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

January 17, 2019

Vice President, Operations
Entergy Nuclear Operations, Inc.
Palisades Nuclear Plant
27780 Blue Star Memorial Highway
Covert, MI 49043-9530

SUBJECT: PALISADES NUCLEAR PLANT – STAFF ASSESSMENT OF FLOODING FOCUSED EVALUATION (EPID NO. L-2018-JLD-0015)

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, under 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 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 March 11, 2015 (ADAMS Accession No. ML15114A209), Entergy Nuclear Operations, Inc. (Entergy, the licensee) responded to this request for Palisades Nuclear Plant (Palisades).

On December 23, 2015 (ADAMS Accession No. ML15356A765), the NRC issued an interim staff response (ISR) letter for Palisades. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Palisades and parameters that were a suitable input for the mitigating strategies assessment (MSA). As stated in the letter, because the local intense precipitation (LIP) and storm surge combined event flood-causing mechanisms at Palisades are not bounded by the plant's CDB, additional assessments of the flood hazard mechanisms were necessary.

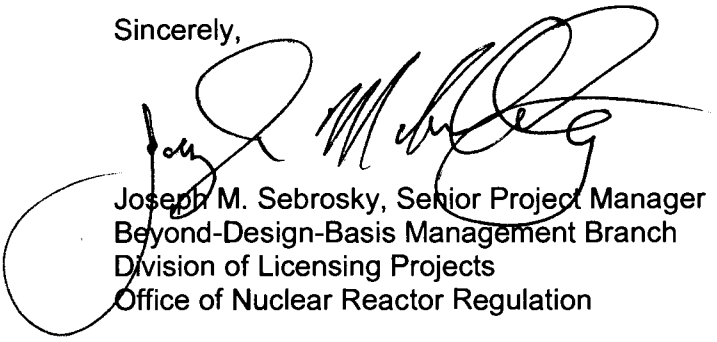
By letter dated September 25, 2018 (ADAMS Accession No. ML18269A270), the licensee submitted the focused evaluation (FE) for Palisades. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood mechanism is bounded 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 Palisades FE.

The NRC staff concludes that the Palisades 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 staff has further concluded that the licensee has demonstrated that effective flood protection exists for the LIP and storm surge combined event flood mechanisms during a beyond-design-basis external flooding event at Palisades. This closes out the NRC's efforts associated with EPID No. L-2018-JLD-0015.

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

Sincerely,



Joseph M. Sebrosky, Senior Project Manager
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Enclosure:
Staff Assessment Related to the
Flooding Focused Evaluation for Palisades

Docket No. 50-255

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE FOCUSED EVALUATION FOR

PALISADES NUCLEAR PLANT

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

RECOMMENDATION 2.1 - FLOODING

(EPID NO. L-2018-JLD-0015)

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, under 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 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 stated that an integrated assessment should be submitted and described the information that the integrated assessment should contain. On November 30, 2012 (ADAMS Accession No. ML12311A214), the NRC staff issued Japan Lessons-Learned Project Directorate (JLD) interim staff guidance (ISG) JLD-ISG-2012-05, "Guidance for Performing the Integrated Assessment for External Flooding."

On June 30, 2015 (ADAMS Accession No. ML15153A104), the NRC staff issued COMSECY-15-0019, describing the closure plan for the reevaluation of flooding hazards for operating nuclear power plants. 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 FE 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 Palisades Nuclear Plant (Palisades) has effective flood protection.

2.0 BACKGROUND

This background section includes a discussion of the Palisades reevaluated flood information provided by Entergy Nuclear Operations, Inc. (Entergy, 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 FE.

Flood Hazard Reevaluation Report

By letter dated March 11, 2015 (ADAMS Accession No. ML15114A209), the licensee responded to the 50.54(f) request for Palisades and submitted the FHRR. After the review of the licensee's response, by letter dated December 23, 2105 (ADAMS Accession No. ML15356A765), the NRC issued an interim staff response (ISR) letter for Palisades. The ISR letter provided the reevaluated flood hazard mechanisms that exceed the CDB for Palisades (LIP and storm surge combined event) and parameters that are a suitable input for the additional flooding assessments, as described in COMSECY-15-0019. The NRC staff issued a final staff assessment of the FHRR by letter dated February 14, 2018 (ADAMS Accession No. ML18037A625). In a letter dated May 3, 2018 (ADAMS Accession No. ML18086A218), the NRC staff issued a correction letter to clarify a reference to the current design basis made in the ISR letter and the FHRR staff assessment. The NRC staff's conclusion regarding LIP and storm surge combined event flood-causing mechanisms exceeding the CDB remained unchanged from the information in the ISR letter.

Mitigation Strategies Assessment

By letter dated September 25, 2018 (ADAMS Accession No. ML18269A247), the licensee submitted the MSA for Palisades for review by the NRC staff. The MSAs are intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigation strategies for beyond-design-basis external events. Although the staff has not completed its assessment of the licensee's MSA, the MSA provides associated effects parameters and flood event duration parameters for the LIP and storm surge combined event flood causing mechanisms that are relevant to the staff's assessment of the flooding FE. These parameters are used in the Palisades flooding FE evaluation found below.

Focused Evaluation

By letter dated September 25, 2018 (ADAMS Accession No. ML18269A270), the licensee submitted the FE for Palisades. 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 further 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 local intense precipitation. 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 Palisades FE.

3.0 TECHNICAL EVALUATION

As described in the ISR letter, the LIP, and storm surge combined event flooding mechanisms were found to exceed the plant's CDB flood at Palisades. The licensee stated that its FE followed Path 2 of NEI 16-05, Revision 1, as endorsed by the NRC staff and utilized Appendix B for guidance on evaluating the site strategy. The licensee noted that the previously submitted MSA dated December 19, 2016 (ADAMS Accession No. ML16354A054), discussed the use of a revised storm surge combined event flood based on the empirical simulation technique (EST) instead of the originally submitted deterministic calculation. The revised EST-based approach is no longer being used as stated in the licensee's revised MSA dated September 25, 2018, nor is it used in the licensee's FE submittal dated September 25, 2018. The staff reviewed the FHRR and FE and found that both use the same flood elevations for both the LIP and storm surge combined event flood mechanisms that were reviewed and approved by the NRC staff in the FHRR staff assessment dated February 14, 2018, as supplemented by letter dated May 3, 2018.

The FE credits passive protection features to demonstrate that key structures, systems, and components (SSCs) are protected from the LIP and storm surge combined event flooding mechanisms. The Palisades site slopes down to the Lake Michigan shoreline. General grading around the Auxiliary Building and Turbine Building is at 590 feet (ft.) mean seal level (MSL). The LIP reevaluated hazard water levels range from 594.4 ft. MSL at critical locations in the lower portions of the site to 626.1 ft. MSL at critical locations in the upper portions of the site. The storm surge combined event reevaluated flood levels range from 594.3 ft. MSL to 602.2 ft. MSL at critical locations. In general, critical locations are those that contain SSCs that provide key safety functions (KSFs) of core cooling, spent fuel cooling, and containment integrity. Table 3.0-1 provides the reevaluated flood hazard data and Figure 3.0-1 provides a general layout of the site to place the data in Table 3.0-1 in context.

3.1 Evaluation of Flood Event Duration Parameters

The NRC staff reviewed information provided by the licensee in the original MSA dated December 19, 2016, and the revised MSA dated September 25, 2018, regarding the flood event duration (FED) parameters needed to evaluate the flood hazards not bounded by the CDB. The FED parameters for flood-causing mechanisms not bounded by the CDB are discussed below and are summarized in Table 3.1-1.

3.1.1 Local Intense Precipitation

The licensee stated that the period of inundation ranges from 0.2 to 0.5 hours at critical locations and that the period of recession is approximately 24 hours. In addition, the licensee stated that the period of inundation is approximately 2 hours in the area near the FLEX Staging Area and is approximately 6 hours near the deployment routes.

3.1.2 Combined Event Flood Mechanism

As discussed in Section 3.0 above, the licensee stated in the FE that, in lieu of the EST, both the FE and the revised MSA dated September 25, 2018, rely on the original deterministic methodology discussed in the licensee's FHRR.

For the storm surge combined event flood mechanism, the licensee stated that the current FLEX strategies cannot be implemented as designed. Therefore, the licensee developed an

Alternate Mitigating Strategy that relies on the currently-installed, safety-related SSCs to perform their safety functions.

The licensee stated that no credit is taken for warning time or site preparation because, under the Alternate Mitigating Strategies, the currently-installed, safety-related SSCs can perform their safety functions. The licensee also stated that the flood maintains its peak elevation for approximately 10 hours. The NRC staff previously determined that the period of recession is approximately 25 hours as documented in an audit report dated August 3, 2016 (ADAMS Accession No. ML16174A248).

In summary, the NRC staff reviewed the licensee's assessment of the FED parameters and determined that the licensee's FED parameters for the LIP and storm surge combined event flood-causing mechanisms are acceptable. This is because the approach used to estimate these parameters is consistent with the guidelines provided in Appendix G of NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 2, dated December 2015 (ADAMS Accession No.ML16005A625), as endorsed by the NRC 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. ML 15357A163).

3.2 Evaluation of Associated Effects

The NRC staff reviewed the information provided in Entergy's FHRR regarding the associated effects (AE) parameters needed to perform the additional assessments of plant response for flood hazards not bounded by the CDB. The AE parameters related to water surface elevation (i.e., stillwater elevation with wind waves and run-up effects) were previously reviewed by the NRC staff and were transmitted to the licensee in the ISR letter. The AE parameters not directly associated with water surface elevation are discussed below and are summarized in Table 3.2-1.

3.2.1 Local Intense Precipitation (LIP)

For the LIP flood-causing mechanism, the licensee concluded in its September 25, 2018, MSA that the AE parameters related to water-borne loads, including hydrostatic, hydrodynamic, debris, and sediment loads, would induce no or minimal impacts due to the low LIP water depths and velocities. The licensee also concluded that other AEs, including sediment deposition and erosion, and concurrent site conditions are not applicable, and effects on groundwater intrusion have no impact at the plant site.

In summary, the NRC staff determined that the licensee-provided AE parameters for the LIP flood-causing mechanism are acceptable as the approach to estimate these parameters is consistent with the guidelines provided by Appendix G of NEI 12-06, Revision 2, as endorsed by the NRC.

3.2.2 Storm Surge Combined Event Flood Mechanism

For the storm surge combined event flood mechanism, the licensee concluded in its September 25, 2018, MSA that the AE parameters related to water-borne loads, including hydrostatic, hydrodynamic, debris, sediment loads, and concurrent site conditions are not applicable, and that groundwater ingress has no impact on the site.

The NRC staff reviewed the AE parameters for the storm surge combined event flood mechanism and determined that the licensee's assessment of the AE parameters is acceptable for use in the FE given that the approach to estimate these parameters is consistent with the guidelines provided by Appendix G of NEI 12-06, Revision 2, as endorsed by the NRC.

3.3 Evaluation of Flood Impact Assessment for Local Intense Precipitation

3.3.1 Description of Impact of Unbounded Hazard

The Palisades FE identified the potential impacts to key SSCs as a result of water ingress due to LIP. The maximum LIP flood elevation is 594.4 ft. MSL for the lower level. The limiting components are the service water pump lower motor bearing oil reservoirs, which are at an elevation of 594.4 ft. MSL. On the upper level, there are two locations of flooding ingress that could potentially impact key SSCs. These are through Manhole (MH) 4 which eventually leads to the 1C Switchgear Room and through Door #107 which eventually leads to the 1D Switchgear Room. The licensee calculated that the water ingress through MH-4 was determined not to impact key safety functions. Regarding water ingress through Door #107, the licensee stated that this door will be modified to install a flood protection feature such as a kickplate to prevent inleakage. In the interim, the licensee has modified its abnormal weather procedure such that sandbags will be installed to protect the door in the event of a heavy rainfall.

3.3.2 Evaluation of Available Physical Margin and Reliability of Flood Protection Features

The licensee relies on passive features such as existing doors and barriers and as an interim measure use of sandbags at one door to justify that there is still margin available using a deterministic approach. The staff performed an audit of Palisades FE supporting documents in accordance with the NRC staff's audit plan for flooding FEs dated July 18, 2017 (ADAMS Accession No. ML17192A452), to verify statements found in the licensee's FE.

Using an electronic portal, the staff audited calculation EA-EC55593-01, "Beyond Design Basis (BDB) Evaluation: Local Intense Precipitation Flow Through Manhole 4 to Manhole 1," Revision 000, dated February 19, 2015. MH-4 is shown as location 28 on Figure 3.0-1. This MH contains unsealed conduits that lead to MHs 1, 2, and 3, which make up the sump in the 1C Switchgear room. Calculation EA-EC55593-01 includes an assessment of five additional MHs (MH-5A/B/C/D/E) that have unsealed conduits leading to MH-4, which would further contribute to the flood levels. The calculation used conservative assumptions, including using maximum hourly rainfall amounts and reducing the MH 1, 2, and 3 volume by 5 percent to account for ladders and other obstructions within the MHs. The licensee concludes in its FE, based on the results provided in Calculation EA-EC55593-01, that there would be 444 $ft.^3$ of inleakage from MH-4 to MH 1, 2, and 3, which have a combined available volume of 684 $ft.^3$. Therefore, leakage from this path would not result in flooding in the 1C Switchgear room.

Calculation EA-EC55593-01 also evaluated the potential for inleakage from a LIP event such that water would travel from MHs 5A/B/C/D/E to MH-4 and subsequently to the 1C Switchgear room. The licensee determined that there was sufficient storage capacity at the bottom of MHs 5A/B/C/D/E such that inleakage from the LIP event into these MHs would not lead to water flowing from these MHs to MH-4. The calculation considered that the conduit leading from MHs 5A/B/C/D/E to MH-4 is 19 inches above the bottom of the MHs, and that based on the parameters associated with the LIP event, the volume at the base of these MHs would be

sufficient to contain the water such that it would not flow from these MHs to MH-4. The staff notes that actions to dewater MHs 1, 2 and 3 are not credited during the LIP event. Based on sufficient volume being present in MHs 5A/B/C/D/E to contain inleakage such that it would not travel to MH-4 during a LIP event, and the capacity of MHs 1, 2, and 3 to contain the inleakage from MH-4 during a LIP event, the staff concludes that the 1C Switchgear Room has reliable "effective" flood protection in accordance with the guidance found in Appendix B of NEI 16-05, Revision 1, as endorsed by the NRC.

Regarding inleakage from Door #107[1], there is the potential that water entering through this door from the LIP event could lead to the 1D Switchgear and thus impact key safety functions. Door #107 is shown as location 36 in Figure 3.0-1. The licensee stated that, to prevent water ingress through Door #107 during a LIP event it intends to install a flood protection feature such as a kickplate as part of a future action. In the interim, the licensee stated that sandbags are stored outside of Door #107 and will be deployed to protect the door in the event of heavy rainfall in accordance with site procedure Abnormal Operating Procedure (AOP)-38, "Acts of Nature," Revision 14. The staff audited AOP-38, Revision 14, and confirmed that it includes steps to place sandbags around Door #107 in the event that predicted or actual rainfall is greater than 4 inches in 1 hour or greater than 6 inches in 2 hours. The staff considers the placement of the sandbags around Door #107 an appropriate interim measure and notes that the licensee includes the installation of a flood barrier to prevent flooding through this door during a LIP-type event as a regulatory commitment as documented in attachment 2 of the licensee's FE. With regards to Regulatory Commitments, the NRC staff notes that NEI 99-04 "Guidelines For Managing NRC Commitments" (ADAMS Accession No. ML003680088), as endorsed by the NRC in SECY-00-0045 "Acceptance of NEI 99-04, "Guidelines For Managing NRC Commitments"" (ADAMS Accession No. ML003679799), provides an acceptable method to manage commitments. Based on the interim and future actions, the staff concludes that the 1D Switchgear has reliable "effective" flood protection from a LIP event in accordance with the guidance found in Appendix B of NEI 16-05, Revision 1, as endorsed by the NRC.

The staff notes that AOP-38, Revision 14, contains guidance that in the event of sustained heavy rains the licensee verifies: 1) that flood doors are fully dogged (i.e., closed and latched), 2) key doors are verified closed, and 3) sandbags are placed along the Turbine Building South roll-up door. The staff concludes that such actions are consistent with the assumptions found in the licensee's FE related to flood protection for key safety functions. As discussed above, the limiting SSC for the LIP event at the lower elevation is the service water pump lower motor bearing oil reservoirs, which are at an elevation of 594.4 ft. MSL. The staff concludes that flooding on the lower elevation from the LIP event is bounded by the site protection level of 594.4 ft. MSL. Therefore, for areas of the plant other than the 1C and 1D Switchgear that contain key SSCs, the staff concludes that these areas of the plant have reliable "effective" flood protection from a LIP event in accordance with the guidance found in Appendix B of NEI 16-05, Revision 1, as endorsed by the NRC.

Guidance is provided in NEI 16-05, Revision 1, Appendix B, as endorsed by the NRC, that negligible or zero available physical margin (APM) can be justified if the use of conservative inputs, assumptions, and/or methods in the flood hazard reevaluation can be established. The evaluation of the LIP event effects found above does not include a discussion of the available physical margin. For the purposes of the staff's evaluation the staff considered that a negligible

[1] The licensee noted in the FE that Door #107 is incorrectly listed as Door #106 in FHRR Rev. 0.

APM was available. The staff notes that the LIP evaluation includes the following conservative assumptions:

- The site drainage network was assumed to be non-functional and culverts were assumed to be blocked and storm sewers were not considered.

- The vehicle barrier system was not assumed to re-direct overland flow away from the site.

Based on the above assumptions the staff concludes that the Palisades APM for the LIP event is acceptable.

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). The NRC staff expects that licensees will continue to maintain flood protection features in accordance with their current licensing basis. The staff also expects that licensees will use the site corrective action program to disposition flood-related maintenance, operations, and design issues, consistent with the provisions of NEI 16-05 and NEI 12-07, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features," as endorsed by the NRC, where appropriate. Continued research involving flood protection systems will be performed and shared by the NRC staff with licensees in accordance with the guidance provided in Management Directive 8.7 "Reactor Operating Experience Program" (ADAMS Accession No. ML122750292).

3.3.3 Overall Site Response

The licensee relies on placement of sandbags as an interim action to minimize water ingress around Door #107. In the long-term, the licensee is tracking the installation of a permanent flood protection feature at this door as a regulatory commitment. The licensee also verifies that doors are closed in accordance with AOP-38. The staff concludes the interim action to place sandbags around Door #107 and the verification that key doors are dogged or closed are consistent with the guidance found in Appendix C of NEI 16-05, Revision 1, as endorsed by the NRC, and therefore acceptable.

3.4 Evaluation of Flood Impact Assessment for Storm Surge Combined Event

3.4.1 Description of Impact of Unbounded Hazard

Table 3.0-1 provides the flood levels for the storm surge combined event. As stated above, key SSCs are located in flood protected areas, or are situated at a minimum elevation of 594.4 ft. MSL. For the storm surge combined event, the licensee evaluated the impact on the lower bearing lube oil reservoirs for the service water pumps that are located at 594.4 ft. MSL. The maximum flood stillwater elevation outside the screen house/intake structure is 593.9 ft. MSL as shown in Table 3.0-1. As stated in FHRR Section 3.9.2.1.4, the reevaluated flood level elevation inside the screen house/intake structure in 593.1 ft. MSL due to direct connection to

the lake. That is, the water that enters the screen house/intake structure is drawn from Lake Michigan through an intake crib in the lake that then passes through a buried intake line (approximately 3000 ft. in length).

For areas of the site that are subject to wind-wave runup, the licensee credits site grade, circulation water pipes, and building exterior features for protection of key SSCs. The circulation water pipes are credited for acting as a wave break in front of the screen house/intake structure.

3.4.2 Evaluation of Available Physical Margin and Reliability of Flood Protection Features

The staff considers site grade and the building exterior features as being reliable flood protection features in accordance with Appendix B of NEI 16-05, Revision 1, as endorsed by the NRC. The APM for the service water pumps is 1.3 ft. (i.e., 594.4 ft. MSL – 593.1 ft. MSL). Guidance is provided in NEI 16-05, Revision 1, Appendix B, as endorsed by the NRC, that negligible or zero APM can be justified if the use of conservative inputs, assumptions, and/or methods in the flood hazard reevaluation can be established. The storm surge combined event evaluation includes the following conservative assumptions:

- The probable maximum wind storm (PMWS) was conservatively assumed to be steady state along a straight track, and therefore storm parameters were not varied with time.

- A maximum wind speed of 100 miles per hour was used for the PMWS, which is higher than the maximum recorded sustained wind of 68 miles per hour.

Based on the above assumptions the staff concludes that the Palisades APM for the storm surge combined event is acceptable.

The staff's evaluation of the circulation water pipes serving as a wave break for the screen house/intake structure, including its APM and reliability is found below.

Structural Evaluation of Circulation Water Pipes

In its FE, the licensee credited the circulation water pipes as a Type 2 protective feature per NEI 16-05 Appendix B, Section B.1. The circulation water pipes are part of the circulating water system, are made of ½ inch steel plates, have a diameter of 96 inches (8 ft.), and are typically full of water. These pipes run underground from the turbine building to the cooling tower discharge structure, and the portion in-between that is not underground (over 90 ft. long) is supported by reinforced concrete saddles. A portion of this piping is shown in Figure 3.4-1. The Palisades updated final safety analysis report (UFSAR) Table 5.2-3 classifies the circulation piping as Noncategory I, Class 3. Section 5.2.2.3 of the Palisades UFSAR defines Class 3 as those SSCs whose failure would not result in the release of radioactivity and would not prevent reactor shutdown. The circulation water pipes are credited by the licensee to break wind-driven waves in front of the screen house/intake structure adjacent to the southern portion of the turbine building facing Lake Michigan. The licensee stated in its FE that it assessed the structural capacity of the circulation pipe against the waves generated by the reevaluated, combined event flood and concluded that there is adequate APM. Following the audit process

described in the letter dated July 18, 2017, the NRC staff requested supporting information to confirm these statements.

Using an electronic portal, the licensee made available Calculation EA-EC54930-04, Revision 0, "32-9234660-000 – Palisades Nuclear Plant Flooding Hazard Re-Evaluation – Wave Loading on Cooling Tower Piping." In this calculation, the licensee assessed the structural properties of the pipe (full of water) closest to the lake against hydrostatic, hydrodynamic, and debris impact loads generated by the reevaluated storm surge combined event flood. When auditing this calculation, the NRC staff assessed the loading information and the adequacy of the analysis approach used by the licensee. The NRC staff confirmed that the loading information used in the calculation came from Calculation 32-9234660-000, "32-9226981-001, Palisades Nuclear Plant Flooding Hazard Re-Evaluation – Combined Events." The staff concludes this is reasonable because Calculation 32-9234660-000 defines the storm surge combined event flood that could generate the waves under consideration. Also, the NRC staff confirmed that flood elevations and estimated loads in Calculation 32-9234660-000 are the same as those in the NRC FHRR staff assessment. Regarding the potential for debris impacting the pipe, the NRC staff considered the debris-impact load assumed by the licensee and the likelihood of having a piece of debris with sufficient mass and kinetic energy to break the pipe. The staff concludes that the debris-impact load used by the licensee is conservative. The staff further concludes that the licensee's analysis was conservative because it considered this worst-case debris-impact load in its analysis, even though the likelihood of debris of any significant magnitude impacting the circulation pipe is low.

In addition, the NRC staff confirmed that the analysis approach used in Calculation EA-EC54930-04 to quantify the structural capacity of the circulation pipe and saddle supports referred to acceptable engineering standards such as ANSI B31.1, "Power Piping," the AISC Manual of Steel Construction, and ACI 318-63, "Building Code Requirements for Structural Concrete." Also, the analysis in Calculation EA-EC54930-04 assessed the capacity of only one pipe, when in reality, there are other pipes of similar dimensions that could protect the screen house/intake structure if the pipe closest to the lake were to fail. Based on the information provided by the licensee, the NRC staff concludes that the licensee reasonably considered the loading conditions the piping could be exposed to, that the analysis was done conservatively, and that there is adequate APM to withstand the wave action generated by the reevaluated storm surge combined event flood. This conclusion is consistent with statements in Section 4.3 of the NRC FHRR staff assessment (ML18037A625), wherein the staff first assessed the use of the circulation piping as a protective measure against the waves. The licensee's analysis also provided sufficient information to conclude that the circulation pipe behaves similarly to the passive permanent flood barriers described in NEI 16-05, Appendix B. Reliability of the pipe to serve as a protective feature is addressed by the inspection and maintenance programs that ensures the pipe will serve its intended function to carry circulating water and in so doing can be reasonably assumed to serve the function of a wave break.

Conclusion

Based on the passive features that protect key SSCs from the storm surge combined event and the protection provided by the circulation water piping to the screen house/intake structure from wave action during a storm surge combined event, the staff concludes that key SSCs have reliable "effective" flood protection from a storm surge combined event in accordance with the guidance found in Appendix B of NEI 16-05, Revision 1, as endorsed by the NRC.

3.4.3 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 storm surge combined event. As described above, the licensee's evaluation relied on passive existing features to demonstrate adequate flood protection. Therefore, there is no need to review overall site response.

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 review of the Palisades FE was limited to the audit of the procedures and calculations 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 NRC staff's July 18, 2017, letter.

5.0 CONCLUSION

The NRC staff concludes that the licensee performed the Palisades 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 that effective flood protection exists against the reevaluated flood hazards of LIP and storm surge combined event. Furthermore, the NRC staff concludes that Palisades screens out for an integrated assessment based on the guidance found in JLD-ISG-2016-01. As such, the staff concludes that in accordance with Phase 2 of the process outlined in the 50.54(f) letter, additional regulatory actions associated with the reevaluated flood hazard are not warranted.

Table 3.0-1 Reevaluated Hazard Elevations for Flood-Causing Mechanisms Not Bounded by the Palisades Current Design Basis

Mechanism	Stillwater Elevation, ft. NGVD29	Waves/ Runup, ft.	Reevaluated Hazard Elevation, ft. NGVD29	Reference
LIP Service Building-East Side (Non-Category 1 Structure	605.8	Minimal	605.8	FHRR Section 2.3.1.1 and FHRR Table 4-1
Upper Level (Category 1 Structures)	626.1	Minimal	626.1	FHRR Section 2.3.1.1, FHRR Table 4-1 and FHRR Table 5-2
Lower Level (Category 1 Structures)	594.4	Minimal	594.4	FHRR Section 2.3.1.1, FHRR Table 4-1 and FHRR Table 5-1
Storm Surge (H.4 Combined Flood Event): Lakeward of Circulation Water Pipes	593.9	8.3	602.2	FHRR Section 3.9.2.1.2, FHRR Table 4-5 and FHRR Figure 3-29
Landward of Circulation Water Pipes	593.9	0.4	594.3	FHRR Section 3.9.2.1.2, FHRR Table 4-5 and FHRR Figure 3-29
Landward of Turbine Building	593.9	0.4	594.3	FHRR Section 3.9.2.1.2, FHRR Table 4-5 and FHRR Figure 3-29
North of Turbine Building	593.9	1.1	595.0	FHRR Section 3.9.2.1.2, FHRR Table 4-5 and FHRR Figure 3-29

Table 3.1-1 Flood Event Durations for Flood-Causing Mechanisms Not Bounded by the CDB

Flood-Causing Mechanism	Time Available for Preparation for Flood Event	Duration of Inundation of Site	Time for Water to Recede from Site
Local Intense Precipitation and Associated Drainage	Not Required	0.2-0.5 hours at critical locations[1]	24 hours[1]
		2 – 6 hours at deployment routes[2]	
Combined Event	Not Required	10 hours[2]	25 hours[3]

1. Source - MSA dated December 19, 2016
2. Source – Revised MSA dated September 25, 2018
3. Source - NRC, audit report dated August 3, 2016

TABLE 3.2-1 ASSOCIATED EFFECTS PARAMETERS NOT DIRECTLY ASSOCIATED WITH TOTAL WATER HEIGHT FOR FLOOD-CAUSING MECHANISMS NOT BOUNDED BY THE CDB.[4]

Associated Effects	Local Intense Precipitation	Combined Effects
Hydrodynamic loading at plant grade	Not Applicable	Not Applicable
Debris loading at plant grade	Not Applicable	Not Applicable
Sediment loading at plant grade	Not Applicable	Not Applicable
Sediment deposition and erosion	Not Applicable	Not Applicable
Concurrent Conditions, including adverse weather	Not Applicable	Not Applicable
Groundwater ingress	Not Applicable	Not Applicable
Other factors	Not Applicable	Not Applicable

4. Source – Revised MSA dated September 25, 2018

Figure 3.0-1 Palisades Site Layout (Adapted from Figure 3.2-1 of March 11, 2015, FHRR (ADAMS Accession No. ML15114A209)

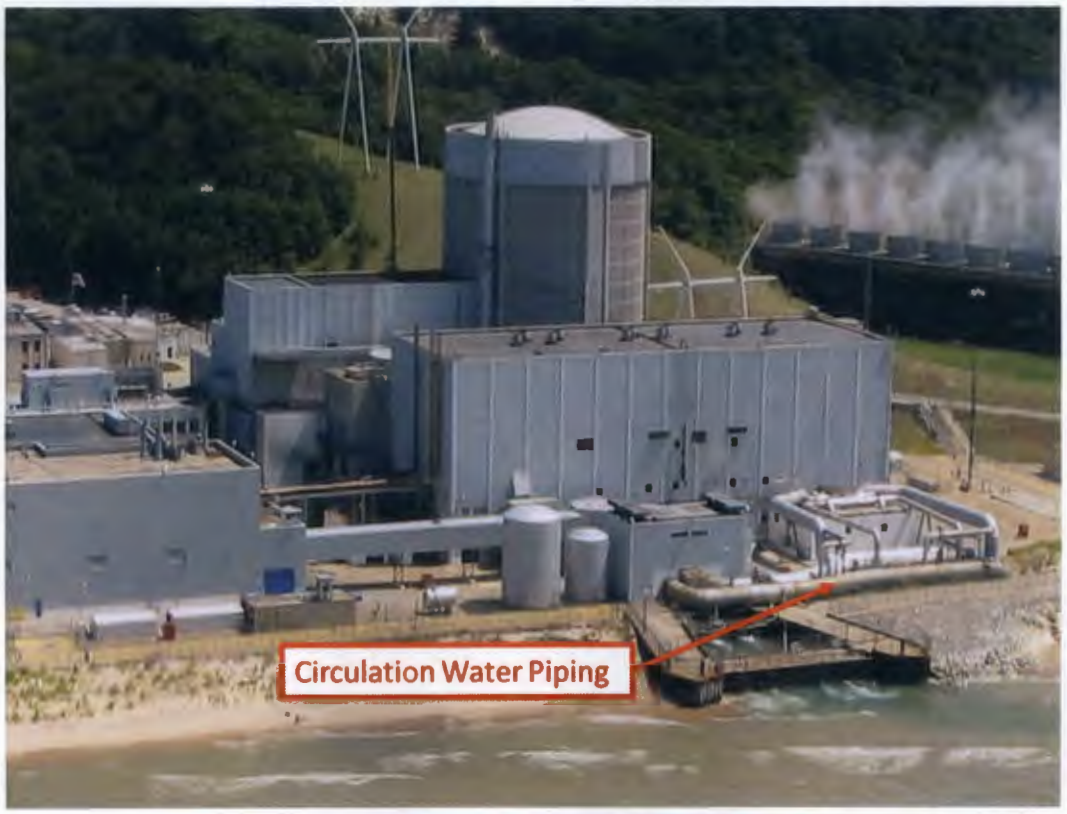

Figure 3.4-1 Palisades Site

SUBJECT: PALISADES NUCLEAR PLANT– STAFF ASSESSMENT OF FLOODING FOCUSED EVALUATION (EPID L-2018-JLD-0015) DATED JANUARY 17, 2018

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