP is not susceptible to hurricanes as the plant site is a significant distance from the final contour line shown in Figure 7-1 of NEI 12-06 [Reference 6]. The licensee also concluded that the CPNPP site has the potential to experience damaging winds caused by a tornado exceeding 130 mph. Figure 7-2 of NE112-06 indicates a maximum wind speed of 200 mph for Region 1 plants, including CPNPP. However, the UFSAR defines the design-basis tornado for Comanche Peak as 360 mph winds. Therefore, the licensee determined that a design-basis tornado wind speed of 360 mph would be used in analysis for CPNPP's FLEX strategies. In its FIP [Reference 18], the licensee stated that seismic Category I buildings are vented to the atmosphere in the event of a tornado. These buildings are designed to withstand the loadings due to wind, depressurization and re-pressurization, and tornado generated missiles.

The determination of the applicable high winds hazard for the CPNPP site has been evaluated in the NRC staff's ISE [Reference 16]. The NRC staff concluded that a hurricane hazard is not applicable and need not be addressed. The tornado hazard is 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 [Reference 6], 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 [Reference 18], the licensee stated that the CPNPP site is located below the 35th Parallel and therefore impedance due to severe snowfall need not be considered. In its OIP [Reference 10], the licensee concluded that since the Comanche Peak site is not a Level 1 or 2 region as defined by Figure 8-2 of NEI 12-06 [Reference 6], the FLEX strategies must consider the impedances caused by low to medium ice storms. In its FIP, the licensee stated that ice storms occur occasionally in the region during the period December through March. Moderate to heavy ice storms can be quite damaging to utility lines and trees, as well as being a serious traffic hazard. In the UFSAR, Section 2.3.1.2.8 states the worst ice storm on record in the Dallas-Fort Worth area occurred on January 6-9, 1937. As much as 2 inches (") of ice formed and did not disappear until January 12, 1937. Communications were disrupted and highway traffic was extremely hazardous.

In its FIP [Reference 18], the licensee stated that temperatures in the site region occasionally fall below 32 °F (UFSAR Section 2.3.1.1). The lowest temperature recorded in Fort Worth was 4 °F in January 1964 (UFSAR Table 2.3-15). The UFSAR information is limited to data from 1931 to 1973. From published data for the time period between 1973 and 2011, the lowest temperature recorded in Fort Worth was -1 °F in December 1989.

In summary, based on the available local data and Figures 8-1 and 8-2 of NEI 12-06 [Reference 6], the plant site does not experience extreme snowfall or extreme low temperatures. The site is susceptible to moderate ice storms; therefore, the hazard is screened in. The licensee has appropriately screened in the hazard and characterized the hazard in terms of expected severity.

3.5.5 Extreme Heat

In its FIP [Reference 18], the licensee stated that, summer time outdoor temperatures in the site region often exceed 100 °F (UFSAR Section 2.3.1.1). The peak temperature recorded in Fort Worth was 108 °F in August 1964 (UFSAR Table 2.3-15). The UFSAR information is limited to data from 1931 to 1973. From published data for the time period between 1973 and 2011, the peak temperature recorded in Fort Worth was 113 °F in June 1980.

In summary, based on the available local data and the guidance in Section 9 of NEI 12-06 [Reference 6], 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 [Reference 6] 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

In its FIP [Reference 18], the licensee stated all major FLEX equipment and supplies will be stored and protected in a new robust concrete building designated as the FLEX equipment storage building (FESB) or the fuel building station service water tunnel and are therefore fully protected from all applicable external events. The NRC staff also reviewed FDA-2013-0008-26, "FLEX Equipment Storage Building," Revision 4 [Reference 75] that stated the function of the FESB was to protect FLEX equipment from extreme heat, snow, ice, external flooding, and seismic events. In addition to the FLEX pumps and generators, debris removal equipment and tow equipment required for Phase 2 equipment deployment will also be stored within the FLEX storage building. The debris removal equipment consists of one Bobcat and one Pettibone vehicles. Also, two fueling trailers each with a 500 gallon fuel tank and associated fuel oil transfer pumps are stored in the FESB. The FESB is located outside the protected area.

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

3.6.1.1 Seismic

The licensee stated that the newly constructed FESB is designed to withstand the hazards defined in NEI 12-06 [Reference 6] Section 5.3.1 considerations 1 through 3. As described in Attachment 2 to the compliance letter and FDA-2013-0008-26, "FLEX Equipment Storage Building," Revision 4 [Reference 75], the FESB has been designed to the meet the plant's design basis SSE. Additionally, equipment in the FESB will be stored in accordance with existing site procedures to prevent the potential of any unacceptable seismic interactions.

3.6.1.2 Flooding

The FESB is located above the PMF level. The site is considered a "dry" site and as such the FESB is not susceptible to flooding. In FDA-2013-0008-26, "FLEX Equipment Storage Building," Revision 4 [Reference 75] it states that the top of the floor slab is at an elevation of 810.5' and the PMF level is 789.7'.

3.6.1.3 High Winds

In its FIP [Reference 18] and FDA-2013-0008-26, "FLEX Equipment Storage Building," Revision 4 [Reference 75], the licensee stated that the concrete FESB is designed against all hazards, which include the high wind and tornado borne missiles. All major FLEX equipment and supplies are protected within the FESB. The licensee stated that portable hard plastic piping used to connect Phase 3 equipment from the NSRC to the service water system is stored in three separate locations. These locations are separated in accordance with the criterion in NEI 12-06 [Reference 6] to assure availability of sufficient piping in case of a tornado.

3.6.1.4 Snow, Ice, Extreme Cold and Extreme Heat

In its second six month update, the licensee described that for proper storage environment, the FESB will be provided with forced ventilation and heating, as appropriate. During the site audit

[Reference 17], the licensee also indicated that a separate room inside the FESB will contain items such as food, water and communication devices, which will be environmentally controlled. The NRC staff walked down the FESB to confirm the forced ventilation portions on both sides of the building and the separate room being constructed for the described items.

The NRC staff audited the licensee's plans to protect FLEX equipment from ice. The licensee stated that the FESB will protect FLEX equipment from design basis snowfall or ice storm. The licensee referenced Calculation CSCA- 0000-5516 Revision 0, which provided details of the FESB load combinations and analysis for building design as compared to the design-basis snowfall. The licensee concluded that the FESB would be able to withstand any accumulated loads related to snow or ice on the roof, which in turn will not impact the equipment inside the building. In addition, the NRC staff reviewed FDA-2013-00008-29, "FLEX Equipment Storage Building (X-FX-2K19)," Revision 3 [Reference 76] provided HVAC, supply air handling unit, exhaust fan, and climate controlled air conditioning system to control the heat and cold temperatures inside the FESB.

3.6.2 Availability of FLEX Equipment

Section 3.2.2 of NEI 12-06 [Reference 6] 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.

Table 3 in the licensee's FIP lists the type and number of FLEX pumps and generators stored in the FESB. For makeup to the SGs, the licensee provided three diesel driven pumps designated as SG/AFW low pressure FLEX pumps. These pumps will be deployed next to each unit's CST and will be available to feed the SGs in the event the TDAFW pumps fail to operate. For makeup to the RCS, three electrically driven pumps designated as high pressure RCS injection FLEX pumps are provided. These pumps will be deployed near the BATs. In addition, the licensee provided three diesel driven pumps designated as multi-purpose high flow FLEX pumps. One multi-purpose pump is deployed at the service water intake structure and feeds the ring header from which flow is diverted to both CSTs to refill them. The pump is sized to support both units simultaneously. A second multi-purpose pump is deployed to draw on either unit's RWST to supply makeup to the spent fuel pools. The pump is sized to supply makeup to both SFPs simultaneously. A third multipurpose pump is designated as the N+1 pump. Lastly, two 500 kW 480 Vac diesel DGs are provided. Each DG is sized to carry the loads for both units in implementing the FLEX strategies.

The licensee stated that in addition to the equipment and supplies stored in the robust FESB, some FLEX designated plastic piping is stored in three separate locations within the owner controlled area and each location is separated in accordance with NEI 12-06 to address the tornado hazard.

In its FIP [Reference 18], the licensee requested to have quantities of hoses and cables that met the guidance of Item 16 of Section 3.2.2 of NEI 12-06 Revision 2, instead of stated that N sets of FLEX hoses and cables with additional spare hose and cable quantities meet Item 16 of Section 3.2.2 of NEI 12-06 Revision 2. This is further discussed in Section 3.14 below.

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 SG makeup, RCS makeup and boration, SFP makeup, and maintaining containment consistent with the N+1 recommendation in Section 3.2.2 of NEI 12-06.

3.6.3 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 [Reference 6] guidance, as endorsed by JLD-ISG-2012-01 and should adequately address the requirements of the order.

3.7 Planned Deployment of FLEX Equipment

In its FIP [Reference 18], the licensee stated that pre-determined, preferred haul paths have been identified and documented in the FSIs. In Figure 1 of the FIP, the licensee identified two potential haul paths outside the protected area from the FESB to the alternate access point (AAP). Figure 2 of the FIP shows the haul routes within the protected area from the AAP to the staged locations of the FLEX equipment. The preferred haul paths have been selected to avoid areas with trees, narrow passages, etc. to the extent possible. After performing the initial damage assessment, debris removal from the haul paths will be initiated within six hours of the event. The first Phase 2 FLEX equipment to be deployed is the FLEX 500 kW DG within 12 hours of the event.

3.7.1 Means of Deployment

In Table 3 of the FIP, tow and debris removal vehicles are listed. The stored FLEX equipment includes multiple tow vehicles equipped with rear and/or front tow connections to move debris from the needed travel paths. Tow straps will be provided for the two pickup trucks and the two water trucks to move vehicles and debris. For more significant debris conditions, this mobile equipment includes one Pettibone and one Bobcat track loader. In addition, two acetylene cutting torch setups will be staged to facilitate large debris removal. These vehicles are stored in the FESB such that the equipment remains functional and deployable to clear obstructions from the pathway between the storage building and the deployment location(s).

Deployment of the FLEX and debris removal equipment from the FESB is not dependent on off-site power. All actions are accomplished manually with the use of FLEX equipment power sources.

In its second six month update [Reference 12], the licensee stated that CPNPP is not susceptible to extreme snowfall, however, the site can be subjected to ice storms for short durations. Existing severe weather procedures provide guidance for mitigation of icy site roads, which include maintaining the capability to spread sand over site roadways (including credited deployment pathways) to enhance equipment traction.

3.7.2 Deployment Strategies

The licensee evaluated the potential impacts of soil liquefaction and flooding on the haul paths both outside and inside the protected area. Geotechnical core borings and studies demonstrated that soil liquefaction at the location of the FESB and from the FESB along the various haul routes to the FLEX equipment staging locations around the plant is not a concern at CPNPP. The licensee also stated that since CPNPP is considered a "dry" site, flooding along the haul paths is not a concern.

The UHS, the safe shutdown impoundment, is accessed in the deep water section of the service water intake structure using the multipurpose low head/high flow FLEX pump. A portable, diesel driven FLEX pump will be transported from the FESB to a location north of the service water intake structure. A flexible hose and eductor will be routed from the pump suction and lowered into the SSI, south of one of the traveling screens. The trash rack and the eductor inlet provide straining to limit solid debris size for pump protection. A flexible hose will be routed from the multi-purpose high flow FLEX pump discharge to a ring header then to the CST makeup connection.

3.7.3 Connection Points

3.7.3.1 Mechanical Connection Points

Core Cooling (SG) Primary and Alternate Connections

The licensee described in its FIP [Reference 18] the primary connection for SG makeup as being located on the individual AFW injection lines (4 SG per unit) located in the Safeguards Building 810' elevation main hallway. The Safeguards Building is described in Section 2.3.4.9 of the FIP as being a Seismic Category I structure and can protect the primary connections from all applicable external hazards. The licensee indicated that a flexible hose will be routed from the SG/ AFW Low Pressure FLEX pump discharge to a portable manifold staged in the Safeguards hallway. The hoses are routed from the manifold to individual AFW injection lines for each SG. The licensee stated the alternate connection for SG makeup would be located on the TDAFW pump discharge line in the TDAFW pump room. A flexible hose will be routed from the SG/ AFW Low Pressure FLEX pump discharge to a TDAFW secondary connection line located in the CST valve room. A dry pipe is routed through a pipe tunnel terminating at approximately 790' elevation in the Safeguards building near the TDAFW pump room. An additional flexible hose will be routed from the TDAFW secondary connection line dry pipe to the FLEX connection located on the TDAFW pump discharge line.

The licensee also described in its FIP, a suction connection to the CST for the portable SG/ AFW Low Pressure FLEX pump for backup SG injection if the TDAFW pump is unavailable. The connection is seismically designed and located inside the CST valve room and is protected from all applicable external hazards. An additional connection is also provided to the CST for makeup using any available water source and a Multi-Purpose High Flow FLEX pump. The connection is seismically designed and located inside the CST valve room and is protected from all applicable external hazards.

RCS Inventory Control Primary and Alternate Connections

The licensee described in its FIP [Reference 18] the primary connection for RCS makeup as a permanent installed hose connection (each located in the unit's Safeguards Building). The High Pressure RCS Injection FLEX pump discharge will be connected through a high pressure hose to this permanent hose connection, which will provide the borated water source from the BAT or RWST through the Safety Injection flow path to the RCS cold legs. The Safeguards Building for each unit is a Seismic Category I building and is protected from all applicable external hazards. The licensee described the alternate RCS makeup connection in the FIP as a permanent installed hose connection upstream of valves on the normal charging header, in each of the unit's Safeguards Building.

The licensee also described in its FIP [Reference 18], additional connections for direct connection from the borated water sources to the High Pressure RCS Injection FLEX pump. A suction connection from the BAT is installed on the drain line to allow borated water from the BAT to be supplied to a portable High Pressure RCS Injection FLEX pump. The BAT is safety-related, seismically designed and located inside the Auxiliary Building and is protected from all applicable external hazards. A suction connection from the RWST is installed inside the RWST valve room. A gated "wye" or manifold will be installed outside the RWST valve room for a shared suction for both a FLEX pump for SFP makeup and the High Pressure RCS Injection FLEX pump, allowing borated water from the RWST to be supplied to both pumps. The suction connection is seismically designed and located inside the RWST valve room and is protected from all applicable external hazards.

SFP Makeup Primary and Alternate Connections

The licensee described in its FIP [Reference 18], the primary strategy SFP makeup, which will utilize a permanently installed overhead spray header fed by two redundant FLEX SFP makeup connections located on the outside of the Fuel Building east wall. The new external FLEX connections are seismically qualified, missile protected and are located outside the Fuel Building just above plant grade elevation. The seismically mounted overhead spray header will provide SFP makeup through two nozzles for each SFP. Check valves are installed in each primary connection flow path to permit a FLEX pump to supply either connection without requiring manual isolation of the non-operating connection. The water source for the primary strategy is either Unit's RWST as suction to a FLEX pump connected to either of the FLEX SFP makeup connections outside the Fuel Building.

The licensee described the alternate SFP makeup connection as using three portable spray nozzles set up on the deck next to the SFPs. The spray nozzles are connected to the fire protection system through three local hose stations. Two spray nozzles will be aligned to the SFP with the highest decay heat load and one spray nozzle will be aligned to the other SFP. The water source for the alternate strategy is the pressurized fire main, which can be pressurized by the diesel driven fire pump with suction from a Fire Protection Storage Tank if available. Deployment of the portable spray nozzles required to execute this strategy will be performed prior to the Fuel Building becoming uninhabitable and regardless of the potential for primary strategy success. If the secondary strategy is required, it can be executed from outside the Fuel Building.

3.7.3.2 Electrical Connection Points

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

During Phase 2, the licensee has developed a primary and alternate strategy for supplying power to equipment required to maintain or restore core cooling, containment, and SFP cooling using a combination of permanently installed and portable components. In its FIP [Reference 18], the licensee stated that the Phase 2 480 Vac, 500 kW FLEX DGs and cables will be stored in the FLEX Equipment Storage Building. There are two portable, trailer-mounted 480 Vac, 500 kW FLEX DGs, but only one FLEX DG is needed to implement the licensee's strategy for both Units. One set of cables including spares will be stored on a single trailer. The cable trailer and one 480 Vac, 500 kW FLEX DG will be deployed to the east of transformer 2ST. Either FLEX DG can be connected to a primary or secondary connection point. The primary connection is located outside at panel XB10-1. In the event the primary connection panel is unusable, the generator can be connected to the secondary connection box located in the Unit 2 Train A Switchgear Room at panel XB10-1-4. The licensee would use Procedure FSI 5.0 to deploy the portable 480 Vac, 500 kW FLEX DG.

The 480 Vac load center supply breakers for the portable 480 Vac, 500 kW FLEX DGs can be closed or opened manually by using FLEX procedures to prevent electrical equipment damage from simultaneous power supply from two electrical power sources (i.e., FLEX DG and the existing Class 1E power supply). The breaker that will be used to connect the FLEX DGs to the electrical distribution system is Class 1E.

Both the connections and the cables are equipped with color-coded cam lock connectors to ensure proper connection. Although there is the ability to connect four battery chargers, two battery room exhaust fans, and one High Pressure RCS Injection FLEX pump per Unit, the DG is only sized to power three battery chargers, two battery room exhaust fans, and one High Pressure RCS Injection FLEX pump per unit at any given time. When the 480 Vac, 500 kW FLEX DG is connected to the secondary connection, Panels XBl0-1-3 and 2B10-1-1 can only supply two battery chargers and two battery room exhaust fans each. The licensee would utilize FSI-4.0A/B to deploy, stage, and connect the 480 Vac, 500 kW FLEX DG. Procedure FSI-4.0A/B includes a step to verify proper phase rotation. Based on the above, the NRC staff finds that Comanche Peak meets the intent of NEI 12-06 by having two diverse sets of electrical strategies that can be used to fulfill the required functions (N and N+1).

For Phase 3, the licensee will receive two 1-MW 4160 Vac CTGs per unit from an NSRC that will be used to re-energize one 6900 Vac safeguard ac bus on each unit. These CTGs will be connected to an NSRC supplied 4160 Vac distribution system and then to a 4160 Vac/6900 Vac step-up transformer (stored onsite in the FLEX Equipment Storage Building) in order to meet the 6900 Vac load requirements. To prevent generator overload and provide optimum flexibility and diversity of equipment, one Train A bus would be energized on one Unit and one Train B bus would be energized on the opposite unit. This alignment allows recovery of the train-related 480 Vac buses and both trains of common 480 Vac motor control centers, common 118 Vac distribution panels, and common 125 Vdc switch panels.

The CTGs for Unit 1 will be deployed to the area east of the Unit 1 EDG building. The CTGs for Unit 2 will be deployed to the north and west of the Unit 2 EDG building. One 4160 Vac/6900

Vac step-up transformer and grounding transformer for each unit will be deployed from the FLEX Equipment Storage Building and staged near the locations of the 4160 Vac CTGs. The NSRC will also supply cables for connections between the 4160 Vac distribution systems, step-up transformers, and the Phase 3 bus connections. Using the primary connection, the 4160 Vac/6900 Vac step-up transformers will be connected to existing Alternate Power DG transfer switches mounted external to the Unit 1 Train A Switchgear Room and external to the Unit 2 Train A Switchgear Room. The transfer switches allow powering one 6900 Vac safeguards bus per Unit (either Train). If the primary connections are unavailable (the transfer switches are not protected), the 4160 Vac/6900 Vac step-up transformers can be connected either directly to each Unit's Train A 6900 Vac safeguards bus via feeder breakers located in each Unit's Train A Switchgear Room, or to each Unit's Train B EDG Exciter panel located in each Unit's Train B EDG Room. Therefore, both of the secondary/alternate connection points are protected. The licensee would utilize FSI-30.0 [Reference 65] to deploy, stage, and connect the NSRC supplied CTGs. Procedure FSI-30.0 includes a step to verify proper phase rotation.

In addition to the 4160 Vac CTGs being supplied by an NSRC, the licensee will receive two 480 Vac, 1100 kW CTGs. These CTGs could be used as a replacement for the Phase 2 480 Vac, 500 kW FLEX DGs. The 480 Vac CTGs have identical connections as those for the Phase 2 FLEX DGs. Therefore the license could utilize FSI-4.0A/B to deploy, stage, and connect the NSRC supplied 480 Vac CTGs. Procedure FSI-4.0A/B includes a step to verify proper phase rotation.

The electric power system connections (Phases 2 and 3) to the Comanche Peak, Units 1 and 2, electrical distribution system are designed to provide diversity of reliable power sources, which are physically and electrically isolated such that a failure will only affect a single power source and will not adversely affect alternate power sources.

3.7.4 Accessibility and Lighting

With regard to lighting, in its FIP [Reference 18] the licensee stated that the emergency lighting systems installed to satisfy Station Blackout and Appendix R requirements will be available for the first eight hours of the event. These lighting fixtures are positioned strategically around the plant in areas that will be required by the FLEX strategies. Lighting for access into and egress out of a majority of areas in the unit is provided by emergency dc-powered lighting. In addition, portable lights and batteries which may be required to perform some local actions are provided to the operators in tool kits that are distributed throughout the plant and marked for "Emergency Use Only". A sufficient number of these tool kits are located in areas illuminated by emergency dc-powered lighting.

An ample supply of battery powered head lamps, LED lanterns, and hand-crank LED flashlights are staged in the FESB. Lighting within the FESB will be restored using one 12 kW generator, also stored within the FESB.

The licensee stated that exterior illumination will be provided by use of the four diesel engine powered portable light towers that are stored in the FESB and with the diesel powered portable light towers being provided in the Phase 3 response from the NSRC. Additionally, each of the multi-purpose high flow and SG/AFW low pressure FLEX pumps is equipped with a light package for local illumination.

3.7.5 Access to Protected and Vital Areas

In attachment 2 to the FIP [Reference 18], the licensee provided information describing that access to protected areas and internal locked 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 [Reference 18], the licensee stated that FLEX equipment stored in the FESB is maintained in a fueled condition, including the two 500 gallon trailer mounted fuel tanks, such that refueling from the diesel generators fuel oil storage tanks (DGFOSTs) will not be required for greater than 30 hours after event initiation. The fuel trailers are equipped with diesel driven fuel oil pumps to draw from the underground tanks and have electric driven fuel oil transfer pumps to refuel the majority of the FLEX equipment.

The primary source of fuel oil will be the four underground DGFOSTs. Each tank has a nominal storage capacity of 102,000 gallons. These tanks are safety-related, seismic Category I components and are protected from high winds and tornado borne missiles by virtue of their underground location. The DGFOSTs have sufficient capacity to support continuous operation of the major FLEX equipment expected to be deployed and placed into service for several weeks following ELAP initiation. Diesel fuel is also available from local offsite resources to replenish onsite fuel oil supplies.

In its FIP [Reference 18], the licensee stated that diesel fuel in the fuel oil storage tanks is routinely sampled and tested to assure fuel oil quality is maintained to ASTM standards. This sampling and testing surveillance program also assures the fuel oil quality is maintained for operation of the station emergency diesel generators.

Additional details regarding licensee's fuel oil quality measures are contained in the NRCs audit report [Reference 17]. During the onsite audit, the licensee stated fuel oil will be monitored through the site's existing preventive maintenance (PM) program, STA-677, "Preventative Maintenance." The licensee plans to evaluate the amount of fuel oil needed for readiness after an ELAP. The licensee stated that its chemistry staff performs testing of the fuel oil samples from the fuel oil tanks as needed to ensure fuel oil quality.

3.7.7 Conclusions

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 [Reference 6] 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 Comanche Peak 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 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 NRC 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 [Reference 6] guidance; therefore, the NRC 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 Comanche Peak Alternate Staging Area D is Cleburne Regional Airport. Staging Area C is the Granbury Regional Airport. Staging Area B is NOSF Annex Building parking lot. There are multiple Staging Area A's for individual FLEX components inside the protected area.

Use of helicopters to transport equipment from Staging Area C and D to Staging Area B is recognized as a potential need within the Comanche Peak 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 [Reference 6] 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 Comanche Peak, ventilation providing cooling to occupied areas and areas containing FLEX strategy equipment will be lost. As discussed in the guidance given in NEI 12-06 [Reference 6], FLEX strategies must be capable of execution under the adverse conditions (unavailability of installed plant lighting, ventilation, etc.) expected following a BDBEE resulting in an ELAP.

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. The licensee performed several loss of ventilation analyses to quantify the maximum steady state temperatures expected in specific areas related to FLEX implementation to ensure the environmental conditions remain acceptable for personnel habitability and within equipment qualification limits.

The key areas identified for all phases of execution of the FLEX strategy activities are the Control Room, the TDAFW pump rooms, the battery and inverter rooms, the SG ARV area and the Fuel Building. The licensee evaluated these areas to determine the temperature profiles following an ELAP and LUHS event. The results of the calculation have concluded that temperatures remain within acceptable limits based on conservative input heat load assumptions for all areas with no actions initially being taken to reduce heat load or to establish either active or passive ventilation (e.g., portable fans, open doors, etc.).

Control Room

The NRC staff reviewed Evaluation 12048420-R-M-00001 (VDRT-4796567), "Technical Report Updated Evaluation Environmental Temperatures to Support Response for INPO Event Report Level 1 11-4," Revision 0 [Reference 77] which provided the evaluation of the Control Room temperature transient through 72 hours following a BDBEE resulting in an ELAP. The acceptance criterion for the calculated temperatures is based on the guidance in NUMARC-87-00, Revision 1, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," which states that a Control Room temperature of 120 °F is an acceptable limit for Control Room equipment operability. The calculation determined that maximum temperatures would not exceed 110 °F without opening doors to the Control Room for 72 hours. However, FSI-5, "Initial Assessment and FLEX Equipment Staging," Revision 0 [Reference 80] directs that operator actions within 32 hours, to deploy portable fans and small generators, de-energize one lighting train, and open doors to the Control Room to reduce temperatures below 104 °F. The NRC staff reviewed the calculation and performed a walkdown of the Control Room during the audit and was able to confirm the above room operator actions and the availability of restoring CR ventilation would keep the CR temperature from rising above 110 °F.

TDAFW Pump Rooms

The licensee described in its Evaluations 12048420-R-M-00001, "Technical Report Updated Evaluation Environmental Temperatures to Support Response for INPO Event Report Level 1 11-4," Revision 0, and EV-CR-2012-002652-25, "Turbine Driven Auxiliary Feedwater Pump Room Temperature on Loss of Ventilation," Revision 0 [Reference 78] that the temperature in the TDAFW Pump Rooms will not exceed 122 °F for the first 40 hours after ELAP initiation. Procedure FSI-5 [Reference 80] will direct operators to block open the TDAFW pump room doors within 40 hours of ELAP to maintain room temperature less than 122 °F throughout an ELAP. During the audit, the NRC staff reviewed both evaluations to confirm that the temperature value of 122.2 °F from the licensee was comparable to the duration expected in the TDAFW pump room during an ELAP. The NRC staff also walked down the TDAFW pump room to identify the access portions of where the operators would make alternate FLEX pump connections for makeup and valve manipulations as needed. The NRC staff finds that the licensee has adequately addressed the ventilation of the TDAFW pump room in regards to equipment functionality.

Battery and Inverter Rooms

Evaluation 12048420-R-M-00001 (VDRT-4796567), Revision 0, [Reference 77] concluded that the maximum temperature inside the Battery Rooms will be around 110 °F 72 hours after the ELAP event. The maximum temperature in the Inverter Rooms will be 131°F at 18 hours within the ELAP event. Procedure FSI-5 [Reference 80] will direct operators to induce cooling of the Battery and Inverter Rooms by opening doors at 5.5 hours, block open adjacent stairwell, roof access, and Cable Spreading room doors at 12 hours, and deploy portable fans at 18 hours. These actions will limit the temperature from rising in the Battery and Inverter Rooms and maintain equipment habitability. The NRC staff reviewed the evaluation and walked down the Battery and Inverter Rooms locations during the audit to confirm that there would be no equipment habitability issues as long as the operator actions are taken in accordance to FSI-5 [Reference 80].

Fuel Building

The licensee indicated in its FIP [Reference 18], that ventilation is established by opening the external doors to the Fuel Building at different elevations prior to 14 hours after declaration of ELAP. The operator action is a contingency to the primary SFP makeup strategy, which will call for staging of hoses and nozzles near the SFP areas for both units. The primary SFP makeup strategy does not require Fuel Building access. The licensee indicated that SFPIS will remain functional in the Fuel Building environment expected during an ELAP. The NRC staff walked down the staging locations of the hoses and nozzles to confirm that the staging locations and also walked down the locations of the SFP instrumentation locations to confirm that they will be available during the ELAP event.

Based on temperatures remaining at or below 120 °F (the temperature limit, as identified in NUMARC-87-00 for electronic equipment to be able to survive indefinitely), the NRC staff finds that the equipment in the CR, the TDAFW Pump Rooms, Battery and Inverter Rooms, and Fuel

Building should not be adversely impacted and should perform their required functions at the expected temperatures as a result of loss of ventilation during an ELAP and LUHS event.

3.9.1.2 Loss of Heating

The licensee indicated during the audit that the heat tracing and normal area temperature controls are provided to maintain the boric acid solution greater than or equal to 65 °F. The licensee also indicated that the BATs are located within the Auxiliary Building and is protected from outside cold conditions. The licensee stated that the plant internal and external conditions surrounding the BATs would not expect to precipitate out of solution. The RWST and associated piping is located outside and within the Safeguards Building and is subjected to the same area heat gain characteristics on loss of ventilation as the BATs. The NRC staff walked down the location of the BATs and RWST with associated piping to confirm that the locations would provide suitable protection from cold temperatures. The licensee did not identify any other plant SSCs in the FIP that would require heat tracing for ELAP mitigation strategies.

3.9.1.3 Hydrogen Gas Control in Vital Battery Rooms

An additional ventilation concern applicable to Phase 2 is the potential buildup of hydrogen in the battery rooms. Off-gassing of hydrogen from station batteries is only a concern when the station batteries are charging. The licensee described in its FIP, the action to repower battery room ventilation using the restored 480 Vac power supply almost 12 hours after ELAP to prevent hydrogen accumulation. This would occur when the Phase 2 portable FLEX 480 Vac DG is deployed and connected to the electrical distribution system. The battery room ventilation will be in operation to remove any hydrogen accumulation from the recharging of the batteries.

Based on its review, the NRC staff finds that hydrogen accumulation in the safety-related battery rooms should not reach the combustibility limit for hydrogen during an ELAP since the licensee plans to repower the battery room ventilation when the battery chargers are repowered during Phase 2.

3.9.2 Personnel Habitability

To address room heat-up concerns during an ELAP, the licensee referenced evaluation 12048420-R-M-00001 (VDRT-4796567), Revision 0, [Reference 77] and Procedure FSI-5, "Initial Assessment and Equipment Deployment," [Reference 80] which describe the strategies and compensatory actions for operators to manage high temperatures when performing actions during ELAP events in the Control Room, SFP areas, and TDAFW Pump Rooms.

3.9.2.1 Control Room

As described above in SE Section 3.9.1.1, the Control Room would not exceed 110 °F for the first 72 hours after ELAP is declared. Procedure FSI-5 [Reference 80] provides instructions to operators to open Control Room doors, shed lighting, and deploy the portable fans and generators from the FLEX Storage Equipment Building to establish Control Room ventilation within 32 hours of ELAP event to maintain the temperature in the Control Room below 104 °F for the duration of the event. The NRC staff identified during the audit the location of the doors to be opened in the Control Room and where the portable fans would be staged to create ventilation for the operators in the Control Room to mitigate the ELAP event.

Based on the licensee's evaluation of the Control Room temperature below 110 °F for 72 hour and the FSI-5 [Reference 80] allowing for actions and the use of portable equipment to provide additional cooling to the Control Room, the NRC staff finds that the long-term personnel habitability in the Control Room should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

3.9.2.2 Spent Fuel Pool Areas

As described above in SE Section 3.9.1.1, ventilation is established by the 14 hour mark of the ELAP to allow habitability for the operators to stage hoses and nozzles near the SFPs for both Units for the alternate SFP makeup strategy as described in SE Section 3.7.3.1. Procedure FSI-5 [Reference 80] and FSI-6, "Alternate SFP Makeup," Revision 0 [Reference 79] also provide instructions for the operators to assess and provide ventilation prior to the staging of the hoses and nozzles. The NRC staff reviewed both procedures during the audit and walked down the staging locations to confirm the operators' capability to perform the alternate SFP makeup strategy as long as the instructions in FSI-5 [Reference 80] and FSI-6 are implemented as directed.

3.9.2.3 Other Plant Areas

TDAFW Pump Rooms

As described in SE Section 3.9.1.1, the TDAFW Pump Rooms are provided ventilation within 40 hours of declaration of ELAP to allow the TDAFW pumps to function and providing operators the ability to make alternate connections for SG makeup as described in SE Section 3.7.3.1. The doors to the TDAFW Pump Rooms are blocked open to reduce and maintain temperatures under 122°F for the duration of the ELAP event. The NRC staff walked down the locations of the TDAFW Pump Rooms during the audit to confirm that ventilation can be established by propping open the doors as directed by the instructions in FSI-5 [Reference 80].

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 [Reference 6] 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

In its FIP [Reference 18], the licensee described that at the onset of an ELAP the initial source of makeup water to the SGs is each unit's condensate storage tank. The TDAFW pump starts automatically upon loss of all ac power and is aligned to the CST. The CST is seismic Category I and is protected from tornado missiles. The tank contains a minimum of 269,700 gallons of usable water and can provide makeup to the SGs for approximately 16 hours. Prior to depletion of the CST inventory, the TDAFW pump suction will be cross-tied to the seismic Category I, missile protected RMWST, allowing simultaneous drawdown of both the CST and RMWST. The licensee stated that the minimum usable RMWST capacity of approximately 73,900 gallons will provide an additional suction source to the TDAFW pump for a minimum of 8 hours. Prior to depletion of the CST and RMWST, makeup to the CST will be provided from the SSI. The SSI dam is safety-related and seismically designed, and as an earthen dam it is not susceptible to tornado damage or other extreme environmental events. The SSI will essentially provide an indefinite supply of makeup to the SGs.

In its FIP, the licensee provided a table listing other clean water sources that could be used for makeup to the SGs, if they survived the beyond-design-basis (BDB) hazard. These water sources would be aligned after depletion of the CST and the RMWST. The additional potential water sources and their priority of use are the 315,790 gallon demineralized water storage tank, 275,000 gallon reverse osmosis product water storage tank, 228,000 gallon filtered water storage tank, and the fire protection storage tanks (each tank has a 519,000 gallon capacity).

The on-site water sources have a wide range of associated chemical compositions. The licensee evaluated the impact on SG performance and SG material degradation from using these various on-site water sources. Use of the available clean water sources are limited only by their quantities while the water supply from SSI is essentially unlimited by quantity, but is limited by quality.

The results of the licensee's water quality evaluation show that raw water from the SSI could be used for 48 hours, after depletion of the CST and RMWST, and purified water from the SSI could be used for another 216 hours before the SG design corrosion limit or precipitate limit would be expected to be reached. Once the water purification equipment is in operation the credited fully protected on-site water sources provide for approximately 12 days (total) of SG feed before SG corrosion or precipitate limits are challenged. The non-protected non-borated water sources provide significant quantities of additional CST makeup, if available following ELAP initiation. It is expected that the residual heat removal system will be restored prior to 12 days post-ELAP initiation.

3.10.2 Reactor Coolant System Make-Up

The RCS makeup is required in order to both borate the RCS and control RCS inventory. In its FIP [Reference 18], the licensee stated that a high pressure FLEX pump deployed at each unit will be aligned to first draw borated water from the BATs and then from their respective RWST. Each unit has access to both BATs located inside the auxiliary building. The BATs are safety-related, seismically designed and being located inside the auxiliary building are protected from all applicable external hazards. During normal power operation each BAT contains a minimum of 23,000 gallons of water at a boron concentration of at least 7,000 ppm. The BAT borated water source will be used initially for the RCS injection strategy.

The licensee stated that each unit is equipped with one RWST located at grade level just outside of its respective safeguards building. The RWST is safety-related, seismic and missile protected structure and therefore designed to withstand all applicable external events. During normal power operation each operating unit's RWST borated volume is maintained greater than 473,700 gallons at a boron concentration between 2,400 and 2,600 ppm. The RWST borated water source will be used following BAT depletion for the RCS injection strategy. The licensee stated that the significant borated water volume available in each unit's protected RWST and the BATs ensures RCS makeup capability will exist until restoration of permanent plant equipment in Phase 3.

3.10.3 Spent Fuel Pool Make-Up

In its FIP [Reference 18], the licensee stated that the primary source of makeup water to the spent fuel pools is either unit's RWST. As stated above, each RWST is safety-related, seismic and missile protected structure and therefore designed to withstand all applicable external events. Makeup to both SFPs is provided by a single multi purpose FLEX pump drawing suction on one of the RWSTs.

The licensee stated that a secondary source of water may be utilized for SFP makeup. The fire protection storage tank may be aligned to provide makeup should it survive the BDBEE.

3.10.4 Containment Cooling

For Phases 1 and 2 the licensee's calculations demonstrated that no actions are required to maintain containment pressure below design limits provide containment cooling is initiated within 72 hours of the ELAP initiation. During Phase 3, an alternate station service water flow is aligned for cooling various plant loads via one CCW heat exchanger. The safe shutdown impoundment is necessary for establishing alternate SSW flow and as previously described is a robust source designed to withstand all BDB external events.

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 [Reference 6] 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 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 16 hours are available to implement makeup before boil-off results in the water level in the SFP dropping off to a level 15' above the top of the fuel racks, and the licensee has stated that they have the ability to implement makeup to the SFP within that time.

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. On September 18, 2013, NEI submitted to the NRC a position paper entitled "Shutdown /Refueling Modes" [Reference 33], which described methods to ensure plant safety in those shutdown modes. By letter dated September 30, 2013 [Reference 34], the NRC staff endorsed this position paper as a means of meeting the requirements of the order.

The position paper 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. The NRC staff concludes that the position paper provides an acceptable approach for demonstrating that the licensees are capable of implementing mitigating strategies in shutdown and refueling modes of operation. In its FIP [Reference 18], the licensee informed the NRC staff of its plans to follow the guidance in this position paper. During the audit process, the NRC staff observed that the licensee had made progress in implementing this position paper.

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 [Reference 6] 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 FSIs provide guidance that can be employed for a variety of conditions. Clear criteria for entry into FSIs ensure that FLEX strategies are used only as directed for BDB external event conditions, and are not used inappropriately in lieu of existing procedures. When FLEX equipment is needed to supplement Emergency Operating Procedures (EOPs) or Abnormal Procedure (ABN) strategies, the EOP or ABN directs the entry into and exit from the appropriate FSI procedure. The licensee stated that the FLEX strategy support instructions were developed in accordance with PWROG guidelines. FLEX support instructions provide available, pre-planned FLEX strategies for accomplishing specific tasks in the EOPs or ABNs. The licensee further stated that FSIs are used to supplement and not replace the existing procedure structure that establishes command and control for the event.

The licensee stated that FSIs have been reviewed and validated to the extent necessary to ensure the strategy is feasible. Validation was accomplished in accordance with station procedures.

3.12.2 Training

In its FIP [Reference 18], the licensee described that Comanche Peak's Nuclear Training Program has been revised to assure personnel proficiency in the mitigation of BDBEE is adequate and maintained. These programs and controls were developed and have been implemented in accordance with the Systematic Approach to Training (SAT) process.

The licensee stated that initial training has been provided and periodic training will be provided to site emergency response leaders on BDB emergency response strategies and implementing guidelines. Personnel assigned to direct the execution of mitigating strategies for BDBEEs have received the necessary training to ensure familiarity with the associated tasks, instructions, and mitigating strategy time constraints.

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 [Reference 6], Section 11.4, and a training program has been established and will be maintained in accordance with NEI 12-06 [Reference 6], Section 11.6.

3.13 Maintenance and Testing of FLEX Equipment

As a generic issue, NEI submitted a letter to the NRC dated October 3, 2013 [Reference 35], which included Electronic Power Research Institute (EPRI) Technical Report 3002000623, "Nuclear Maintenance Applications Center: Preventive Maintenance Basis for FLEX Equipment." By letter dated October 7, 2013 [Reference 36], the NRC endorsed the use of the EPRI report and the EPRI database as providing a useful input for licensees to use in developing their maintenance and testing programs.

In its FIP, the licensee has committed to abide by the EPRI generic resolution described above. The FLEX equipment program ensures the equipment is maintained to the standards of NEI 12-06 [Reference 6] Section 11.5. The licensee stated that it uses the existing station procedures as an initiating point for identifying maintenance and testing requirements for the FLEX equipment. The EPRI templates are used, if available, as one of the inputs to development of PMs. Inputs also included manufacturer provided information, recommendations, or other plant experience for maintaining non-plant equipment or equipment that would be in storage for long periods.

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, Section 11.5.

3.14 Alternatives to NEI 12-06, Revision 0

3.14.1 Reduced Set of Hoses and Cables As Backup Equipment

In its FIP [Reference 18], the licensee took an alternative approach to the NEI 12-06, Revision 0 [Reference 6] guidance for hoses and cables. In NEI 12-06 [Reference 6], Section 3.2.2, Revision 0 states that in order to assure reliability and availability of the FLEX equipment required to meet these capabilities, the site should have sufficient equipment to address all functions at all units on-site, plus one additional spare, i.e., an N+1 capability, where "N" is the number of units on-site. Thus, a single-unit site would nominally have at least two portable pumps, two sets of portable ac/dc power supplies, two sets of hoses and cables, etc.

The licensee requested to use the guidance of item 16 of Section 3.2.2, NEI 12-06, Revision 2, which allows each site to use either Method 1 or Method 2 for hoses and cables. Method 1 states either a) Provide additional hose or cable equivalent to 10 percent of the total length of each type and size of hoses or cable necessary for the N capability; or b) Provide spare cabling and hose of sufficient length and sizing to replace the single longest run needed to support any FLEX strategy. The NRC staff approves this alternative as being an acceptable method of compliance with the order.

In conclusion, the NRC staff finds that although the guidance of NEI 12-06, Revision 0 has not been met, the licensee met the guidance described in NEI 12-06, Revision 2 if these alternatives are implemented as described by the licensee, they will meet the requirements of the order.

3.14.2 Nominal Initial Tank Levels

In its FIP [Reference 18], the licensee took an alternative approach to the NEI 12-06, Revision 0 [Reference 6] guidance for initial plant conditions. In NEI 12-06 [Reference 6], Section 3.2.1.2 Revision 0 states that at the time of the postulated event, the reactor and supporting systems are within normal operating ranges for pressure, temperature, and water level for the appropriate plant condition. All plant equipment is either normally operating or available from the standby state as described in the plant design and licensing basis.

The licensee requested to use the guidance of item 2 of Section 3.2.1.2, NEI 12-06, Revision 2. The licensee stated that NEI 12-06 specifies that the minimum conditions for plant equipment operability or functionality does not need to be assumed in establishing the capability of that equipment to support FLEX strategies provided there is an adequate basis for the assumed value.

In conclusion, the NRC staff finds that although the guidance of NEI 12-06, Revision 0 has not been met, the licensee met the guidance described in NEI 12-06, Revision 2 if these alternatives are implemented as described by the licensee, they should meet the requirements of the order.

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 28, 2013 [Reference 22], the licensee submitted its OIP for Comanche Peak in response to Order EA-12-051. By letter dated June 7, 2013 [Reference 23] the NRC staff sent a request for additional information (RAI) to the licensee. The licensee provided a response by letter dated July 3, 2013 [Reference 24]. By letter dated November 4, 2013 [Reference 25], the NRC staff issued an ISE and RAI to the licensee.

By letters dated August 28, 2013 [Reference 26], February 27, 2014 [Reference 27], and August 28, 2014 [Reference 28], 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 SFPIS which will function following a BDBEE, including modifications necessary to support this implementation, pursuant to Order EA-12-051. By letter dated

December 16, 2014 [Reference 29], the licensee reported that full compliance with the requirements of Order EA-12-051 was achieved. By letter dated April 24, 2015 [Reference 50] the NRC staff sent a RAI to the licensee regarding the information contained in the compliance letter. The licensee provided its responses by letters dated June 11, 2015 [Reference 45], and August 13, 2015 [Reference 49].

The licensee has installed a SFP level instrument system designed by Westinghouse, LLC. During an audit, the NRC staff reviewed Westinghouse's SFPIS design specifications, calculations and analyses, test plans, and test reports. The NRC staff issued its audit report on August 18, 2014 [Reference 30].

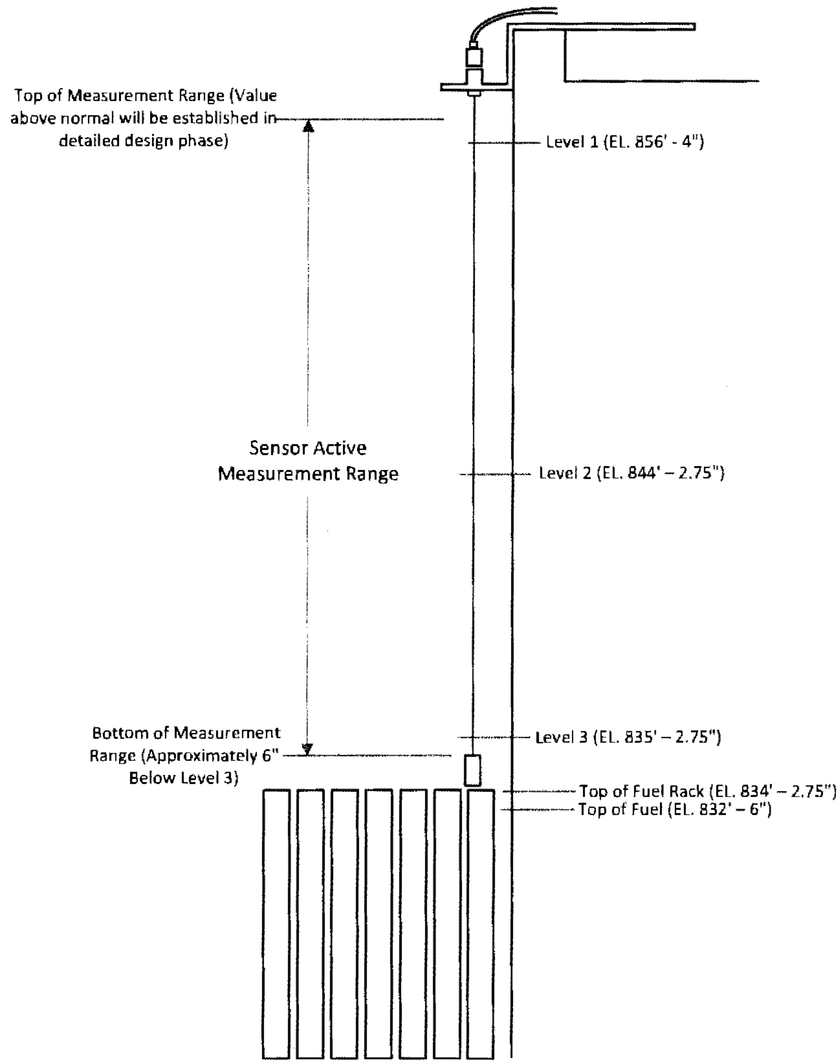
Refer to Section 2.2 above for the regulatory background for this section.

4.1 Levels of Required Monitoring

Comanche Peak has two SFPs for Units 1 and 2, each pool is approximately 30' wide by 40'-3" long. These SFPs have similar configurations. In its OIP, the licensee stated that Level 1 corresponds to 22', 1.25" above the top of the fuel storage racks; Level 2 corresponds to 10' ±1'above the top of the fuel storage racks; and Level 3 corresponds to 1' above the top of the fuel storage racks.

In its letter dated July 3, 2013 [Reference 24], the licensee stated that Comanche Peak designated Level 1 to be Elevation 856'-4" (22'-1.25" above the top of the fuel racks). This level corresponds to the LO-LO [low-low] level process setpoint that trips the fuel pool cooling pump as described in Comanche Peak UFSAR, Section 9.1.3.2. The LO-LO level process set point is selected to ensure that the pump will trip prior to a point where a void will occur in the suction lines. The licensee's analysis has demonstrated that there is adequate NPSH [net positive suction head] for pump operation at saturated conditions for water at plant elevation 856'. In its letter dated July 3, 2013 [Reference 24], the licensee also provided a sketch depicting Levels 1, 2, and 3 and SFP level measurement range as shown in the figure below (Figure 1 - Comanche Peak SFP Levels of Monitoring).

Figure 1 - Comanche Peak SFP Levels of Monitoring



As discussed in NEI 12-02 [Reference 8], Section 2.3.1, Level 1 will be the HIGHER of two points. The first point is the water level at which suction loss occurs due to uncovering of the spent fuel cooling inlet pipe. The second point is the water level at which loss of spent fuel cooling pump NPSH occurs under saturated conditions. The NRC staff determines the designated Level 1 (856'-4") is the HIGHER of the above two points and therefore consistent with NEI 12-02 [Reference 8]. Level 2 was identified as elevation 844'-2.75". The NRC staff has determined this level is consistent with NEI 12-02 [Reference 8], since it is 10' (±1') above the highest point of any fuel rack seated in the SFP. Finally, the NRC staff found that Level 3 (835'-2.75") is consistent with NEI 12-02 [Reference 8] Level 3, since it is above the highest point of any fuel rack seated in the SFP.

Based on the evaluation above, the NRC staff finds that the licensee's selection of Levels 1, 2, and 3 appears to be consistent with NEI 12-02 [Reference 8] 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 SFPIS shall include specific design features, including specifications on the instruments, arrangement, mounting, qualification, independence, power supplies, accuracy, testing, and display. The specific requirements are outlined in Section 2.2 of this safety evaluation with regards to the design features. Below is the NRC staff's assessment of the design features of the SFPIS.

4.2.1 Design Features: Instruments

In its OIP [Reference 22], the licensee stated that the Comanche Peak SFPIS will utilize fixed primary and backup guided wave radar (GWR) sensors. The GWR technology uses the principle of time domain reflectometry to detect the SFP water level. A microwave signal is sent down the cable probe sensor, and when it reaches the water, it is reflected back to the sensor electronics. This is due to the difference between the dielectric constants of air and water. Using the total signal travel time, the sensor electronics embedded firmware computes the level of the water in the SFP. The probe, which is located in the SFP, is separated from the sensor electronics, and connected by an interconnecting cable that is routed into an adjacent building. By placing the sensor electronics outside of the SFP area it is not subject to the harsh environment resulting from the boiling or loss of water in the pool during a postulated loss of inventory event that creates high humidity, steam and/or radiation.

As for the SFP level measurement range, the licensee stated that the primary and backup instrument channels will provide continuous level indication over a range of 23'-9.25", from 12" above the top of the fuel storage racks (plant elevation 835'-2.75") to the high pool level elevation (plant elevation 859'). In its letter dated July 3, 2013 [Reference 24], the licensee provided a sketch depicting the SFP levels of monitoring and the instrument measurement ranges (Figure 1 of this evaluation).

The NRC staff noted that the measurement range covers Levels 1, 2, and 3, as described in Section 4.1 above. However, the NRC staff had concerns regarding the availability of the SFPIS when the SFP swing gate(s) and/or transfer canal lift gate is (are) closed. In its letter dated June 11, 2015 [Reference 45], the licensee provided a response to the NRC staff's concern, in which it stated that if each SFP is isolated from the other, there are two level indications in each pool. The normal system alignment is for one train of SFP cooling to cool both pools, with each pool's swing gate closed and sealed, and the transfer canal lift gate in its storage position in the Wet Cask Pit. Depending on plant evolutions, both SFP cooling trains may be in operation with each train cooling both pools or each train of SFP cooling aligned to its respective pool. The swing gates are allowed to remain open during periods of inactivity for up to a maximum of 24 hours (during fuel handling activities). The transfer canal lift gate will normally only be installed in a transfer canal position to allow draining and inspecting underwater portions of the transfer system prior to an outage. When one train of SFP cooling is aligned to both SFPs, flow is balanced so level is maintained essentially equal between the pools. Additionally, the SFP Suction Isolation Valves are normally maintained in an open position. These valves would be closed when filling a cooling train (restoration from maintenance) or when one train of cooling is aligned to only one pool (not a preferred lineup). Because of this normally cross connected suction piping between both pools, the level between the pools remains relatively constant even if both trains of cooling flow are stopped. This hydraulic coupling would remain as long as SFP level remains above the suction screens (centerline elevation of the suction piping is 854'-6"; bottom of the suction piping is at 854'). With the SFP swing gates closed and sealed, the pools cannot be drained below 854' via system piping. When the pools are hydraulically coupled through the suction cross connects (> 854') pool level can be indicated by all 4 level indicators.

The licensee further stated that when both SFP swing gates are open and the transfer canal swing gate is not installed in a transfer canal position, both SFPs are hydraulically coupled through the transfer canal. This hydraulic coupling would remain as long as SFP level remains above 834'-2" which is the highest elevation of the bottom liner of the transfer canal. In this configuration (level above 834'-2") pool level can be indicated by all 4 level indicators. The SFP swing gates are not left open for longer than 24 hours during periods of inactivity (personnel not located within the SFP area capable of closing the swing gates) since there are suction piping connections in the transfer canal and wet cask pit that could drain a SFP down to 834'-2".

In its letter dated June 11, 2015 [Reference 45], the licensee also provided a table listing all possible pool interconnections and separation conditions with gate combinations, and the available number(s) of level indication for each pool under those conditions.

As for compensatory measures for the loss of SFP level indication, in its letter dated June 11, 2015 [Reference 45], the licensee provided the following measures:

Loss of one SFP level indication in a pool:

1. Ensure that the SFP suction cross connects are open to hydraulically couple both pools. This would require one or both cooling trains to be aligned to cool both pools which is the normal system alignment.

2. Monitor the remaining SFP level indication and compare/trend to the normal SFP level indications (plant computer and/or locally) to ensure continued reliable indication of the remaining instrument for that pool. Trending to be done at same frequency as logging normal SFP level indication (logged twice daily per operator rounds).

Loss of both SFP level indications in a pool:

1. Ensure that the SFP suction cross connects are open to hydraulically couple both pools. This would require one or both cooling trains to be aligned to cool both pools which is the normal system alignment.

2. Normal SFP level indications (plant computer and/or locally) will continue to be monitored at the normal frequency.

- Normal SFP level indication can be determined using the plant computer or locally. Low SFP level (<858'-0") will generate a plant computer alarm in the control room and locally at the SFP panel. Low-Low SFP level (<856'-4") will cause a plant computer alarm and trip the associated cooling water pump (requires 2 of 2 instruments for the same pool) and generate an alarm at the SFP panel. Alarms on the SFP panel are annunciated in the control room by a common SFP panel trouble alarm.

- Plant procedures are already in place to makeup to the SFP if below normal level. ABN-909, "Spent Fuel Pool/Refueling Cavity Malfunction," initiates makeup to a pool if level drops below normal (<858'). ECA-0.0, "Loss of All AC Power" [Reference 55] has personnel initiate makeup to the SFP from the fire protection system per ABN-909 if level is < 857'-4". Both of these procedures ensure that SFP level is maintained above the hydraulic coupling level of 854' through the cooling train suction lines.

- It is not intended to open SFP swing gates to hydraulically couple the SFPs as this presents a higher risk of draining both pools to lower levels than by coupling through the suction piping.

The NRC staff noted that the licensee adequately addressed the NRC staff's concern with regard to the impacts could have on the availability of the SFPIS as the result of possible pool interconnections and separation conditions. The NRC staff also noted that the licensee adequately addressed the compensatory measures for the loss of SFP level indication.

Based on the evaluation above, the NRC staff finds that the licensee's design, with respect to the number of SFP instrument channels and instrument range, appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.2 Design Features: Arrangement

For Comanche Peak SFP level instrument arrangement, in its letter dated December 16, 2014 [Reference 29], the licensee stated that the Unit 1 SFP primary instrument channel sensor is mounted near the southeast corner of the pool. From the primary sensor, the coaxial signal cable raceway is routed west along the south side of the pool until it enters a fire/radiation barrier wall penetration to the adjacent Auxiliary Building (AB) 852' elevation, Room X-235. The Unit 1 SFP backup instrument channel sensor is mounted near the southwest corner of the pool. This places the backup sensor between the south side wall and the gate to the transfer canal, and at least 30' from the primary sensor. From the backup sensor, the coaxial signal cable raceway is routed west around the transfer canal until it enters a second fire/radiation barrier wall penetration to the adjacent AB 852' elevation, Room X-235. The Unit 2 SFPIS layout is a mirror image of the Unit 1 layout. In the AB the raceway for both pools maintain physical separation of the primary and backup instrument channel signal cables and power cables that meet site standards for separation for Class 1E conduit.

In addition, in its letter dated December 16, 2014 [Reference 29], the licensee provided a sketch depicting the locations of the sensor probes and cable routings for the primary and backup instrument channels for both units.

The NRC staff noted that the SFP level instrument channel arrangement does not satisfy the separation requirement of the NRC Order EA-12-051. The Unit 1 primary and backup signal cables are routed side by side from the southwest corner of the pool to the wall penetration to the AB. Similarly, the Unit 2 primary and backup signal cables are routed side by side from the northwest corner of the pool to the wall penetration to the AB.

As such, the NRC staff considered the licensee's design feature to be an alternative approach to the NEI 12-02, Section 3.2 [Reference 8] guidance regarding cable arrangement.

Specifically, NEI 12-02, Section 3.2 adds that the arrangement requirement is to be accomplished by reasonable separation and missile protection, including routing the cabling for power supplies and channel indications separately from other cabling for the other channels.

In response to the NRC staff's concern, in its letter dated June 11, 2015 [Reference 45], the licensee stated that the Comanche Peak SFP level instrument channels are protected from damage due to missiles. The Fuel Building (FB) is a massive reinforced concrete Seismic Category I structure. The South and North ends of the FB are against the Unit 1 and Unit 2 Containment Buildings, respectively, and are thereby shielded from tornado missiles. The West face of the FB is against the East face of the AB, which is a multi-level massive reinforced concrete Seismic Category I structure that rises above the FB, and thereby shields the FB from tornado missiles. Thus, the layout of the Seismic Category I structures leaves only the East face and the roof of the FB exposed to tornado missile strikes. The SFP level instrument channels are routed on the FB floor in metal conduits, which are robust enough to withstand pedestrian traffic.

In its letter dated June 11, 2015 [Reference 45], the licensee also provided an evaluation of potential missiles from both BDBEE and internal missiles generated by BDBEE or explosion as summarized below:

Tornado

According to the licensee, based on the Licensing Basis design requirements for Seismic Category I structures, tornado based missiles do not present a credible hazard to the SFP level instruments or their channels. In the UFSAR, Section 3.5.3 states that the "Reinforced concrete external roofs and walls of seismic Category I structures form barriers against tornado-generated missiles." Using established design requirements, the external reinforced concrete roofs and walls will prevent penetration and backside spalling (an internal missile) from all design-basis tornado missiles.

Seismic

According to the licensee, seismically induced internally generated missiles do not present a credible hazard to the SFP level instruments or their channels based on the following information:

- Based on design requirements at CPNPP, the generation of internal missiles by components in the overhead being shaken loose during a seismic event is not credible. Nuclear Safety Related (NSR) Seismic Category I components are designed to the requirements of Position C.1 in NRC RG 1.29, "Seismic Design Classification," to remain functional during and after an SSE. Non-nuclear safety (NNS) related components that meet the requirements of Position C.2 in RG 1.29, are classified as Seismic Category II, and have supports that are designed to remain structurally intact following the SSE. Small lightweight non-nuclear safety related components that cannot be designed as Seismic Category II (i.e., suspended lights) are provided with stainless steel aircraft cable restraints to prevent them from falling in the event that they experience a structural failure during a seismic event. All SSC above the elevation of the SFP have either Seismic Category I or Seismic Category II mountings, or seismic restraints, to preclude them from falling into the SFP.

- The only NNS components massive enough to present a credible damage potential to the SFP level instrument channels would be the HVAC ducting and components. UFSAR Section 3.2.1.2 for Seismic Category II states that both the FB and AB HVAC Systems have been designed as Seismic Category II. Other less massive potential missiles would include small and large bore electrical conduit. The Design Basis Documents, that govern the design of NSR and NNS conduit inside Seismic Category I structures, state that the conduits are designed to remain structurally intact during and after an SSE.

- Expansion anchor bolts are typically used to mount components to concrete. CPNPP only purchases expansion anchor bolts that are suitable for Seismic Category I applications. In addition, there is only one procedure for the installation of expansion anchor bolts for both Seismic Category I and Seismic Category II applications. The uniformity between Seismic Category I and Seismic Category II anchorage applications provides reasonable assurance that they will perform their design function that is structural integrity.

<u>Internal Missiles/Explosion</u>

According to the licensee, internally generated missiles produced with or without an explosion do not present a credible hazard to the SFP level instruments or their channels based on the following information:

- A suspended load dropped from a crane or hoist could be considered to be a gravitationally propelled missile. The FB overhead crane has a travel path that runs east and west between the two SFP, but does not travel over the pools. The parked position for the crane is towards the eastern end of its rails over the EL 841' floor which further removes it as a potential hazard source from the SFP level instrument channels at EL 860'.

- The Fuel Handling Bridge Crane (FHBC) runs north and south over both SFP, and is designed for the movement of fuel assemblies. The park position for the FHBC is over the New Fuel Vault that is located between SFP 2 and the Wet Cask Pit. The designed features of the FHBC prevent it from hoisting a fuel assembly out of the SFP which precludes the FHBC from being a source for a dropped load on the SFP level instruments. In the event of a BDBEE induced ELAP, both the FB overhead crane and the FHBC have design features that permit the bridges to be moved by manual means to the designated parking positions.

- The locations of the SFP level instrument channels do not have high-energy piping or large reciprocating machinery. A review of UFSAR Table 3.5-1 verifies that missiles outside of the containment are typically associated with high-energy piping systems and their components that could potentially come apart.

- In accordance with the station administrative procedures, the storage of combustible or explosive gases either in or within 50' of a Seismic Category I structure is prohibited. If a maintenance activity requires the use of a combustible or explosive gas, such as acetylene for a cutting torch, only the quantity required for the activity is brought to the work site, it is tracked under station administrative controls, and removed when the activity has been completed. Hydrogen gas is used in the turbine generators and as a cover gas in the Volume Control Tank, but is not used inside the FB. The bulk storage of hydrogen gas is outside the plant's protected area west of the Turbine Building. The hydrogen bulk gas storage area and the FB are separated by about 900'. Thus, the site purchased gases do not present an explosion hazard to the SFP level instruments or their channels.

- The generation of a significant amount of hydrogen gas in the FB would require uncovering of the spent fuel in the SFP. For the fuel in the SFP to be uncovered, it would require that the primary and secondary strategies for maintaining SFP water level provided in response to EA-12-049 had failed along with the backup equipment to be provided in Phase 3 by the National SAFER Response Centers (NSRC). So this is judged to not be a credible scenario to consider. There is almost 58'-6" of head room over the SFP for a gas such as hydrogen to accumulate. As discussed in FLEX Response Procedure FSI-5.0, certain doors will be opened within 14-hours of the BDBEE that caused the ELAP. Opening these FB doors to the outside with over 100' of vertical height difference will set up a natural chimney draft that will be assisted by the warm air rising from the SFP. Based on the design features of the FB and the FLEX response procedures, it will not be possible for a significant volume of explosive gas such as hydrogen to accumulate. In the highly unlikely event that a volume of hydrogen did manage to accumulate, it would have to be of sufficient concentration to exceed the Lower Explosive Limit (LEL) of 4.1-percent by volume. As discussed in the Department of Energy Report HNF-9411, a minimum oxygen concentration of 5-percent by volume is also required for deflagration to occur. The hydrogen gas is not confined so that ignition of the gas would not result in an explosive rupture of a container. The ignition of the unconfined accumulation of hydrogen would result in a deflagration induced short duration impulse pressure, but no shrapnel or missiles. The only area of the FB where hydrogen gas would gravitate towards and thereby be the most likely location for a deflagration, is not over the SFP but rather the Wet Cask Pit.

The NRC staff found that the licensee's evaluation of potential missiles from both BDBEE and internal missiles generated by BDBEE or explosion reasonably addressed the NRC staff's concerns with regards to the SFP level instrument channel separation.

Based on the evaluation above, the NRC staff finds that although the licensee's arrangement for the SFPIS does not meet the guidance of NEI 12-02 [Reference 8], this alternative is acceptable to the NRC staff. This is based on the robust nature of the FB, the AB that shields the FB from tornadic missiles, the lack of high energy piping and reciprocating machinery inside the FB that is associated with internal missiles, and the design of components and supports to either remain functional or intact following an SSE.

4.2.3 Design Features: Mounting

In its letter dated June 11, 2015 [Reference 45], the licensee stated that in accordance with the Westinghouse site specific calculations and the Design Change Package, FDA-2013-000008-25-03, the design of the sensor bracket and its mounting are classified as Seismic Category I, the highest seismic or safety classification of the SFP in which the probes are located. The seismic loads, both inertial and hydrodynamic sloshing, were based on the in-structure acceleration response spectra curves for the site SSE. The in-structure SSE acceleration response spectra are based on the Design Response spectra shown in UFSAR Figures 3.7B-1 and 3.7B-7. The mounting brackets are attached to the EL 860' FB "floor" next to the SFP, which is the edge of the 9-foot thick wall of the SFP that extends down to the basemat that is founded on undisturbed rock that underlies the entire site. Since bolted connections are used in the load path for the mounting bracket, per NRC Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," the SSE response spectra for 7 percent damping were used. The hydrodynamic sloshing loads were computed based on the application of TID-7024, "Nuclear Reactors and Earthquakes", August 1963. The lateral convective pressure was found to vary from 0.24359 psi at the top of the storage racks to 0.87208 psi at EL 859'-0". The qualification of the mounting bracket was conservatively based on 0.9 psi.

For mounting anchorage of the SFP level instrument probes, in its letter dated June 11, 2015 [Reference 49], the licensee stated that the reactions on the expansion anchor bolts were evaluated for Seismic Category I structural integrity in the Engineering Basis of the Design Change Package, FDA-2013-000008-25-03. The maximum tension and shear loads on the four anchor bolts for the alternate mounting bracket from the Westinghouse site specific analysis are 638.0 lbs. and 39.9 lbs., respectively. For the primary mounting bracket the maximum tension and shear loads were 1,879.1 lbs. and 148.5 lbs, respectively. The 1/2" outside diameter (OD) Hilti Kwik Bolt 3's with a minimum embedment of 3-1/2" were used. The allowable basic tension and shear for a 1/2" OD Kwik Bolt 3 with 3-1/2" of embedment is 2,286 lbs. and 2,067 lbs., respectively.

By letter dated June 11, 2015 [Reference 45], the licensee also provided the descriptions of the electronic equipment and conduit support mounting designs as summarized below:

PULL Boxes:

The four pull boxes are located on the face of the west wall of the FB. The pull boxes were mounted using generic Train 'C' Seismic Category II details found on Drawing 0210-TC0-0002, Sheet 03L, Revision CP-1. The generic Seismic Category II qualification of the pull boxes (a.k.a. junction boxes) is performed in site Calculation CS-CNDTC-TCO-0002. The 7 percent damped SSE acceleration response spectra are applicable to the pull box qualification.

Electronics Enclosures

The four electronic enclosures are located in the AB. The Seismic Category II qualification of the electronic enclosure mounting is in site Calculation CS-CA-0000-5519, Revision 0. In accordance with the CPNPP procedures, the Seismic Category II mounting is designed for the SSE in a manner similar to that of a Seismic Category I mounting. The analysis of the SSE loads was conservatively based on the use of 1.5 times the peak of the in-structure acceleration response spectra from the 7 percent curves.

Conduit Supports

The conduit is routed from the side of the SFP in the FB to the display panels in the AB. The design of the SFP level instrument channel conduit and their supports uses the pertinent SSE 7 percent damped acceleration response spectra curves for the FB Elevation (EL) 860' and AB EL 852'. The Seismic Category II qualification basis for these conduit support details is found in site Calculation CS-CND-TC-TC0-0002. In accordance with the CPNPP procedures, the Seismic Category II mounting is designed for the SSE in a manner similar to that of a Seismic Category I mounting. The Engineering Basis of FDA-2013-000008-25-03 addresses an edge distance challenge with the conduit for the primary instrument that runs along the edge of the SFP. The required minimum edge distance is 5.5" but only 4" could be provided. As a result, the shear capacity of the 3/8" OD Hilti Kwik Bolt 3's had to be reduced. In accordance with Section 5.6.2.4 of DBD-CS-015, the allowable shear capacity was reduced from 1,231 lbs. to 889 lbs. For a 1" OD conduit with a weight of 2 lbs/ft, an 8' maximum tributary span, and using 1.5 times the peak of the EL 860' FB SSE spectra plus 1g for gravity (1.455g*1.5 + 1g = 3.2 g), the maximum support shear force was determined to be 51.2 lbs. The impact on the shear and tension interaction ratio can be seen by examining the shear contribution. The revised shear capacity resulted in the contribution of shear to the shear and tension interaction remaining less than 1 percent and supports the conclusion in the Engineering Basis of the FDA. Therefore, according to the licensee, it is reasonable to conclude that the conduit with these supports will perform their function of supporting the conduit during and after an SSE.

In addition, the licensee stated that the optimum routing of the SFPIS conduit in the AB required that Seismic Category I cable tray hangers be used for support rather than a concrete surface. The licensee used three cable tray supports. The licensee's conclusions for these three revised cable tray hanger calculations were that the addition of the four Seismic Category II SFP level instrument channel conduit did not adversely impact their Seismic Category I qualification. Therefore, the licensee concluded that the structural integrity of the SFP level instrument channel conduit that are supported was likewise assured.

By letter dated August 13, 2015 [Reference 53], the licensee provided a description of the SFP level transmitter mounting design. The level transmitters are located in the AB. The Seismic Category II qualification of the level transmitter mounting is documented in site Calculation CS-CA-0000-5519, Revision 1. In accordance with the licensee's procedures, the Seismic Category II mounting is designed for the UFSAR described SSE in a manner similar to that of a Seismic Category I application.

The level transmitter mounting details are shown in FDA-2013-000008-25-03 on implementation Drawing SK-0009-13-000008-25-01. The licensee stated its analysis of the SSE loads was conservatively based on the use of 1.5 times the peak of the in-structure acceleration response spectra from the 7 percent curves. The weight of the level transmitter, its mounting bracket, tributary weight of cables and the conduit coupler was 30 lbs. The anchorage and mounting evaluations performed in CS-CA-0000-5519, Revision 1, were conservatively based on a total weight of 40 lbs. The licensee determined that the SSE and self-weight loads resulted in a maximum anchor bolt tension of 163 lbs and a maximum shear of 50 lbs. The combined anchor bolt interaction ratio for the level transmitter was then computed to be 0.03 which is significantly less than the acceptance value of 1.0. The mounting bolts that connect the level transmitter to the mounting bracket were similarly checked for the SSE and self-weight loads. The licensee calculated the loads to a maximum mounting bolt tension of 140 lbs and a maximum shear of 100 lbs. The combined mounting bolt interaction ratio for the level transmitter was then computed to be 0.15 which is less than the acceptance value of 1.0.

The NRC staff finds the licensee's proposed mounting design appears to be consistent with NEI 12-02 [Reference 8] 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. In its OIP, the licensee stated that the instrumentation systems will meet the requirements for augmented quality in accordance with NEI 12-02 [Reference 8] and the ISG.

The NRC staff finds that, if implemented appropriately, this approach appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.4.2 Equipment Reliability

Section 3.4 of NEI 12-02 [Reference 8] 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.

During the vendor audit [Reference 32], the NRC staff reviewed the Westinghouse SFPIS's qualifications and testing for temperature, humidity, radiation, shock and vibration, and seismic. The NRC staff further reviewed the anticipated Comanche Peak's seismic, radiation, and environmental conditions. Below is the NRC staff's assessment of the equipment reliability of Comanche Peak SFPIS.

4.2.4.2.1 Temperature, Humidity, and Radiation

In its letter dated July 3, 2013 [Reference 24], the licensee stated that components subject to significant radiation under BDB conditions are those in the SFP area. These include the sensor probe, bracket, coupler and interconnecting cable. The sensor probe and bracket are stainless steel and will not be affected by the anticipated radiation. The coupler and cable are selected by design for the beyond design basis radiation service. With regard to environmental conditions of the SFP area, in its letter dated December 16, 2014 [Reference 29], the licensee stated that the coaxial cable, the coupler, the pool-side bracket, and the probe in the SFP area are required to operate reliably in the service environmental conditions specified in the table below (Table 1 – SFP Area Environmental Conditions).

Table 1 – SFP Area Environmental Conditions

Parameter	Normal	BDB
Temperature	50 – 140 °F	212 °F
Humidity	0 – 95% Relative Humidity (RH)	100% RH (saturated steam)

Related to radiological and environmental conditions of the outside of SFP area, in its letter dated December 16, 2014 [Reference 29], the licensee stated that the level sensor electronics, sensor electronics bracket, indicators, and the electronics enclosures outside of the SFP area are required to operate reliably in the service conditions specified in the table below (Table 2 – Outside of SFP Area Radiological and Environmental Conditions).

Table 2 – Outside of SFP Area Radiological and Environmental Conditions

Parameter	Normal	BDB
Radiation TID	≤ 1E03 Rads γ	≤ 1E03 Rads γ
Temperature	50 – 120 °F	140 °F
Humidity	0 – 95% RH	95% RH (non-condensing)

According to the licensee, based on the Westinghouse environmental qualifications (WNA-TR-03149-GEN / proprietary) and the radiological assessment in site Calculation ME-CA-0000-5530, the SFPIS components and associated level indication functions mounted outside the SFP environment were evaluated for a 40 year normal operating dose of 876 Rem. This was based on a dose rate of 2.5 mrem/hr and a conservative one year SFP BDB accident dose of 0.1 Rem that was based on a resultant concrete shielded/attenuated dose rate of 7.06E-06 rem/hr at the location of the transmitter electronics. The resultant 40 years of normal operations plus 1 year BDB Accident Total Integrated Dose (TID) is 876.1 Rem. Therefore,according to the licensee, the transmitter electronics can be expected to operate satisfactorily for the normal and BDB service.

The licensee further stated that under bounding plant accident conditions, the maximum expected temperature for the AB 852.5' areas containing SFPIS components has been evaluated for 130.8 °F; the maximum expected temperature for the SFP FB 860' area containing SFPIS components has been evaluated for 160 °F. The post-ELAP BDB accident RH environmental parameters are not available for the AB 852.5' areas. To estimate a realistic post-ELAP event RH data range, the historical temperature data and actual field temperature/RH values were used to establish a baseline set of data typically expected under normal conditions such as to derive a spectrum set of post-accident values. The estimated maximum expected RH for the AB 852.5' areas under post-ELAP accident conditions is expected to be less than 95 percent (non-condensing); the FB 860' Elev. at the SFPs is conservatively expected to achieve 100 percent RH (Saturated Steam). Therefore, according to the licensee, it is determined that the SFPIS component qualifications bound the estimated RH values and maximum temperatures expected for the respective areas of concern.

The NRC staff noted that the licensee adequately addressed the equipment reliability of SFPIS with respect to temperature, humidity and radiation. The equipment qualifications envelop the expected Comanche Peak's radiation, temperature, and humidity conditions during a postulated BDBEE. The equipment environmental testing demonstrated that the SFP instrumentation should maintain its functionality under expected BDB conditions.

4.2.4.2.2 Shock and Vibration

In its letter dated December 16, 2014 [Reference 29], the licensee stated that the active electronic components of the SFPIS are firmly mounted inside NEMA [National Electrical Manufacturers Association] -4X housings. These housings are mounted to a seismically qualified support / structure and will not be subject to additional shock or vibration forces outside of those for seismic. Therefore, according to the licensee, no additional shock testing is required beyond Seismic Qualification Requirements defined in Institute of Electrical and Electronics Engineers (IEEE) 344-2004, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations". The Westinghouse SFPIS's equipment seismic adequacy is demonstrated based on the guidance of IEEE Standard 344-2004. The results of testing on the SFPIS are included in Westinghouse documents EQ-QR-269 and WNA-TR-03149-GEN (proprietary).

The NRC staff noted that the licensee adequately addressed the equipment reliability of SFPIS with respect to shock and vibration. The test parameters envelop the Comanche Peak's expected shock and vibration conditions during a postulated BDBEE.

4.2.4.2.3 Seismic

In its letter dated December 16, 2014 [Reference 29], the licensee stated that the Westinghouse SFPIS, including the four pool-side brackets, is qualified as Seismic Category I in accordance with IEEE Std 344-2004. The testing and analysis demonstrated that the SFPIS meets the seismic performance requirements of Westinghouse design specification WNA-DS-02957-GEN (proprietary). The Required Response Spectra (RRS) for this program includes the 10 percent margin recommended by IEEE Std. 323-2003. The seismic test and analysis results are documented in the proprietary Westinghouse Test Reports, EQQR-269 and WNA-TR-03149-GEN (proprietary). Although the Westinghouse SFPIS is qualified to Seismic Category I, the system as a whole (e.g., display units, transmitter units, conduit routing) is considered Seismic Category II.

The NRC staff had concerns of Seismic Category II mounting for SFPIS that may not meet the Order EA-12-051 mounting requirement. Although the SFPIS is non-safety related, the mounting shall be designed considering the maximum seismic ground motion to the design-basis of the SFPI structures to meet the requirements of the order. In response to the NRC staff's concern, in its letter dated June 11, 2015 [Reference 49], the licensee stated that In accordance with CPNPP established processes and procedures, the Seismic Category II mounting is designed for the UFSAR described SSE in a manner similar to that of a Seismic Category I mounting. The NRC staff found that the licensee adequately addressed the NRC staff's concerns as its SFP level instrument mounting design considered Comanche Peak SSE. Further seismic qualifications of the SFPIS mounting is addressed in Subsection 4.2.3, "Design Features: Mounting," of this evaluation.

The NRC staff noted that the licensee adequately addressed the equipment reliability of SFPIS with respect to seismic. The SFPIS was tested to the seismic conditions that enveloped Comanche Peak's expected highest SSE. The NRC staff also noted that the assumptions, analytical, and conclusion model used in the sloshing analysis for the sensor mounting bracket are adequate.

Based on the evaluations above, the NRC staff finds the licensee's proposed instrument qualification process appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.5 Design Features: Independence

For the SFP level instrument channel independence, in its letter dated July 3, 2013 [Reference 26], the licensee stated that each system will be installed using completely independent cabling structures, including routing of the interconnecting cable within the SFP area in separate hard-pipe conduits. The 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. The system displays will be installed in separate qualified NEMA-4X or better enclosures, with the primary display in the control room envelope. The primary and backup systems will be completely independent of each other, having no shared components.

For the SFP level instrument channel electrical independence, in its letter dated December 16, 2014 [Reference 29], the licensee stated that each SFPIS channel of equipment has an independent power supply and an independent UPS with 24V battery backup. The primary and backup level instruments in each pool receive normal power from dedicated breakers in separate Class Non-IE lighting panels, AB20 and AB19. These lighting panels are fed from different buses, independent back to the 480V switchgear crossties, reducing the occasions when both are de-energized at the same time.

The NRC staff noted, and verified during the walkdown, that the licensee adequately addressed the SFP level instrument channel independent. With the licensee's proposed power design, the loss of one level instrument channel power would not affect the operation of other channel under BDBEE conditions. The instrument channels' physical separation is further discussed in Subsection 4.2.2, "Design Features: Arrangement".

Based on the evaluation above, the NRC staff finds the licensee's proposed design, with respect to instrument channel independence, appears to be consistent with NEI 12-02

[Reference 8] 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 December 16, 2014 [Reference 29], the licensee stated that the primary and backup level instruments in each SFP will receive normal power from dedicated breakers in separate Class Non-IE lighting panels, AB20 and AB19 [as shown in Table 3, SFP Level Instrument Power Sources, below]. These lighting panels are fed from different buses, independent back to the 480V switchgear crossties, reducing the occasions when both are de-energized at the same time.

Table 3 – SFP Level Instrument Power Sources

Channel	Normal PWR	480V MCC	480V SWGR
X-01 Primary Loop	AB20	MCC XB1-3	480V SWGR 1B1/SWGR 2B1
X-01 Backup Loop	AB19	MCC XB3-4	480V SWGR 1B3/SWGR 2B3
X-02 Primary Loop	AB20	MCC XB1-3	480V SWGR 1B1/SWGR 2B1
X-02 Backup Loop	AB19	MCC XB3-4	480V SWGR 1B3/SWGR 2B3

If power is not restored to the normal power sources before batteries are depleted, all four SFP level instruments can be powered from either Class 1E Train A lighting panel EAB1 or Class 1E Train Blighting panel EAB2, using the bulkhead connector in each SFPIS remote display panel. NOTE: EAB1 or EAB2 are included in the panels to be supplied by a portable generator as part of the mitigating strategies in response to NRC Order EA-12-049.

In its letter dated June 11, 2015, the licensee further stated that wide range SFP level instruments normally receive power from Train C lighting panels. During an ELAP event, SFP level instruments continue to receive power from an integral UPS battery backup supply. This power supply is designed to last for at least 72 hours. By this time the NSRC is expected to deliver large generators to the site. Once either unit is able to re-energize either train 6.9 KV safeguard bus, power to the associated Train A or Train B lighting panel will be restored. Once either Train A or Train B lighting panel power is restored, a temporary power cord will be supplied from a dedicated breaker in the lighting panel and the power cord will be routed to each of the four SFP level instrument remote display panels. FSI-30.0, Attachment 23 [Reference 65], describes how to align alternate power to the SFP wide range level instruments.

Related to the battery backup duty cycle, in its letter dated December 16, 2014 [Reference 29], the licensee stated that its power consumption calculation demonstrated that the SFPIS will last greater than 3 days from a fully charged battery after ac power loss. The CPNPP Site Acceptance Test verified the installed UPS batteries function longer than 3 days.

The NRC staff finds the licensee's proposed power supply design appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.7 Design Features: Accuracy

With regard to the SFP level instrument design accuracy, in its letter dated December 16, 2014 [Reference 29], the licensee stated that the channel accuracy for each SFPIS instrument channel is ±3" for the full level measurement range. This covers the normal SFP surface level or higher to within 6" of the fuel assembly under both normal and BDB conditions. Both SFP primary and backup sensor electronics require periodic calibration verification to check that the channel's measurement performance is within the specified tolerance (±3"). If the difference is larger than the allowable tolerance during the verification process, then an electronic output verification/calibration will be performed. In addition, if the electronic output verification/calibration fails to restore the performance, then a calibration adjustment will be performed. The calibration adjustment is performed to restore level measurement accuracy be within the acceptance criteria at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent points of the full span.

The NRC staff noted that the licensee adequately addressed the SFPIS accuracy requirements including the expected instrument channel accuracy performance under both normal and BDB conditions. If implemented properly, the instrument channels should maintain the designed accuracy following a power source change or interruption without the need of recalibration.

The NRC staff finds the licensee's proposed instrument accuracy appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.2.8 Design Features: Testing

Regarding the SFPIS periodic testing and calibration, in its letter dated December 16, 2014 [Reference 29], the licensee stated that the calibration verification is performed by simulating a change in SFP level through the use of a tool designed specifically in conjunction with the fixed pool-side bracket design. If the calibration verification indicates that the channel being checked is operating out of specification or an anomaly is observed, an electronic output verification/calibration is performed on the level sensor electronics outside of the SFP area. If the electronic output verification/calibration does not restore performance, a calibration adjustment will need to be performed. The calibration adjustment uses a portable test kit that attaches at the sensor electronics mounting, allowing the full calibration to be performed outside of the SFP area without removing installed SFPIS components from the SFP area.

For the SFP level instrument channel check, in its letter dated December 16, 2014 [Reference 29], the licensee stated that the SFP level indications will be subject to periodic recording during Operator rounds with appropriate qualitative acceptance criteria. Readings of the primary and backup level indications in each SFP which fall outside the established criteria will be identified in the CPNPP Corrective Action Program for resolution. The independent channels are checked against each other, consistent with their shared accuracy and post BDB event function.

For the SFP level instrument functional checks, in its letter dated December 16, 2014 [Reference 29], the licensee stated that periodic calibration verification checks on each SFPIS channel will be performed based on the plant maintenance procedure. The periodic calibration verification will be performed within 60 days of a planned refueling outage considering normal testing scheduling allowances (e.g., 25 percent). This calibration check is not required to be performed more than once per 12 months on any individual SFPIS channel. Calibration verification will be included in the site preventive maintenance program. Additionally, at the time of the calibration verification check, the probe will be inspected to ensure no frays or nicks have occurred since the last verification check and to remove any significant accumulation of boron.

The NRC staff finds the licensee's proposed SFP instrumentation design that allows for testing, including functional test and channel check, appears to be consistent with NEI 12-02 [Reference 8] 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 letter dated December 16, 2014 [Reference 29], the licensee stated that the primary and backup level display panels for both pools are installed near the AB corridor. The location and arrangement was chosen since the panels are grouped together at Operations request to allow both pool levels to be easily monitored; installation near the AB 852' corridor is easily accessible within minutes for Control Room personnel through the rear exit of the Control Building 852' elevation; and the AB corridor also provides easy access to 120 Vac power for the display panels UPS from nearby lighting panels AB19 and AB20.

The licensee further stated that location of the remote display panels in Room X-241 are approximately 50' from the rear exit of the Control Building. After a BDB event the Control Building rear door would be a standard egress and ingress for Operations personnel.

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 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.3 Evaluation of Programmatic Controls

4.3.1 Programmatic Controls: Training

In its OIP [Reference 24], the licensee stated that a systematic approach will be used to identify the population to be trained and to determine both the initial and continuing elements of the required training. Personnel will complete training prior to being assigned responsibilities associated with this instrument. The NRC staff noted that the use of systematic approach to identify the training population and to determine both the elements of the required training is consistent with NEI 12-02 [Reference 8].

The NRC staff finds that the licensee's proposed plan to train personnel in the operation, maintenance, calibration, and surveillance of the SFPI and the provision of alternate power to the primary and backup instrument channels, including the approach to identify the population to be trained, appears to be consistent with NEI 12-02 [Reference 8] guidance, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.3.2 Programmatic Controls: Procedures

For Comanche Peak procedures related to the SFPIS, in its letter dated July 3, 2013 [Reference 26], the licensee stated that site procedures for inspection, maintenance, repair, operation, abnormal response and administrative controls for the SFPIS will be developed in accordance with Comanche Peak procedure controls, using the vendor technical manual and other documentation. The vendor technical manual and documentation will include principles of operation, inspection and maintenance recommendations, drawings and technical documentation, individual component manufacturer manuals and documentation and recommended spare parts. Additional procedures for abnormal response will be developed in conjunction with FLEX implementation.

In its letter dated December 16, 2014 [Reference 29], the licensee provided a list of procedures associated with SFP level instrument calibration, testing, maintenance, abnormal responses as shown below:

- For NORMAL operating conditions, Operations Procedure OWI-104-19 addresses Operations log keeping, including primary and backup channel deviation criteria.

- For ABNORMAL operating conditions, procedure(s) ECA0.0A/B, "Loss of All AC Power," [Reference 55] will provide for any actions during loss of power events.

- Procedure INC-4876X, "Channel Calibration Spent Fuel Pools X-01 and X-02 Wide Range level Channels 4876, 4877, 4878, and 4879," Revision 0, dated January 21, 2015 [Reference 74] was developed to address:
  - Calibration/verification requirements
  - Replacement (if required)

- The site preventive maintenance program will specify the frequency of the required calibration activities and include Inspection/cleaning

- Westinghouse Procedure WNA-OG-00127-GEN, "Spent Fuel Pool Instrumentation System Technical Manual," contains instructions for installation, normal operation, abnormal response/troubleshooting, cleaning, calibration, maintenance, spare parts, and special tools for the SPFIS as well as the major components of the system.

- Westinghouse Procedure WEC WNA-TP-04709-GEN, "Spent Fuel Pool Instrumentation System Calibration Procedure," contains the calibration and test procedures, the periodic calibration verification checks, and periodic maintenance checks for the probe. This procedure ensures that the SFPIS will retain its accuracy as defined by the design specification document WNA-DS-02957-GEN, the NRC order and NEI guidance.

The NRC staff noted that the licensee adequately addressed the SFP level instrument procedure requirements. The procedures had been established for the testing, surveillance, calibration, operation, and abnormal responses for the primary and backup SFP level instrument channels. The NRC staff finds that the licensee's proposed procedures appear to be consistent with NEI 12 02, as endorsed by JLD-ISG-2012-03, and should adequately address the requirements of the order.

4.3.3 Programmatic Controls: Testing and Calibration

For the SFP level instrument testing and calibration programs, in its letter dated December 16, 2014 [Reference 29], the licensee stated that the maintenance and testing program will ensure that regular testing and calibration is performed. Calibration and testing for the instruments will be based on Westinghouse Procedure WNATP-04709-GEN, "Spent Fuel Pool Instrumentation System Calibration Procedure," as adapted to specific site procedures. The site specific procedures will define the periodicity for Operator rounds to record the primary and backup instrument channel indications. The periodic testing and inspection of the installed instrument channel will be scheduled and tracked within the site Preventative Maintenance program.

In its letter dated December 16, 2014 [Reference 29], the licensee stated that In the event that a non-functioning instrument channel cannot be returned to service within the 90 day period, any compensatory actions will be identified in the corrective action program. For example, enhanced monitoring through operator rounds could be performed to compare the available instrument channel indications to existing SFPIS.

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

4.4 Alternative to NEI 12-02, Revision 1

In its December 16, 2014 [Reference 29], compliance letter, the licensee took an alternative approach to the NEI 12-02, Section 3.2 [Reference 8] guidance regarding cable arrangement. Specifically, NEI 12-02, Section 3.2 adds that the arrangement requirement is to be accomplished by reasonable separation and missile protection, including routing the cabling for power supplies and channel indications separately from other cabling for the other channels. The NRC staff evaluated the licensee's proposed alternative in Section 4.2.2.

Based on the evaluation above, the NRC staff finds that although the licensee's arrangement for the SFPIS does not meet the guidance of NEI 12-02 [Reference 8], this alternative is acceptable to the NRC staff. This is based on the robust nature of the FB, the AB that shields the FB from tornadic missiles, the lack of high energy piping and reciprocating machinery inside the FB that is associated with internal missiles, and the design of components and supports to either remain functional or intact following an SSE.

4.5 Conclusions for Order EA-12-051

In its letter dated December 16, 2014 [Reference 29], the licensee stated that they would meet the requirements of Order EA-12-051 by following the guidelines of NEI 12-02 [Reference 8], 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 [Reference 8], as endorsed by JLD-ISG-2012-03. In addition, the NRC staff concludes that if the SFPIS is installed at Comanche Peak Nuclear Power Plant 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 NRC staff conducted an onsite audit in April 2015 [Reference 17]. The licensee reached its final compliance date as documented in letter dated July 28, 2016 [Reference 18], and has declared that both of the reactors are 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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62. Comanche Peak Calculation EE-1E-BT2ED3, "125 VDC Battery and Charger Sizing Calculation CP2-EPBTED-03, CP1-EPBCED-05, CP1-EPBCED-07," Revision 3

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64. Comanche Peak FDA-2013-000008-27, "Final Design Authorization for the development of a specification for the procurement of two 480V FLEX diesel generators and the installation of a quick connection ground at the generator staging location," Revision 0 (This FDA did not include an official title), Attachment 6.28, "25 kV Loop Phase 2 Generator Connection," of ER-ME-133 dated April 30, 2015

65. Comanche Peak FSI-30.0, "Phase 3 Equipment Operation," Revision 0

66. Comanche Peak FSI-20.0A/B, "Loss of All AC Power While on Shutdown Cooling," Revision 0

67. Comanche Peak FSA-24.0A/B, "MODE 5/6 DC Bus Load Management and Phase 2 480 VAC Generator Alignment," Revision 0.

68. Comanche Peak CPNPP Calculation CN-SEE-II-12-36, "Determination of the Time to Boil in the Comanche Peak Units 1 and 2 Spent Fuel Pools After an Earthquake," Revision 0

69. Comanche Peak Calculation CN-SEE-II-12-36, "Determination of the Time to Boil in the Comanche Peak Units 1 and 2 Spent Fuel Pools After an Earthquake," Revision 0

70. Comanche Peak Calculation ME-CA-000-5507, "FLEX Spent Fuel Pool Make-up Pressure Drop," Revision 0

71. Comanche Peak Calculation ME-CA-000-5507, "FLEX Spent Fuel Pool Make-up Pressure Drop," Revision 0

72. Comanche Peak Calculation ER-ME-133, "Beyond-Design-Basis External Event Mitigation Strategies," Revision 1

73. Comanche Peak Calculation CN-ISENG-14-3, "Containment Pressures and Temperatures for Comanche Peak Units 1 and 2 During an ELAP Calculated with MAAP 4.07," Revision 0

74. Comanche Peak Procedure INC-4876X, "Channel Calibration Spent Fuel Pools X-01 and X-02 Wide Range level Channels 4876, 4877, 4878, and 4879," Revision 0, dated January 21, 2015

75. Comanche Peak FDA-2013-00008-26, "FLEX Equipment Storage Building," Revision 4

76. Comanche Peak FDA-2013-00008-29, "FLEX Equipment Storage Building (X-FX-2K19)," Revision 3

77. Comanche Peak Evaluation 12048420-R-M-00001 (VDRT-4796567), "Technical Report Updated Evaluation Environmental Temperatures to Support Response for INPO Event Report Level 1 11-4," Revision 0

78. Comanche Peak Evaluation EV-CR-2012-002652-25, "Turbine Driven Auxiliary Feedwater Pump Room Temperature on Loss of Ventilation," Revision 0

79. Comanche Peak FSI-6, "Alternate SFP Makeup," Revision 0

80. Comanche Peak FSI-5.0, "Initial Assessment and FLEX Equipment Staging," Revision 0

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Date: December 14, 2016

By letter dated February 28, 2013 (ADAMS Accession No. ML13071A344), the licensee submitted its OIP for Comanche Peak 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 enclosed safety evaluation. By letters dated November 4, 2013 (ADAMS Accession No. ML13295A674), and August 5, 2015 (ADAMS Accession No. ML15180A261), 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 December 16, 2014 (ADAMS Accession No. ML15016A188), the licensee 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 the licensee's strategies for Comanche Peak. The intent of the safety evaluation is to inform the licensee 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 NRC staff will evaluate implementation of the plans through inspection, using Temporary Instruction 2515/191, "Inspection of the Implementation of Mitigation Strategies and Spent Fuel Pool Instrumentation Orders and Emergency Preparedness Communications/Staffing/ Multi-Unit Dose Assessment Plans, Revision 1" (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 Stephen Monarque, Orders Management Branch, Comanche Peak Project Manager, at 301-415-1544 or at Stephen.Monarque@nrc.gov.

Sincerely,
/RA/
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Office of Nuclear Reactor Regulation

Docket Nos.: 50-445 and 50-446
Enclosure:
Safety Evaluation
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ADAMS Accession No. ML16334A173 ***via email**

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