



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

March 2, 2017

Vice President, Operations
Entergy Operations, Inc.
Grand Gulf Nuclear Station
P.O. Box 756
Port Gibson, MS 39150

SUBJECT: GRAND GULF NUCLEAR STATION, UNIT 1 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT (CAC NO. MF7930)

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).

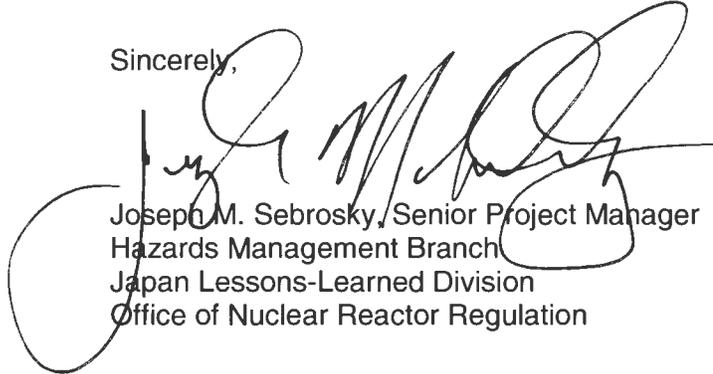
Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). Concurrent with the reevaluation of flood hazards, licensees were required to develop and implement mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML12054A735). In order to proceed with implementation of Order EA-12-049, licensees used the current licensing basis flood hazard or the most recent flood hazard information, which may not be based on present-day methodologies and guidance, in the development of their mitigating strategies.

By letter dated December 30, 2016 (ADAMS Accession No. ML16365A194), Entergy Operations, Inc. (the licensee) submitted the mitigation strategies assessment (MSA) for Grand Gulf Nuclear Station, Unit 1 (Grand Gulf). 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. The purpose of this letter is to provide the NRC's assessment of the Grand Gulf MSA.

The NRC staff has concluded that the Grand Gulf MSA was performed consistent with the guidance described in Appendix G of Nuclear Energy Institute 12-06, Revision 2, as endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-01, Revision 1, and that the licensee has demonstrated that the mitigation strategies are reasonably protected from reevaluated flood hazards conditions for beyond-design-basis external events. This closes out the NRC's efforts associated with CAC No. MF7930.

If you have any questions, please contact me at 301-415-1132 or at Joseph.Sebrosky@nrc.gov.

Sincerely,

A handwritten signature in black ink, appearing to read "Joseph M. Sebrosky", is written over the typed name and title. The signature is fluid and cursive, with a large loop at the end.

Joseph M. Sebrosky, Senior Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Enclosure:
Staff Assessment Related to the
Mitigating Strategies for Grand Gulf

Docket No. 50-416

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT RELATED TO THE
MITIGATION STRATEGIES FOR
GRAND GULF NUCLEAR STATION, UNIT 1
AS A RESULT OF THE REEVALUATED FLOODING HAZARDS REPORT
NEAR-TERM TASK FORCE RECOMMENDATION 2.1- FLOODING
CAC No. MF7930

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 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). Concurrent with the reevaluation of flood hazards, licensees were required to develop and implement mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML12054A735). That order requires holders of operating reactor licenses and construction permits issued under 10 CFR 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 to the NRC for review a final integrated plan (FIP) that describes how compliance with the requirements of Attachment 2 of the order was achieved. In order to proceed with implementation of Order EA-12-049, licensees used the current licensing basis flood hazard or the most recent flood hazard information, which may not be based on present-day methodologies and guidance, in the development of their mitigating strategies.

The NRC staff and industry recognized the difficulty in developing and implementing mitigating strategies before completing the reevaluation of flood hazards. The NRC staff described this issue and provided recommendations to the Commission on integrating these related activities in COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flood Hazards," dated November 21, 2014 (ADAMS Accession No. ML14309A256). The Commission issued a staff requirements memorandum on March 30, 2015 (ADAMS Accession No. ML15089A236), affirming that the Commission expects licensees for operating nuclear power plants to address the reevaluated flood hazards, which are considered beyond-design-basis external events, within their mitigating strategies.

Nuclear Energy Institute (NEI) 12-06, Revision 2, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide" (ADAMS Accession No. ML16005A625), has been endorsed by

the NRC as an appropriate methodology for licensees to perform assessments of the mitigating strategies against the reevaluated flood hazards developed in response to the March 12, 2012, 50.54(f) letter. The guidance in NEI 12-06, Revision 2, and Appendix G in particular, supports the proposed Mitigation of Beyond-Design-Basis Events rulemaking. The NRC's endorsement of NEI 12-06, including exceptions, clarifications, and additions, is described in NRC Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) 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). Therefore, Appendix G of NEI 12-06, Revision 2, describes acceptable methods for demonstrating that the reevaluated flooding hazard is addressed within the Grand Gulf Nuclear Station, Unit 1 (Grand Gulf) mitigating strategies for beyond-design-basis external events.

2.0 BACKGROUND

By letter dated December 4, 2015 (ADAMS Accession No. ML15329A043), the NRC issued a supplemental staff assessment for Grand Gulf. The letter provided the reevaluated flood hazards that exceeded the current design basis (CDB) for Grand Gulf and were suitable input for the mitigating strategies assessment (MSA). For Grand Gulf, the mechanisms listed as not bounded by the CDB in the letter are flooding from: local intense precipitation (LIP), a probable maximum flood (PMF) associated with Stream "A," and a dam failure coincident with a PMF on the Mississippi River. These flooding mechanisms are shown on Table 4.0-2 of the supplemental staff assessment. The values provided in Table 4.0-2 of the December 4, 2015, letter are hereafter referred to as mitigation strategies flood hazard information (MSFHI) values.

The supplemental staff assessment provided the NRC staff evaluation of the flood event duration parameters (including warning time and period of inundation) and flood-related associated effects previously developed by the licensee. This is consistent with the guidance provided in Revision 2 of NEI 12-06. By letter dated December 30, 2016 (ADAMS Accession No. ML16365A194), Entergy Operations, Inc. (the licensee) submitted the mitigation strategies assessment (MSA) for Grand Gulf. The MSA is intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis external events.

3.0 TECHNICAL EVALUATION

3.1 Mitigating Strategies under Order EA-12-049

The NRC staff evaluated the Grand Gulf strategies as developed and implemented under Order EA-12-049. This evaluation is documented in a safety evaluation issued by letter dated September 27, 2016 (ADAMS Accession No. ML16253A322).

The safety evaluation concluded that Grand Gulf has developed guidance and proposed designs which if implemented appropriately will adequately address the requirements of Orders EA-12-049.

3.2 Evaluation of Current FLEX strategies

The licensee stated in its MSA, that the existing FLEX strategy can be successfully implemented and deployed as designed for all applicable flood-causing mechanisms. A brief summary of Grand Gulf's FLEX strategies are listed below:

- For Phase 1, the Reactor Core Isolation Cooling (RCIC) system is initiated at the beginning of the extended loss of alternating current power (ELAP) event and is normally aligned to take suction from the condensate storage tank (CST). Because the CST is not protected from all postulated hazards, the licensee's mitigation strategy assumes that the RCIC pump suction realigns to the suppression pool. The RCIC takes suction from the suppression pool for about three hours before the RCIC is realigned to take suction from the upper containment pool (UCP). At approximately 4 hours after the initiation of the ELAP event, when the suppression pool temperature exceeds 190 °F, the modified emergency operation procedure 20-inch diameter containment vent is opened to remove containment heat. In this configuration RCIC can provide adequate core cooling for at least 20 hours into the ELAP event during Phase 1.

Station batteries and the Class 1E 125 Vdc [volts direct current (dc)] distribution systems provide power to RCIC systems and instrumentation. The dc load shedding is accomplished within 2 hours of event initiation to extend the battery capacity to power the Phase 1 systems and instrumentation. After load shedding, the installed batteries can maintain the necessary voltage for about 12 hours.

- For Phase 2, Grand Gulf relies on FLEX components that consist of a 480 Vac diesel generator (DG), a 500 gallon per minute diesel-driven makeup pump, a 500 gallon fuel tank trailer and portable fans to remove decay heat from the reactor pressure vessel (RPV) and spent fuel pool and to cool the main control room. A complete set of FLEX equipment is stored in each of the two FLEX storage buildings (FSBs).

At approximately 20 hours after the initiation of the ELAP event, the volume in the UCP is expected to be depleted. At this point the RCIC pump will no longer be available. The licensee's primary strategy is to pump water from a standby service water basin to the RPV using a diesel-driven FLEX pump.

To support decay heat removal, prior to battery depletion a 480 Vac FLEX DG will be utilized to recharge the Division I and Division II batteries, ensuring dc-powered components in the RCIC system will continue to have power. Additionally, the battery chargers will provide power to critical instrumentation.

- For Phase 3, the equipment from the national SAFER [Strategic Alliance of FLEX Emergency Response] response center (NSRC) will be transported to on-site staging area B for interim staging prior to being transported to the final location in the plant. The licensee notes in its MSA that since deployment of the NSRC equipment occurs later in the event, that deployment of the Phase 3 equipment will not be impacted by any flood mechanisms identified in the flooding hazard reevaluation report (FHRR) (ADAMS Accession No. ML13071A457).

The licensee's MSA notes that although the CDB flood height for the site is 133.25 ft above mean sea level (MSL) the FLEX equipment design basis is 133.7 ft. MSL. The grade level for the plant is 132.5 ft MSL. As noted earlier, the flood mechanisms that are not bounded by the CDB are LIP, a PMF associated with Stream "A," and a dam failure coincident with a PMF on the Mississippi River.

Local Intense Precipitation

Section 2.1 of the MSA described the LIP flood height at 133.7 ft which is above the CDB flood height of 133.25 ft MSL (although the 133.7 ft MSL flood height was considered when designing the FLEX response as noted earlier). As discussed above, there are two redundant FSBs that are referred to as the "north" and "south" FSB. The north FSB was constructed on "Site 1" and the south FSB was constructed on "Site 4."

Due to its remote location and grade elevation, the north FSB found at Site 1 is not included in the LIP reanalysis performed by the licensee. Nevertheless, the LIP reanalysis supports a maximum expected depth of 0.1 ft to 0.2 ft based upon the adjacent modeled areas. The foundation designs of both FSBs include an internal spill containment curb extending 0.5 ft above the top of slab. The north FSB is located such that the top-of slab elevation is at 163 ft. Given the concrete slab and curb elevations, the north FSB elevations are sufficient to preclude challenges or impact to the stored equipment. However, the primary deployment path from the north FSB runs along the North Access Road for most of its length. In one location the road dips approximately 6 feet below the LIP flood elevation. Therefore, the licensee's MSA does not credit equipment being available from the north FSB during a LIP event.

The licensee's MSA does credit deployment from the south FSB at Site 4 during a LIP event. Site 4 is located approximately 500 ft west of the protected area. Site 4 has a top of slab elevation of 133.2 ft MSL with a containment curb extending 0.5 ft above the top of slab for an "effective" top of slab elevation of 133.7 ft. As noted in the licensee's MSA and the staff's evaluation of the licensee's response to EA-12-0049 dated September 27, 2016, although not required, the licensee decided to address the impact of the revised FHRR on the FLEX strategies. The MSA notes the following regarding LIP:

- The deployment path from the south FSB may be inundated by a maximum water depth of 1.5 feet from the LIP event, however, the maximum flood water level typically reaches the peak flood level 30 minutes after the beginning of a LIP event dropping rapidly to below half of the peak flood depth approximately 2 hours after the onset of the LIP event and almost completely recedes by 8 hours. The MSA notes this general trend is appropriate for the south FSB and the primary deployment path from the south FSB. (The MSA notes that these recession times may not apply to Stream A that includes the area of the North Access Road that is under approximately 6 ft of water, preventing deployment of equipment from the north FSB).
- The reevaluated LIP event exceeds the CDB for the flooding at the plant site, but is bounded by the FLEX design-basis. The FHRR provides the LIP flood elevations at each doorway to a safety related structure that could potentially be impacted by this event. Sandbags up to a height of 1.5 ft and door seals at inactive doors 1D301 and OCT05 are credited for protecting equipment in the diesel generator building, standby service water buildings and control building. Therefore, the licensee considers

equipment in these areas protected from a LIP event and considers these areas accessible for use during a LIP event.

Grand Gulf's MSA notes that the use of sandbags to provide protection for the identified doorways to safety related structures was credited in their FIP dated May 24, 2016 (ADAMS Accession No. ML16145A523). The staff also noted the use of sandbags to protect key doorways in the September 27, 2106, safety evaluation associated with the FIP. The licensee's MSA notes the use of sandbags has been identified as a nonconforming condition for the use of manual operator actions in place of a permanent plant modifications and is being addressed through the Grand Gulf corrective action program. The staff finds the use of sandbags up to a height of 1.5 ft acceptable, as a temporary measure, to protect key doorways associated with the Grand Gulf mitigation strategies. The results of the licensee's evaluation of the use of sandbags in the Grand Gulf corrective action program are subject to future NRC inspection.

- The MSA notes that no equipment is required to be deployed prior to 2 hours, at which time the maximum flood depth is approximately 0.75 ft. The licensee concludes that the truck used to deploy the equipment from the south FSB will be capable of delivering the FLEX equipment at this water level. In addition, the trailer mounted FLEX equipment being deployed from the south FSB will not be submersed in flood waters since the trailer height is sufficiently above the flood levels at the time the equipment is needed to be deployed.

Based on the redundant equipment being able to be deployed from the south FSB in the event of a LIP and installed plant equipment credited for FLEX being protected against a LIP event, the NRC staff finds the licensee has adequately assessed the MSFHI hazard for this event and that the applicable FLEX strategy can be implemented.

Probable Maximum Flood on Stream A

The MSFHI hazard level for a PMF on Stream A is 132.5 ft MSL. The licensee's MSA notes that this flood level does not result in inundation of structures, systems and components important to safety. Therefore, installed equipment credited as part of the FLEX strategies is not impacted. The licensee's MSA notes that this level results in inundation of the primary access road to the plant from the north FSB. However, the PMF on Stream A does not impact the equipment stored in the south FSB nor does it affect the deployment path from the south FSB to the plant.

Based on the redundant equipment being able to be deployed from the south FSB in the event of a PMF on Stream A, and the installed plant equipment credited for FLEX being protected against this event, the NRC staff finds that the licensee has adequately addressed the MSFHI hazard for this event and that the applicable FLEX strategy can be implemented.

Dam Failure Coincident with a PMF on the Mississippi River

The MSFHI hazard for a dam failure flooding coincident with a PMF on the Mississippi River is 117.4 ft (without wind effects). The licensee's MSA notes that plant grade is 132.5 ft and any safety-related equipment or FLEX equipment is protected from this event. The licensee's MSA concludes that the FLEX strategies are not challenged by this event.

Based on the dam failure flooding coincident with a PMF on the Mississippi River being bounded by the FLEX design basis, the staff finds that the licensee has adequately addressed this hazard and that the applicable FLEX strategies can be implemented.

3.2.1 Evaluation of Flood Event Duration and Associated Effects

Flood-related associated effects and flood event duration for Grand Gulf were assessed during the NRC staff's review of the Grand Gulf FHRR. In the supplemental staff assessment, the NRC staff reviewed the following flood hazard parameters needed to perform the additional assessments or evaluations of plant response:

- Flood event duration (see Table 4.0-1), including warning time and intermediate water surface elevations that trigger actions by plant personnel, as defined in JLD-ISG-2012-05
- Flood height and associated effects, as defined in JLD-ISG-2012-05 (see Table 4.0-2)

The NRC staff confirmed that the reevaluated flood-related associated effects and flood event durations are appropriate input to the assessment of mitigation strategies developed in response to Order EA-12-049.

3.2.2 Evaluation of Flood Protection Features

No additional flood protection features were necessary as a result of the MSA. The MSA does credit the use of sandbags up to a height of 1.5 ft and door seals on inactive doors 1D301 and OCT05 to protect the entrances to the DG building, standby service water buildings and control building in the event of a flood from LIP. In addition, the access road from the north FSB is potentially flooded in a LIP event or a PMF on Stream A. Although the north FSB deployment path is potentially impacted for these events, the redundant equipment in the south FSB remains available for these events.

3.2.3 Conclusion

The NRC staff has reviewed the information provided in the Grand Gulf MSA related to the original FLEX strategies, as evaluated against the reevaluated hazard(s) described in Section 2 of this staff assessment, and found that:

- the boundary conditions and assumptions of the initial FLEX design are maintained for the dam failure coincident with a PMF on the Mississippi River,
- the boundary conditions and assumptions of the initial FLEX design including the redundant equipment found in the south FSB are maintained for the LIP and PMF on Stream A event,
- the sequence of events for the FLEX strategies for a dam failure coincident with a PMF on the Mississippi River is not affected by the impacts of the MSFHI (including impacts due to

the environmental conditions created by the MSFHI) in such a way that the FLEX strategies cannot be implemented as currently developed

- the sequence of events for the FLEX strategies for a LIP and PMF on Stream A is not affected by the impacts of the MSFHI (including impacts due to the environmental conditions created by the MSFHI) in such a way that the FLEX strategies cannot be implemented using the redundant equipment found in the south FSB as currently developed, and
- with the exception of the deployment path for equipment from the north FSB for LIP and PMF on Stream A events, the validation performed for the deployment of the FLEX strategies is not affected by the impacts of the MSFHI.

Therefore, the NRC staff concludes that the licensee has demonstrated the capability to deploy the original FLEX strategies, as designed, against a postulated beyond-design-basis event for the LIP flood, a PMF associated with Stream "A," and a dam failure coincident with a PMF on the Mississippi River, including associated effects and flood event duration, as described in NEI 12-06, Revision 2 and ISG-2012-01, Revision 1.

4.0 CONCLUSION

The NRC staff has reviewed the information provided in the Grand Gulf MSA related to the original FLEX strategies, as evaluated against the reevaluated hazards described in Section 2 of this staff assessment, and found that the licensee has adequately assessed the MSFHI for the LIP flood, a PMF associated with Stream "A," and a dam failure coincident with a PMF on the Mississippi River. The NRC staff made its determination based upon:

- Although the north FSB deployment path is potentially impacted for the LIP flood, and a PMF associated with Stream A, the redundant equipment in the south FSB remains available for these events.
- The use of sandbags to enhance the mitigating strategies for a LIP flood by diverting water from potentially affected doorways;

Therefore, the NRC staff concludes that the licensee has followed the guidance in NEI 12-06, Revision 2, and demonstrated the capability to deploy FLEX strategies against a postulated beyond-design-basis event for the LIP and PMF events, including associated effects and flood event durations.

GRAND GULF NUCLEAR STATION, UNIT 1 – FLOOD HAZARD MITIGATION STRATEGIES
ASSESSMENT DATED MARCH 2, 2017

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