



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
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February 12, 2018

ANO Site Vice President  
Arkansas Nuclear One  
Entergy Operations, Inc.  
N-TSB-58  
1448 S.R. 333  
Russellville, AR 72802

SUBJECT: ARKANSAS NUCLEAR ONE, UNITS 1 AND 2 - STAFF ASSESSMENT OF  
FLOODING FOCUSED EVALUATION (CAC NOS. MF9809 AND MF9810;  
EPID L-2017-JLD-0011)

Dear Sir or Madam:

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f), "Conditions of Licenses" (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807). Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). By letter dated September 14, 2016 (ADAMS Accession No. ML16260A060), Entergy Operations, Inc. (the licensee) responded to this request for Arkansas Nuclear One, Units 1 and 2 (ANO).

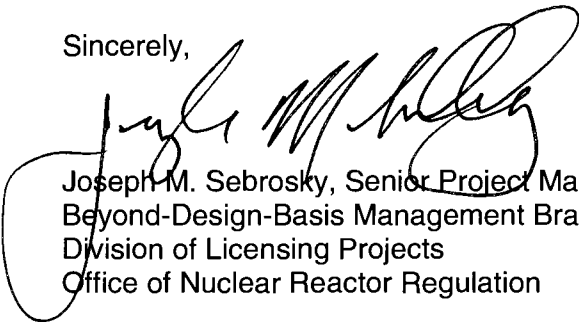
After its review of the licensee's response, by letter dated December 2, 2016 (ADAMS Accession No. ML16327A494), the NRC issued an interim staff response (ISR) letter for ANO. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for ANO and parameters that are a suitable input for the mitigating strategies assessment (MSA). As stated in the letter, because the local intense precipitation (LIP) flood-causing mechanism at ANO is not bounded by the plant's CDB, additional assessments of the flood hazard mechanism are necessary.

By letter dated May 31, 2017 (ADAMS Accession No. ML17153A280), the licensee submitted the focused evaluation (FE) for ANO. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood mechanism is bounded based on a reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is LIP. The purpose of this letter is to provide the NRC's assessment of the ANO FE.

The NRC staff has concluded that the ANO FE was performed consistent with the guidance described in Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178). Guidance document NEI 16-05, Revision 1, has been endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation" (ADAMS Accession No. ML16162A301). The NRC staff has further concluded that the licensee has demonstrated that effective flood protection, if appropriately implemented, exists for the LIP flood mechanism during a beyond-design-basis external flooding event. This closes out the licensee's response for ANO for the reevaluated flooding hazard portion of the 50.54(f) letter and the NRC's efforts associated with CAC Nos. MF9809 and MF9810.

If you have any questions, please contact me at 301-415-1132 or at [Joseph.Sebrosky@nrc.gov](mailto:Joseph.Sebrosky@nrc.gov).

Sincerely,



Joseph M. Sebrosky, Senior Project Manager  
Beyond-Design-Basis Management Branch  
Division of Licensing Projects  
Office of Nuclear Reactor Regulation

Enclosure:  
Staff Assessment Related to the  
Flooding Focused Evaluation for  
Arkansas Nuclear One

Docket Nos: 50-313 and 50-368

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE FOCUSED EVALUATION FOR

ARKANSAS NUCLEAR ONE, UNITS 1 AND 2

AS A RESULT OF THE REEVALUATED FLOODING HAZARD NEAR-TERM TASK FORCE

RECOMMENDATION 2.1 - FLOODING

(CAC NOS. MF9809 AND MF9810)

1.0 INTRODUCTION

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807).

Enclosure 2 of the 50.54(f) letter requested that licensees reevaluate flood hazards for their respective sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). If the reevaluated hazard for any flood-causing mechanism is not bounded by the plant's current design basis (CDB) flood hazard, an additional assessment of plant response would be necessary. Specifically, the 50.54(f) letter states that an integrated assessment should be submitted, and described the information that the integrated assessment should contain. By letter dated November 30, 2012 (ADAMS Accession No. ML12311A214), the NRC staff issued Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-201-05, "Guidance for Performing the Integrated Assessment for External Flooding."

On June 30, 2015, the NRC staff issued COMSECY-15-0019, describing the closure plan for the reevaluation of flooding hazards for operating nuclear power plants (ADAMS Accession No. ML15153A104). The Commission approved the closure plan on July 28, 2015 (ADAMS Accession No. ML15209A682). COMSECY-15-0019 outlines a revised process for addressing cases in which the reevaluated flood hazard is not bounded by the plant's CDB. The revised process describes a graded approach in which licensees with hazards exceeding their CDB flood will not be required to complete an integrated assessment, but instead will perform a focused evaluation (FE). As part of the FE, licensees will assess the impact of the hazard(s) on their site and then evaluate and implement any necessary programmatic, procedural, or plant modifications to address the hazard exceedance.

Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178), has been endorsed by the NRC as an appropriate methodology for licensees to perform the focused evaluation in response to the 50.54(f) letter. The NRC's endorsement of NEI 16-05, including exceptions, clarifications, and additions, is described in NRC JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force

Recommendation 2.1, Flood Hazard Reevaluation” (ADAMS Accession No. ML16162A301). Therefore, NEI 16-05, Revision 1, as endorsed, describes acceptable methods for demonstrating that Arkansas Nuclear One, Units 1 and 2 (ANO) has effective flood protection.

## 2.0 BACKGROUND

This NRC staff assessment is the last staff assessment associated with the information that the licensee provided in response to the reevaluated flooding hazard portion of the 50.54(f) letter. Therefore, the background section includes a discussion of the reevaluated flood information provided by the licensee and the associated staff assessments. The reevaluated flood information includes: 1) the flood hazard reevaluation report (FHRR); 2) the mitigation strategies assessment (MSA); and 3) the focused evaluation.

### Flood Hazard Reevaluation Report

By letter dated September 14, 2016 (ADAMS Accession No. ML16260A060), Entergy Operations, Inc. (Entergy, the licensee) responded to the 50.54(f) request for ANO and submitted the flood hazard reevaluation report (FHRR). After the review of the licensee's response, by letter dated December 2, 2016 (ADAMS Accession No. ML16327A494), the NRC issued an interim staff response (ISR) letter for ANO. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the CDB for ANO and parameters that are a suitable input for the MSA. As stated in the letter, because the local intense precipitation (LIP) flood-causing mechanism at ANO is not bounded by the plant's CDB, additional assessments of the flood hazard mechanisms are necessary. The staff issued a final staff assessment of the FHRR by letter dated August 29, 2017 (ADAMS Accession No. ML17230A261). The NRC staff's conclusions regarding LIP exceeding the ANO CDB remained unchanged from the information provided in the December 2, 2016, letter.

### Mitigation Strategies Assessment

By letter dated May 31, 2017 (ADAMS Accession No. ML17153A295), Entergy submitted its MSA for ANO for review by the NRC staff. The MSAs are intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis external events. By letter dated February 12, 2018 (ADAMS Accession No. ML17234A432), the NRC issued its assessment of the ANO MSA. The NRC staff concluded that the ANO MSA was performed consistent with the guidance described in Appendix G of Nuclear Energy Institute 12-06, Revision 2, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide” (ADAMS Accession No. ML16005A625), as endorsed by the NRC. The NRC's endorsement of NEI 12-06, Revision 2, is described in 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” (ADAMS Accession No. ML15357A163). The NRC staff further concluded that the licensee has demonstrated that the mitigation strategies, if appropriately implemented, are reasonably protected from reevaluated flood hazards conditions for beyond-design-basis external events.

### Focused Evaluation

By letter dated May 31, 2017 (ADAMS Accession No. ML17153A295), the licensee submitted the FE for ANO. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood

mechanism is bounded based on a reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is LIP. These 3 options associated with performing an FE are referred to as Path 1, 2, or 3, as described in NEI 16-05, Revision 1. The purpose of this staff assessment is to provide the results of the NRC's evaluation of the ANO FE.

### 3.0 TECHNICAL EVALUATION

Entergy stated that its FE followed Path 2 of NEI 16-05, Revision 1 and utilized Appendix B for guidance on evaluating the site strategy. As described in the ISR letter, the LIP flooding mechanism was found to exceed the plant's CDB flood at ANO, and was addressed by Entergy in the ANO FE. Therefore, this technical evaluation will address the following topics: characterization of flood parameters, evaluation of flood impact assessments, evaluation of available physical margin (APM) and reliability of flood protection features, and overall site response.

#### 3.1 Characterization of Flood Parameters

The FE credits passive protection features to demonstrate that key structures, systems and components (SSCs) are protected from the LIP flooding mechanism. The calculated ponding levels from a LIP event are below the controlling CDB event, which is a probable maximum flooding (PMF) from the Arkansas River coincident with an Ozark dam failure. Based on the flood protection associated with the CDB, key SSCs are not impacted by floodwaters during the LIP event.

#### 3.2 Evaluation of Flood Impact Assessment for LIP

##### 3.2.1 Description of Impact of Unbounded Hazard

The ANO FE references the ISR LIP flood evaluation levels that range from 351.4 feet (ft.) to 357.7 ft. National Geodetic Vertical Datum of 1929 (NGVD29) at representative locations around the site. The CDB flood elevation level for the Arkansas River PMF coincident with the Ozark Dam Failure is 361.0 ft. NGVD29.

##### 3.2.2 Evaluation of Available Physical Margin and Reliability of Flood Protection Features

The licensee relies on passive features to demonstrate key safety functions of core cooling, spent fuel pool cooling, and containment are maintained in the event of a LIP event. The finished plant floor is at elevation 354 ft. NGVD29. The FE and the FHRR state that the licensee evaluated areas that were potentially vulnerable to flooding (maximum flood elevation above 354 ft. NGVD29) and it was determined that the only location where water ingress may potentially impact key SSCs is the Turbine Building via the train bay doors. The FE includes Appendix 1 that provides a supporting evaluation of the licensee's conclusion in the FE that key SSCs are not impacted by the LIP event.

The ANO key SSCs are flood protected up to elevation 361 ft. NGVD29. Nevertheless, the licensee reviewed its natural emergencies procedures to identify potential manual actions that are required for a CDB flood event that cannot be credited for the LIP event. The licensee identified three flood barriers for additional review. The first two, hatches HTC-492 and HTC-493 (Train Bay to drumming station), are normally closed. The licensee determined that if the

hatches were out-of-position-open for access during a LIP event, procedures are in place such that compensatory measures would be taken before key safety functions are impacted.

The licensee identified a third potential vulnerability of a ventilation duct 2VSF-38 that is sealed prior to a CDB flooding event impacting the units. In the event of the CDB of 361 ft. NGVD flood conditions, an existing procedure directs the licensee to install a blind flange in place of the ductwork before the area housing the ductwork is inundated. The licensee evaluated not having the blind flange installed in the event of a LIP because it could not be assumed the blind flange would be installed in time. The duct in the discharge flow path from 2VSF-38 penetrates the floor at elevation 354 ft. sending air to the drumming station below. This ductwork could provide a pathway for flood water to the ANO Unit 1 Auxiliary Building if the flood level exceeds 354 ft. 4 inches NGVD29. The licensee concluded that there would not be an impact to key safety functions based on the following assumptions:

- The connection is at elevation 354 ft. 4 inches NGVD29
- The maximum LIP elevation at the train bay door is 354 ft. and 5 inches NGVD29
- The LIP elevation of the water at the train bay door would be at its peak for approximately 30 minutes.
- The duct is in a room that is accessed through normally closed doors
- The duct connection has a normally installed neoprene gasket

Given the small elevation difference of approximately 1 inch, short duration of flood exceedance, and tortuous pathway to the connection, and protection provided by the normally connected neoprene gasket, the NRC staff concludes that floodwaters due to a LIP are not expected to leak into this vent in a quantity that could affect key SSCs.

For the Turbine Building, flooding was evaluated to 354.4 ft. or 354 ft. and 5 inches NGVD29 for a LIP event as described above. Because the LIP evaluation stopped at 354 ft. and 5 inches, the licensee considers the APM to be zero, consistent with the definition in NEI 16-05, Revision 1. The NRC staff concludes that the zero APM is acceptable in accordance with the guidance found in NEI 16-05, Revision 1 because of the following conservative assumptions in the licensee's LIP evaluation:

- Small openings in each vehicle barrier systems were conservatively assumed to be blocked, which results in higher LIP elevations near the key SSCs.
- Roof drains connected to the subsurface drainage systems are assumed to be blocked leading to higher LIP elevation near the key SSCs and potential storage from roof parapet walls was conservatively not incorporated.

#### Reliability of Flood Protection Features

Demonstrating reliability of the flood protection features in accordance with the guidance found in NEI 16-05, Appendix 1, as endorsed is approached differently for the two types of features as follows:

- Type 1 features are engineered in the design-basis of licensing basis as having a flood protection function.

- Type 2 features are engineered for a purpose other than flood protection in the design-basis or licensing basis but are credited in the focused evaluation with a flood protection function.

Site topography and building external flood boundaries are Type 1 features that were designed and constructed to mitigate or minimize the ponding effects of a LIP. These features are already credited as part of the ANO design-basis flood protection of 361 ft. NGVD29 and the NRC staff concludes that a reliability analysis of these features is not necessary in accordance with the guidance found in NEI 16-05, Revision 1.

Regarding Type 2 design features, the staff audited the supporting information associated with the licensee's assessment of the three potentially vulnerable flood barriers in accordance with an audit plan dated July 18, 2017 (ADAMS Accession No. ML17192A452). As described above, HTC-492 and HTC-493 are normally closed hatches. The staff audited Entergy Operations Procedure 5000.28, "Passive Barrier Breach Permitting Process." Attachment 6 of the procedure provides impairment examples that include the conditions under which HTC-492 and HTC-493 are allowed to be open. The procedure directs that these hatches be returned to their normal closed configuration if local or general flooding or flooding condition event is imminent. The staff therefore, considers these barriers to be reliable in accordance with NEI 16-05, Revision 1, as endorsed since the flood protection function of these hatches are normally Type 1 features and procedures are in place to restore them to the closed flood protection condition if they are open to support plant operations and if the conditions associated with a LIP event are imminent.

Regarding the reliability of the duct work associated with 2VSF-38, the staff audited Engineering Change 50519, Revision 000, "2VSF-38 Flood Barrier, Modify Drumming Station Duct Using Quick Latches to Ease Installation of Flood Barrier IAW OP-1203.025," dated June 26, 2014. This calculation package includes pictures of the normally installed neoprene gasket that the licensee partially credits for minimizing flooding into the drumming station below the gasket in the event of a LIP. As stated above, in the event of a LIP this gasket could experience around an inch of water above it for a short period of time (assuming the normally closed doors to the room housing the duct work do not hold back any water). The NRC staff concludes that this gasket is reasonably reliable in minimizing the water from a LIP event entering the drumming station below the duct work and therefore, meets the guidance in NEI 16-05, Revision 1, as endorsed, for a reliable flood protection feature.

Because increased focus has been placed on flood protection since the accident at Fukushima, licensees and NRC inspectors have identified deficiencies with equipment, procedures, and analyses relied on to either prevent or mitigate the effects of external flooding at a number of licensed facilities. Recent examples include those found in Information Notice 2015-01, "Degraded Ability to Mitigate Flooding Events" (ADAMS Accession No. ML14279A268). In addition, the NRC is cooperatively performing research with the Electric Power Research Institute to develop flood protection systems guidance that focuses on flood protection feature descriptions, design criteria, inspections, and available testing methods in accordance with a memorandum of understanding dated September 28, 2016 (ADAMS Accession No. ML16223A495). Therefore, the NRC staff expects that licensees will continue to maintain flood protection features in accordance with their current licensing basis. The NRC staff further expects that continued research involving flood protection systems will be performed and shared with licensees in accordance with the guidance provided in Management Directive 8.7 "Reactor Operating Experience Program" (ADAMS Accession No. ML122750292), as appropriate.

The NRC staff concludes that the ANO flood protection features described above meet the definition of being reliable to maintain key safety functions found in Appendix B of NEI 16-05, Rev 1, as endorsed.

### 3.2.3 Overall Site Response

The licensee does not rely on any personnel actions or new modifications to the plant in order to respond to the beyond-design-basis LIP event. As described above, the licensee's evaluation relied on passive existing flood protection features to demonstrate adequate flood protection.

## 4.0 AUDIT REPORT

The July 18, 2017, generic audit plan describes the NRC staff's intention to issue an audit report that summarizes and documents the NRC's regulatory audit of the licensee's FE. The NRC staff's ANO audit was limited to the review of the calculations and procedures described above. Because this staff assessment appropriately summarizes the results of the audit, the NRC staff concludes a separate audit report is not necessary, and that this document serves as the audit report described in the July 18, 2017, letter.

## 5.0 CONCLUSION

The NRC staff has concluded that Entergy performed the ANO FE in accordance with the guidance described in NEI 16-05, Revision 1, as endorsed by JLD-ISG-2016-01, and that the licensee has demonstrated effective flood protection from the reevaluated flood hazards, if properly implemented. Furthermore, the NRC staff concludes that ANO screens out of performing an integrated assessment based on the guidance found in JLD-ISG-2016-01. As such, in accordance with Phase 2 of the process outlined in the 50.54(f) letter, additional regulatory actions associated with the reevaluated flood hazard, beyond those associated with mitigation strategies assessment, are not warranted. The licensee has satisfactorily completed providing responses to the 50.54(f) activities associated with the reevaluated flood hazards.



ARKANSAS NUCLEAR ONE, UNITS 1 AND 2 – STAFF ASSESSMENT OF FLOODING  
FOCUSED EVALUATION DATED February 12, 2018

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**\*via email**

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