Entergy

Entergy Operations, Inc.
1448 S.R. 333
Russellville, AR 72802
Tel 479-858-3110

Richard L. Anderson
ANO Site Vice President

0CAN121602

December 30 2016

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
11555 Rockville Pike
Rockville, MD 20852

SUBJECT: Mitigating Strategies Assessment (MSA) Report for the New Seismic Hazard Information per Nuclear Energy Institute (NEI) 12-06, Appendix H, Revision 2, H.4.3 Path 3
Arkansas Nuclear One – Units 1 and 2
Docket Nos. 50-313 and 50-368
License Nos. DPR-51 and NPF-6

Dear Sir or Madam:

The purpose of this letter is to provide the results of the assessment for Arkansas Nuclear One, Units 1 and 2 (ANO-1 and ANO-2, respectively) to demonstrate that an Individual Plant Examination of External Events (IPEEE)-based alternate mitigating strategy can be implemented considering the impacts of the reevaluated seismic hazard. The assessment was performed in accordance with the guidance provided in Appendix H of Reference 1, which was endorsed by the NRC in Reference 2.

The mitigating strategies seismic hazard information (MSSHI) is the licensee's reevaluated seismic hazard information at ANO-1 and ANO-2 which was developed using probabilistic seismic hazard analysis. The MSSHI for Path 3 includes the performance-based ground motion response spectrum (GMRS) at various frequencies developed at the ANO-1 and ANO-2 control point elevations. In response to Reference 7, Entergy Operations, Inc. submitted the reevaluated seismic hazard information including the uniform hazard response spectra, GMRS, and the hazard curves (References 3, 5, and 6). The NRC staff concluded that the MSSHI adequately characterizes the reevaluated seismic hazard for the site (Reference 4).

Consistent with Section H.4.3 of Reference 1, the ANO-1 and ANO-2 GMRS is bounded by the high-confidence-of-low-probability-of-failure (HCLPF) spectrum developed from evaluations for the IPEEE between 1 and 10 Hz – referred to as the IPEEE HCLPF spectrum (IHS). Section 6.1.2 of Reference 2 identified that the method described in Section H.4.3 of Reference 1 is applicable to ANO-1 and ANO-2. The ANO-1 and ANO-2 GMRS are not bounded by the IHS at frequencies greater than 10 Hz.

Based upon the mitigating strategies assessment in the attachment to this letter, the mitigating strategies for ANO-1 and ANO-2 considering the impacts of the reevaluated seismic hazard can be implemented as designed.

This letter contains no new regulatory commitments. Should you have any questions regarding this submittal, please contact Stephenie Pyle at 479.858.4704.

I declare under penalty of perjury that the foregoing is true and correct; executed on December 30, 2016.

Sincerely,

ORIGINAL SIGNED BY TERRY A. EVANS (ACTING VP) FOR RICHARD L. ANDERSON

RLA/nbm

Attachment: Mitigating Strategies Assessment for Arkansas Nuclear One

REFERENCES:

1. *NEI 12-06, Revision 2, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide*, December 2015 (ML16005A625)

2. *JLD-ISG-2012-01, Revision 1, Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events*, February 2016 (ML15357A163)

3. Entergy letter to NRC, *Seismic Hazard and Screening Report (Central Eastern United States Sites), Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force (NTTF) Review of Insights from the Fukushima Dai-ichi Accident*, dated March 28, 2014 (ML14092A021) (0CAN031404)

4. NRC letter to ANO, *Arkansas Nuclear One, Units 1 and 2- Staff Assessment of Information Provided Pursuant to 10 CFR 50.54(f), Seismic Hazard Reevaluations for Recommendation 2.1 of the NTTF Review of Insights from the Fukushima Dai-ichi Accident (TAC NOS. MF3822 and MF3823)*, dated December 15, 2015 (ML15344A109) (0CNA121502)

5. Entergy letter to NRC, *Response to Request for Additional Information Associated with NTTF Recommendation 2.1, Seismic Hazard and Screening Report Arkansas Nuclear One*, dated August 21, 2014 (ML14233A275) (0CAN081401)

6. Entergy letter to NRC, *Information Pursuant to 10 CFR 50.54(f) Regarding the Seismic Aspects of Recommendation 2.1 of the NTTF Review of Insights from the Fukushima Dai-ichi Accident*, dated November 4, 2014, (ML14308A212) (0CAN111401)

7. NRC Letter to Entergy, *Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the NTTF Review of Insights from the Fukushima Dai-ichi Accident*, dated March 12, 2012 (ML12053A340) (0CNA031208)

cc: Mr. Kriss Kennedy
Regional Administrator
U. S. Nuclear Regulatory Commission, Region IV
1600 East Lamar Boulevard
Arlington, TX 76011-4511

NRC Senior Resident Inspector
Arkansas Nuclear One
P.O. Box 310
London, AR 72847

U. S. Nuclear Regulatory Commission
Attn: Mr. Thomas J. Wengert
MS O8 B1A
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Attachment to

0CAN121602

Mitigating Strategies Assessment for Arkansas Nuclear One

Mitigating Strategies Assessment for Arkansas Nuclear One

Introduction

The purpose of this mitigating strategies assessment is to evaluate and demonstrate that Arkansas Nuclear One, Units 1 and 2 (ANO-1 and ANO-2, respectively) can mitigate the effects of the reevaluated seismic hazard information developed pursuant to the 10 CFR 50.54(f) letter dated March 12, 2012 (Reference 14). The assessment was performed in accordance with the guidance provided in Reference 1. Reference 1 discusses a method to develop an alternate mitigating strategy (AMS) to address the mitigating strategies seismic hazard information (MSSHI). This includes a modification of the general criteria and baseline assumptions included in Section 3.2.1 of Reference 1 to exclude consideration of losses such as an extended loss of alternating current power (ELAP), loss of offsite power, or loss of ultimate heat sink (LUHS) unless caused by the seismic hazard. Reference 2 provides an NRC staff position that the method described in Section H.4.3 of Reference 1 for an AMS is acceptable for mitigating a beyond-design-basis external event (BDBEE).

An individual plant examination of external events (IPEEE)-based AMS relies on the seismic evaluation of plant equipment to demonstrate robustness of structures, systems, and components (SSCs) to the ground motion response spectrum (GMRS). The IPEEE for ANO-1 and ANO-2 relied on the results of an Electric Power Research Institute (EPRI) seismic margins assessment (SMA) methodology to demonstrate the capability to bring the plant to a safe-shutdown condition following a review level earthquake (RLE) as described in NUREG-1407 (Reference 5). The EPRI SMA methodology approach evaluated two safe-shutdown success paths. The safe-shutdown success paths provide independent means of achieving a safe-shutdown condition following a severe seismic event (e.g., core cooling by heat removal from the steam generators and core cooling by reactor coolant system ‘feed and bleed’).

The IPEEE high-confidence-of-low-probability-of-failure spectrum (IHS) for ANO-1 and ANO-2 demonstrates plant seismic capacity to levels higher than the GMRS in the 1-10 Hz range (Reference 4). Seismic evaluations performed under the IPEEE included SSCs in those two safe-shutdown success paths. Therefore, based on the results of the IPEEE, safe-shutdown of the plant following a seismic event can be accomplished and consequences can be mitigated for a seismic event up to the plant capacity level (i.e., the IHS) for which the SSCs in the IPEEE were evaluated.

Indefinite Coping

A plant-specific evaluation was performed which concluded that SSCs that limit the SMA-based IPEEE coping duration to 72 hours are available for an indefinite period following a beyond-design-basis seismic event at the reevaluated seismic hazard level to support continued maintenance of the safe-shutdown condition. The ANO-1 and ANO-2 IPEEE was based on the EPRI SMA method. This approach defined the Seismic Equipment List for evaluation of safe-shutdown success paths to be comprised of those SSCs required to bring the plant to a safe-shutdown condition and maintain that condition for a minimum of 72 hours. Therefore, the IPEEE results have been evaluated for limitations that are based on the 72-hour coping duration. Generally, the conclusions of the SMA are not sensitive to coping duration; however, certain consumable items, such as water and fuel oil inventories, have been evaluated based

on a limited onsite supply. The ability to continue coping would potentially require re-supply of consumables.

Site access is assumed to be restored to a near-normal status and/or augmented transportation resources are available within a few days as discussed in NEI 12-01 (Reference 6) to allow for additional supplies to be delivered and allow for continuation of coping strategies and maintain the plant in a safe-shutdown condition. A plant-specific evaluation has been performed to identify consumables and/or SSCs that are limiting for the 72-hour coping duration assumed in the development of the IPEEE and to identify methods of addressing any shortfalls.

The coping evaluation (Reference 11) concluded that borated and non-borated water would be available indefinitely for all safety functions. Several water supplies are available to ANO-1 and ANO-2 to support coping for an extended period following the beyond-design-basis seismic event to support continued maintenance of the safe-shutdown condition. This includes multiple large atmospheric storage tanks and the ultimate heat sink. The large atmospheric storage tanks include the ANO-1 condensate storage tank (CST), both ANO-2 CSTs, the safety-related condensate storage tank (QCST), the ANO-1 borated water storage tank, and the ANO-2 refueling water tank. These tanks would provide numerous days of continued operation for reactor coolant inventory control, decay heat removal, and spent fuel pool (SFP) cooling. This would provide ample coping time before inventory from the ultimate heat sink is required. The ultimate heat sink is comprised of the emergency cooling pond (ECP), a large but finite source of inventory, and Lake Dardanelle which can be considered an indefinite supply of water. The National Strategic Alliance for FLEX Emergency Response (SAFER) Response Centers (NSRC) would supply portable pumps and other equipment to support the indefinite coping capability for both ANO-1 and ANO-2.

Although not determined to be limiting, fuel oil supplies supporting emergency diesel generator and portable diesel-driven equipment operation were also evaluated for extended coping (Reference 11). The on-site supplies have been evaluated to last at least 3.5 days to continue the strategies evaluated under the IPEEE and the on-site FLEX strategies for SFP cooling. Consistent with the ANO Final Integrated Plan (FIP) (Reference 9), at least 72 hours of on-site fuel is ample time to have additional fuel oil provided from offsite resources as necessary.

<u>IPEEE Upgrade to Full Scope</u>

The ANO-1 IPEEE was a modified full scope SMA and requires the performance of a detailed review of relay chatter. The ANO-2 IPEEE was a modified focused scope SMA and also requires the performance a detailed review of relay chatter. ANO-2 is included in the focused scope bin, and an upgrade to a full scope assessment is required as described in EPRI 1025287 (Reference 7).

ANO-2 was binned as a 0.3g focused scope plant in NUREG-1407 (Reference 5). As stated in Section 3.3.1 of the EPRI Seismic Evaluation Guidance: Screening, Prioritization, and Implementation Details (SPID), focused-scope IPEEE submittals may be used for screening against the GMRS provided they are enhanced to bring them in line with full scope assessments. The enhancements include (1) a full scope detailed review of relay chatter and (2) a full evaluation of soil failures.

Full Scope Relay Chatter Review

Assessments of relay chatter effects in accordance with the scope and procedures described in NUREG-1407 (Reference 5) were performed for ANO-1 and ANO-2. ANO-1 and ANO-2 were considered A-46 plants, and the relay chatter review was conducted consistent with staff recommendations outlined in NUREG-1407, Appendix D, Table 7.17.2, which includes expansion of the A-46 relay scope to include IPEEE systems and evaluation of the entire expanded scope at the IPEEE RLE.

Soil Failure Analysis

As stated in NUREG 1407 (Reference 5), Section 3.2.1, a plant in the full-scope category that is located on a rock site is not required to perform a soil failure evaluation. The ANO-1 and ANO-2 safety-related structures are founded on rock.

SFP Cooling Evaluation

The evaluation of SFP cooling for ANO was performed based on the initial conditions established in NEI 12-06 (Reference 1) for SFP cooling coping in the event of an ELAP/LUHS. The evaluation also used the results of SFP heatup analyses from the ELAP evaluation as input (Reference 9).

The FLEX strategy for SFP cooling utilizes SFP level monitoring and makeup capability as described in the ANO Final Implementation Plan (Reference 9). The permanently installed plant equipment relied on for the implementation of the SFP cooling FLEX strategy includes components associated with SFP level instrumentation and the SFP makeup riser. This equipment, portable FLEX equipment availability (including its storage and deployment pathways) and the permanently installed plant equipment needed to accomplish SFP cooling have subsequently been evaluated considering the GMRS-consistent loading conditions in accordance with NEI 12-06, Appendix H, Section 5, and/or Seismic Qualification Utility Group (SQUG) experience-based walkdowns (Reference 12). FLEX equipment availability has been demonstrated through evaluations in accordance with NEI 12-06, Appendix H, Section 5, by evaluating the SFP makeup riser pipe supports, both ANO FLEX storage buildings, sliding and rocking of FLEX equipment stored within those buildings, the onsite FLEX equipment deployment path, and the NSRC equipment deployment path. In addition, Seismic Qualification Utility Group (SQUG) experience-based walkdowns were conducted to demonstrate sufficient seismic adequacy of the SFP makeup riser piping, SFP level instrumentation components, operator access pathways needed to implement the FLEX SFP cooling strategies, and local storage of portable flexible hoses near the SFP. Through the evaluations completed in accordance with NEI 12-06, Appendix H, Section 5, and SQUG walkdowns, the means to provide SFP cooling following a severe seismic event has been demonstrated to be adequate for GMRS-consistent loading conditions in accordance with NEI 12-06, Appendix H.

High Frequency Evaluation (HFE)

To address high frequency exceedance above the IHS, ANO-1 and ANO-2 have conducted an evaluation of high frequency motion sensitive components (relays) in accordance with the guidance in EPRI 3002004396 (Reference 8). The HFE confirmed that the applicable devices in the EPRI SMA methodology scope are acceptable for the high frequency motions at both

ANO-1 and ANO-2 (Reference 13). Reliance on post-event operator actions was necessary to resolve outliers. A summary of the operator actions and associated outliers is provided in Reference 13.

Availability of FLEX Equipment

With the exception of SFP cooling, the AMS described in H.4.3 does not rely upon availability of FLEX equipment. On-site FLEX equipment may be available for deployment to support the maintenance of core cooling, containment, and SFP cooling functions. In order to provide additional potential mitigating capability, portable FLEX equipment not being used for the AMS is stored and reasonably protected in accordance with Section 5.3.1 of NEI 12-06.

Additionally, ANO maintains the capability to obtain additional portable FLEX equipment from offsite sources. The use of offsite equipment for ANO is documented in Reference 9. The industry has established two NSRCs to support utilities during BDBEEs, of which ANO has established contracts to participate in the process for support of the NSRCs as required. Each NSRC holds multiple sets of equipment, capable of being fully deployed when requested. In the event of a beyond-design-basis seismic event, equipment can be moved from an NSRC to a local assembly area established by the SAFER team. From there, equipment can be taken to the site and staged at the SAFER onsite Staging Area by helicopter, if ground transportation is unavailable. Communications would be established between the site and the SAFER team via satellite phones and required equipment moved to the site as needed. Initial equipment would be delivered to the site within 24 hours from the initial request. The order in which equipment is delivered is identified in the ANO SAFER Response Plan and no modifications to the sequence are necessary following a seismic event.

Summary of Modifications

Based on the conclusions of the seismic MSA, ANO does not require any modifications to assure SFP cooling, indefinite coping, the availability of FLEX equipment, or to support components evaluated under the HFE.

Implementation of SFP makeup following a severe seismic event would be at the discretion of Operations. The existing site procedures direct operations to restore SFP cooling utilizing various methods in the event of an SFP emergency, one of which includes providing emergency makeup from the respective unit's service water system. The service water system for each unit was determined to be seismically adequate as part of IPEEE, as it is required for safe-shutdown. While Operations would likely utilize the service water systems to provide SFP cooling following a loss of normal SFP cooling, the MSA shows that the FLEX SFP hose makeup strategy is capable of being implemented, providing additional flexibility following a severe seismic event. As such, no procedure changes are necessary because Operations would direct the use of the FLEX SFP makeup based on the condition of the unit.

REFERENCES

1. NEI 12-06, Revision 2, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide*, December 2015 (ML16005A625)

2. JLD-ISG-2012-01, Revision 1, *Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for BDBEEs*, February 2016 (ML15357A163)

3. Entergy letter to NRC, *Seismic Hazard and Screening Report (Central Eastern United States Sites), Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the NTTF Review of Insights from the Fukushima Dai-ichi Accident*, dated March 28, 2014 (ML14092A021) (0CAN031404)

4. NRC letter to ANO, *Staff Assessment of Information Provided Pursuant to 10 CFR 50.54(f), Seismic Hazard Reevaluations for Recommendation 2.1 of the NTTF Review of Insights from the Fukushima Dai-ichi Accident (TAC NOS. MF3822 and MF3823)*, dated December 15, 2015 (ML15344A109) (0CNA121502)

5. U.S. NRC, *NUREG-1407: Procedural and Submittal Guidance for the IPEEE for Severe Accident Vulnerabilities*, Washington, D.C., June 1991 (ML063550238)

6. NEI, *NEI 12-01 Revision 0: Guideline for Assessing Beyond-Design-Basis Accident Response Staffing and Communications Capabilities*, Washington, D.C., May 2012

7. EPRI, *SPID for the Resolution of Fukushima NTTF Recommendation 2.1: Seismic, Report Number 1025287*, Palo Alto, CA, November 2012

8. EPRI, *High Frequency Program: Application Guidance for Functional Confirmation and Fragility Evaluation*, Report Number 3002004396, Palo Alto, CA, July 30, 2015

9. Entergy letter to NRC, *Notification of Full Compliance with NRC Order EA-12-049 Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for BDBEEs*, dated January 12, 2016 (ML16014A396) (0CAN011601)

10. NRC letter to NEI, *Endorsement of EPRI Report 3002007148, Seismic Evaluation Guidance: SFP Integrity Evaluation*, dated March 17,2016 (ML15350A158)

11. CALC-ANOC-CS-16-00008, *Mitigating Strategies Assessment for New Seismic Hazards Information ANO*, Revision 000

12. CALC-13-E-0005-57, *HCLPF Evaluation of FLEX SFP Cooling and Instrumentation*, Revision 000

13. Entergy Letter to NRC, *High Frequency Supplement to Seismic Hazard Screening Report, Response NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the NTTF Review of Insights from the Fukushima Dai-ichi Accident*, dated December 30, 2016 (0CAN121603)

14. NRC Letter to Entergy, *Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the NTTF Review of Insights from the Fukushima Dai-ichi Accident*, dated March 12, 2012 (ML12053A340) (0CNA031208)