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

February 27, 2017

Site Vice President
Entergy Operations, Inc.
Waterford Steam Electric Station
Unit 3
17265 River Road
Killona, LA 70057-3093

SUBJECT: WATERFORD STEAM ELECTRIC STATION, UNIT 3 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT (CAC NO. MF7989)

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) (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 November 16, 2016 (ADAMS Accession No. ML16319A089), Entergy Operations, Inc. (Entergy, the licensee) submitted the mitigation strategies assessment (MSA) for Waterford Steam Electric Station, Unit 3 (Waterford). The MSAs are intended to confirm that licensees have adequately addressed the reevaluated flooding hazard within their mitigating strategies for beyond-design-basis external events. The purpose of this letter is to provide the NRC's assessment of the Waterford MSA.

The NRC staff has concluded that the Waterford MSA was performed consistent with the guidance described in Appendix G of the Nuclear Energy Institute guidance (NEI) document, NEI 12-06, Revision 2, as endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) document 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. MF7989.

If you have any questions, please contact me at 301-415-2621 or at Robert.Bernardo@nrc.gov.

Sincerely,

Robert Bernardo, Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Enclosure:
Staff Assessment Related to the
Mitigating Strategies for Waterford

Docket No: 50-382

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT RELATED TO THE

MITIGATION STRATEGIES FOR

WATERFORD STEAM ELECTRIC STATION, UNIT 3

AS A RESULT OF THE REEVALUATED FLOODING HAZARDS REPORT

NEAR-TERM TASK FORCE RECOMMENDATION 2.1- FLOODING

CAC NO. MF7989

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 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) guidance document 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, Revision 2, including exceptions, clarifications, and additions, is described in 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 Waterford Steam Electric Station, Unit 3 (Waterford) mitigating strategies for beyond-design-basis external events.

2.0 BACKGROUND

By letter dated April 12, 2016 (ADAMS Accession No. ML16090A327), the NRC issued an interim staff response (ISR) letter for Waterford. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Waterford and parameters that are suitable input for the mitigating strategies assessment (MSA) (i.e., defines the mitigating strategies flood hazard information (MSFHI) described in NEI 12-06). For Waterford, the mechanisms listed as not bounded by the CDB in the letter (ISR flood levels) are listed below, with the reason they were not bounded.

- Local intense precipitation (LIP) – the reevaluated flood hazard level was higher than the CDB level

- Streams and rivers – the reevaluated flood hazard level for the probable maximum flooding (PMF) event on the Mississippi River was higher than the CDB level

- Failure of dams and onsite water control structures – the PMF combined with a hypothetical dam break within the Mississippi River and levee failure was not considered in the CDB.

- Storm surge – for a combined event of a 25-year flood in the Mississippi River with probable maximum surge including antecedent water level, levee failure, and coincident wind-generated waves, the maximum wave run-up was not considered in CDB.

The ISR letter also stated that NRC staff would evaluate, as applicable, the flood event duration parameters (including warning time and period of inundation) and flood-related associated effects developed by the licensee during the NRC staff's review of the MSA. This is consistent with the guidance provided in Revision 2 of NEI 12-06. The licensee submitted the MSA by letter dated November 14, 2016 (ADAMS Accession No. ML16319A089). The MSA also included the relevant information regarding the flood event duration parameters and associated effects needed to complete the review.

3.0 TECHNICAL EVALUATION

3.1 Mitigating Strategies under Order EA-12-049

The NRC staff is evaluating the Waterford strategies as developed and implemented under order EA-12-049, as described in the Waterford final integrated plan (FIP) (ADAMS Accession

No. ML16203A321). That review will be documented in a safety evaluation, separate from this assessment. The purpose of the safety evaluation is to document how the licensee's guidance and proposed designs, if implemented appropriately, will adequately address the requirements of Order EA-12-049. An inspection will confirm compliance with the order.

3.2 Evaluation of FLEX strategies

A brief summary of the licensee's FLEX strategies are as follows:

- For Phase 1, decay heat is removed by steaming to atmosphere from the steam generators (SGs) through the atmospheric dump valves (ADVs) or SG safety valves, and makeup to the SGs is initially provided by the turbine-driven emergency feedwater (TDEFW) pump taking suction from the condensate storage pool (CSP). Natural circulation in the RCS is maintained as operators cool the plant. The operators take action to prolong vital battery life until backup generators can be deployed.

- For Phase 2, operators will transition SG makeup to a permanently mounted FLEX core cooling pump (FCCP) that will take water from one of several available sources (CSP, wet cooling tower (WCT) basins, or refueling water storage pool (RWSP)). RCS makeup and boration will be initiated within approximately 12.5 hours of the ELAP to ensure that natural circulation, reactivity control, and boron mixing is maintained in the RCS. RCS makeup will use the installed charging pumps taking suction from the RWSP or boric acid makeup tank (BAMT). The backup FLEX diesel generator (DG) will be in service within 12 hours. The FLEX DG is pre-staged in a new enclosure on the roof of the Reactor Auxiliary Building (RAB).

- For Phase 3, the licensee will use equipment from the National SAFER Response Center (NSRC) to establish and maintain long term cooling. The NSRC will provide high capacity pumps and large combustion turbine-driven generators (CTGs).

As noted in the licensee's FIP, the FLEX design basis (DB) flood height is 30 feet mean sea level (ft. MSL). The nuclear plant island structure (NPIS) is a reinforced concrete box structure with solid exterior walls. The NPIS is the common structure of the reactor containment building (RCB), reactor auxiliary building (RAB) and the Fuel Handling Building (FHB). All seismic Category I structures, safety-related systems and components are housed in the NPIS. All exterior doors and penetrations which lead to areas containing safety-related equipment are watertight up to +30 ft. MSL. The NPIS protects the required credited FLEX structures, systems and components from all applicable external hazards. As noted earlier, four flooding mechanisms are not bounded by the CDB. Two of those four mechanisms are bounded by the FLEX DB. The two flooding mechanisms that are not bounded by the FLEX DB are LIP and the combined event following a 25-year flood combined with levee failure and wind-generated waves.

The licensee states that one complete set of equipment (N) is stored within the NPIS. The LIP (outside the NPIS) maximum flow depths range from 0.5 ft. at the southeast side of the NPIS to 1.1 ft. at the southeast side of the independent spent fuel storage installation (ISFSI) pad. A LIP event could inundate the deployment paths from the "N+1" storage building (located south of the ISFSI, outside of the NPIS). The equipment stored in the "N+1" storage building is not the primary equipment and only serves as a backup capability should the "N" equipment unexpectedly become unavailable. The primary storage location for a full "N" set of equipment is inside and on top of the NPIS and is fully protected from external flooding up to +30 ft. MSL,

well above the hazard level for a LIP event. Thus, the FLEX strategies should be successfully implemented during a LIP event. Additionally, the licensee has provisions to relocate the spare equipment if the primary set will be down for maintenance for an extended period of time.

A LIP event can affect the dry cooling tower (DCT) basins within the NPIS, as well as cause ponding within the main steam isolation valve (MSIV) east and west areas. The LIP maximum flood depth within DCT Basin A is 1.53 ft. and around DCT Basin B is 1.63 ft. Each DCT basin is connected via four, 4-inch-diameter pipes (each with a flapper) to the FHB sub-basement. This area of the FHB (-35 ft. MSL) is considered to be rain water storage capability for the DCT areas. The FLEX strategies do not credit the DCT basins, nor equipment located in the FHB subbasement. Therefore, even when the area in and around the DCT basins becomes inundated during a LIP event, the FLEX strategies can be implemented successfully.

The emergency feedwater (EFW) control and isolation valves are located in the MSIV area. The level of ponding in this area (less than 0.7 feet) does not challenge the manual operation of these valves during an extended loss of alternating current power (ELAP) event. The travel path to get to these valves is within the RAB structure, which is protected from flooding; therefore, the valves are accessible. Thus, the FLEX strategies are not affected by the LIP event (inside the NPIS) and can be implemented successfully.

The combined event flood was also not bounded by the FLEX DB flood height. During this event, the still water elevation is 26 ft. MSL, which is below the FLEX DB. However, the maximum wave run-up reaches a level of 31.8 ft. MSL, on the east side of the NPIS. Since the DCTs are the only portions of the NPIS open to the outside (with the exception of the ventilation intake described below), water will accumulate in the bottom of the DCT basins from wave overtopping. The overtopping rate and resulting ponding is bounded by the LIP event discussed above. Since the FLEX strategies do not credit the DCT basins, they are not affected by this overtopping and ponding.

In addition, the licensee notes that a ventilation intake for the heat and ventilation (H&V) fan room is located at elevation 31.16 ft. MSL. The FLEX Diesel Generator Connection Panel is located within the H&V fan room, on the wall opposite to the air intake, approximately 2' above the floor. The combined event results in a maximum stillwater level at the NPIS of 26.0 ft. MSL, with a maximum significant wave crest elevation of 26.9 ft. MSL, and a maximum reflected wave crest elevation of 31.8 ft. MSL with a duration of approximately 3 hours of wave overtopping (above elevation 31 ft. MSL) on the east side of the NPIS. Since the bottom of the H&V fan room air intake (31.16 ft. MSL) is located above the stillwater level elevation (26 ft. MSL) and the significant wave crest elevation (26.9 ft. MSL), only the maximum reflected wave crest elevation needs to be evaluated.

As noted in the FHRR, the H&V intake is located on the southeast side of the NPIS, where the maximum stillwater elevation is 24.6 ft. MSL. The maximum reflected wave crest of 31.8 ft. MSL corresponds to the east side of the NPIS, where the maximum stillwater elevation is 25.4 ft. MSL (because of the relative orientation to the storm direction). The maximum reflected wave height is a direct function of the stillwater elevation, thus the maximum reflected wave height at the H&V intake can be conservatively determined to be 0.8 ft. below the reported height of 31.8 ft. MSL, or at a height of 31 ft. MSL. This provides a 2 inch margin to the H&V intake opening. In addition, there is a missile grating structure that juts out from the wall, obstructing any wave splashing. Finally, any splashing that would enter the H&V room would not land on top of the FLEX connection panel, which is located on the opposite side of the room.

The licensee also notes that the maximum wave run-up duration is approximately 3 hours, which is a relatively short duration.

In summary, the licensee stated in its MSA that the minimum set of FLEX equipment to support their mitigating strategies is stored within the NPIS, which is protected against flooding up to 30 ft. MSL. For the N+1 equipment, pre-planned strategies are already in place to relocate the N+1 equipment for predictable warning times. With the FLEX equipment protected from external flooding events, all mitigating strategy sequences previously evaluated are not impacted by the reevaluated flood hazards. For Phase 3 equipment, provisions for this equipment to be airlifted to the plant site are in place. Phase 3 equipment will be landed on the RAB roof (69 ft. MSL) and will not be impacted by the reevaluated hazards.

3.3 Evaluation of Associated Effects

Debris hazards within the NPIS are not considered a credible hazard because of relatively low flow velocities and limited debris sources. Annual inspection and cleaning of roof drains on the reactor containment building ensure the roof drains remain free of debris. The NPIS is a box-like reinforced concrete structure, and sediment deposition and erosion is considered minimal. The potential hydrodynamic loading and debris loading are bounded by the missile load requirements of the NPIS exterior wall. The flow velocity of flood waters at the NPIS wall are relatively low due to the configuration of the combined effect flood, and as a result, the hydrodynamic loads and debris impact loads are also relatively low. The hydrodynamic loads and debris impact loads are thus bounded by the FLEX DB.

3.4 Evaluation of Flood Event Duration

For all flooding events, flood event duration parameters have no effect on mitigating strategies because the N set of FLEX equipment is protected and stored away from any flooding areas. In addition, pre-planned strategies are in place to protect the N+1 set of equipment for predictable external events (hurricanes and floods). The flood event duration is thus bound by the FLEX DB.

3.5 Evaluation of Flood Protection Features

No additional flood protection features were necessary as a result of the mitigating strategies assessment.

4.0 CONCLUSION

The NRC staff has reviewed the information provided in the Waterford MSA related to the original FLEX strategies, as evaluated against the reevaluated hazards (ISR flood levels) described in Section 2 of this staff assessment, and found that:

- The FLEX strategies as described in the FIP are not affected by the impacts of the ISR flood levels (including impacts due to the environmental conditions created by the ISR flood levels).

- The deployment of the FLEX strategies as described in the FIP is not affected by the impacts of the ISR flood levels (although redundancy may be reduced for the LIP event).

- Associated effects and flood event durations are reasonable and acceptable for use in the MSA, and have been appropriately considered in the MSA.

Therefore, the NRC staff concludes that the licensee has followed the guidance in NEI 12-06, Revision 2, to demonstrate the capability to deploy the original FLEX strategies, as designed, against a postulated beyond-design-basis event for the LIP, PMF event on the Mississippi River, the PMF event combined with a hypothetical dam break, and the combined event flood, including associated effects and flood event duration. Based on the licensee's appropriate hazard characterization, methodology used in the MSA evaluation and the description of its current FLEX strategy, the staff concludes that the licensee has demonstrated that the mitigation strategies are reasonably protected from reevaluated flood hazards conditions.

WATERFORD STEAM ELECTRIC STATION, UNIT 3 – FLOOD HAZARD MITIGATION STRATEGIES ASSESSMENT DATED FEBRUARY 27, 2017

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