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

April 18, 2018

Mr. Dean Curtland
Site Director
NextEra Energy
Duane Arnold Energy Center
3277 DAEC Road
Palo, IA 52324-9785

SUBJECT: DUANE ARNOLD ENERGY CENTER – STAFF ASSESSMENT OF FLOODING FOCUSED EVALUATION (EPID NO. 000495/05000331/L-2018-JLD-0001)

Dear Mr. Curtland:

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*, 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). By letter dated March 10, 2014 (ADAMS Accession No. ML14072A019), NextEra Energy Duane Arnold, LLC (NextEra, the licensee) responded to this request for Duane Arnold Energy Center (DAEC).

After its review of the licensee's response, on March 31, 2016 (ADAMS Accession No. ML16084A767), the NRC issued an interim staff response (ISR) letter for DAEC. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for DAEC and parameters that are suitable for other assessments associated with NTTF Recommendation 2.1, "Flooding." As stated in the letter, because the local intense precipitation (LIP) and streams and rivers flood-causing mechanisms at DAEC are not bounded by the plant's CDB, additional assessments of these flood hazard mechanisms are necessary.

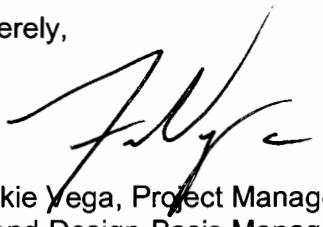
By letter dated January 19, 2018 (ADAMS Accession No. ML18022A178), the licensee submitted the focused evaluation (FE) for DAEC. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood mechanism is bounded based 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. The purpose of this letter is to provide the NRC's assessment of the DAEC FE.

As set forth in the attached staff assessment, the NRC staff has concluded that the DAEC 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 and streams and rivers flood mechanisms during a beyond-design-basis external flooding event at DAEC. This closes out the licensee's response for DAEC for the reevaluated flooding hazard portion of the 50.54(f) letter and the NRC's efforts associated with EPID No. 000495/05000331/L-2018-JLD-0001.

If you have any questions, please contact me at 301-415-1617 or by e-mail at Frankie.Vega@nrc.gov.

Sincerely,



Frankie Vega, Project Manager
Beyond-Design-Basis Management Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket No: 50-331

Enclosure:
Staff Assessment Related to the
Flooding Focused Evaluation for DAEC

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE FOCUSED EVALUATION FOR

DUANE ARNOLD ENERGY CENTER

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

RECOMMENDATION 2.1 - FLOODING

EPID NO. 000495/05000331/L-2018-JLD-0001

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*, 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 stated 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 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 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).

2.0 BACKGROUND

This provides the final NRC 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, this background section includes a summary description of the reevaluated flood information provided by the licensee and the associated assessments performed by the NRC staff. 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 March 10, 2014 (ADAMS Accession No. ML14072A019), NextEra Energy Duane Arnold, LLC (NextEra, the licensee) submitted its flood hazard reevaluation report (FHRR) for Duane Arnold Energy Center (Duane Arnold, DAEC). After reviewing the licensee's response, on March 31, 2016 (ADAMS Accession No. ML16084A767), the NRC issued an interim staff response (ISR) letter for Duane Arnold. The ISR letter discusses the reevaluated flood hazard mechanisms that exceeded the CDB for DAEC and parameters that are a suitable input for the MSA and the FE. As stated in the ISR letter, because the local intense precipitation (LIP) and streams and rivers (Cool-Season Probable Maximum Precipitation) flood-causing mechanisms at DAEC are not bounded by the plant's CDB, additional assessments of the flood hazard mechanisms are necessary. The NRC staff issued a final staff assessment of the FHRR by letters dated April 3, 2017 (ADAMS Accession No. ML17076A193), and April 14, 2017 (ADAMS Accession No. ML17103A440). The NRC staff's conclusions regarding LIP and streams and rivers exceeding the DAEC CDB remained unchanged from the information provided in the ISR letter.

Mitigation Strategies Assessment

By letter dated January 25, 2017 (ADAMS Accession No. ML17026A415), the licensee submitted the MSA for DAEC 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. By letter dated May 24, 2017 (ADAMS Accession No. ML17135A041), the NRC issued its assessment of the DAEC MSA. The NRC staff concluded that the DAEC MSA was performed consistent with the guidance described in Appendix G of NEI 12-06, Revision 2, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide" (ADAMS Accession No. ML16005A625). 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 January 19, 2018 (ADAMS Accession No. ML18022A178), the licensee submitted the FE for DAEC. 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 DAEC FE.

3.0 TECHNICAL EVALUATION

The licensee stated that its FE followed Path 2 of NEI 16-05, Revision 1 and utilized Appendices B and C for guidance on evaluating the site strategy. The DAEC FE addresses the LIP and streams and rivers flooding mechanisms, which were found to exceed the plant's CDB as described in the FHRR and ISR letter. This technical evaluation will address the following topics: characterization of flood parameters; evaluation of flood impact assessments; evaluation of available physical margin (APM); reliability of flood protection features; and overall site response.

3.1 Characterization of Flood Parameters

The LIP and streams and rivers flood elevations, associated effects (AE) and flood event duration (FED) parameters that are used as input to the FE are the same as those that were used for the MSA. These parameters were assessed by NextEra and have already been reviewed by the NRC, as summarized by letter dated May 24, 2017 (ADAMS Accession No. ML17135A041).

For LIP, the licensee stated that the only key structures with openings vulnerable to significant water ingress during a LIP event are exterior doors on the Turbine Building. The maximum estimated water depth would be approximately 0.8 feet (ft.) above the lowest ingress thresholds for these Turbine Building doors. Table 2 of the staff ISR letter identifies four Turbine Building doors that are potential water ingress paths to buildings containing key structures, systems, and components (SSCs). The licensee stated that this potential ingress of water to the Turbine Building would flow to lower levels of the building.

The FE credits passive permanent flooding protection features to demonstrate that key SSCs are protected from the LIP flooding mechanism. The licensee indicated that the site does not require additional manual actions by plant personnel to protect key SSCs; therefore, an evaluation of the overall site response was not necessary for LIP.

For the streams and rivers flood-causing mechanisms, the CDB maximum still water elevation combined with wind-wave run up would result in a flood elevation of 767.0 ft. mean sea level (MSL). The revaluated elevations for the streams and rivers flood event are 767.8 ft. MSL, 766.2 ft. MSL and 766.7 ft. MSL on the south, west and east sides of safety-related buildings, respectively. The licensee stated that even though CDB flood elevation is lower than the reevaluated flood hazard elevation reported in the ISR of 767.8 ft. MSL, additional protection is provided beyond the CDB elevation. Specifically, the licensee stated that the current licensing basis (CLB) requires protection of all openings to 770.5 ft. MSL on the northerly side, 773. 7 ft. MSL on the southerly side, and 769 ft. MSL on all other sides of all flood protected structures.

The FE credits incorporated active and passive and temporary active and passive flood protection features to demonstrate that key SSCs are protected from the streams and rivers

flood. The licensee indicated that the site requires additional manual actions by plant personnel to protect key SSCs; therefore, an evaluation of the overall site response was provided.

The NRC staff reviewed the LIP and streams and rivers parameters listed in the licensee's FE and confirmed that they were consistent with the parameters that were presented in the MSA. Based on the review that was previously performed for the FHRR and MSA, the staff concludes that the licensee's characterization of the LIP and stream and river events in the FE is appropriate.

3.2 Evaluation of Flood Impact Assessment for Local Intense Precipitation

3.2.1 Description of Impact of Unbounded Hazard

The DAEC FE identified the potential impacts on key SSCs as a result of water ingress due to LIP. The LIP event leads to flood water surface elevations above the plant floor elevations at some locations adjacent to the Turbine Building. In order to assess the impacts of the unbounded flood levels, the licensee identified the maximum flood depths above the door threshold and duration of when the flood levels are above the door threshold. With this information, the licensee assessed the impacts of water ingress and potential for accumulation into rooms housing key SSCs.

The licensee's evaluation indicated that the maximum reevaluated flood depths at the four external doors on the Turbine Building vary between 0.5 ft. and 0.8 ft. These affected doors were #124, #136, #137 and #154 and are shown in FHRR Figure 4-9. The water depths above the affected door sills were used in calculations of expected water ingress to the Turbine Building.

An evaluation of the potential impacts of the LIP flood hazard was provided in the FHRR. The licensee assumed that water would ingress through the doors mentioned above. Based on the Turbine Building design and configuration, water would flow to the lower elevation of the Turbine Building. The licensee estimated that the total water accumulating in the basement of the Turbine Building would be less than 8 inches. According to Section 10.4.5.3 in the Updated Final Safety Analysis Report (UFSAR), the lower level of the Turbine Building has the capacity of accumulating as much as 8 ft. of water without compromising achievement of safe plant shutdown. Based on this evaluation, the licensee concluded that internal flooding from a LIP event will not affect any key safety functions (KSFs).

The NRC staff reviewed the information provided by the licensee in order to assure that adequate flood parameters were used for the calculation of water ingress and water accumulation. The NRC staff confirmed the flood parameters used for the calculation of water ingress and water accumulation were consistent with previous information reviewed by the staff for the DAEC FHRR and MSA.

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

The licensee relies on existing doors, site configuration and the capability of the Turbine Building to accommodate in-leakage to justify that there is available margin. The licensee evaluated the potential water depths at several Turbine Building doors and evaluated the potential effects of water ingress at these locations. The licensee stated that several conservative assumptions were made in the estimation of water surface elevation and water ingress, such as not crediting sump pumps in the Turbine Building and assuming plant drainage

system to be non-functional that might result in higher calculated water surface elevations. Based, in part, on the margin available to accept in-leakage when considering the most conservative case, the licensee concludes that there is adequate APM for the Turbine Building.

The NRC staff confirmed that, according to UFSAR Section 10.4.5.3, the Turbine Building is capable of accumulating up to 8 ft. of water. Since the volume of water expected to enter the Turbine Building from the LIP event is significantly less than that expected for pipe breaks evaluated in the DAEC internal flooding analysis documented in the UFSAR, the NRC staff concludes that adequate margin exists for the reevaluated LIP mechanism. The NRC staff agrees that the licensee's estimation of water ingress and accumulation is reasonable and that the key safety functions would likely be maintained during a LIP event. Therefore, the NRC staff concludes that the licensee has demonstrated that there is sufficient APM, as described in Appendix B of NEI 16-05, Revision 1.

Evaluation of Reliability of Protection Features

As stated above, the licensee relies on existing doors and site configuration for flood protection.

The licensee stated that water could accumulate outside several doors of buildings housing key SSCs. The FE specifies doorways that could potentially serve as pathways into structures containing key SSCs and provides the estimated maximum flood depth at such doorways. In its FE and MSA, the licensee stated that water depths adjacent to the Turbine Building are sufficiently small (0.8 ft. above door thresholds) to result in negligible hydrodynamic loading and would not produce debris impacts. The staff verified the information provided by the licensee regarding these loads and, as stated in FE and MSA, and agrees with the licensee that the resultant loads are expected to be low and not likely to exceed design loads for such doors.

Since the existing Turbine Building configuration (i.e., open gratings, pathways) is already credited as part of the Duane Arnold's CLB flooding events, 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.

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 under 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 CLB. 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 DAEC flood protection features described above are reliable to maintain KSFs as defined in Appendix B of NEI 16-05, Rev 1.

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 LIP event. As described above, the licensee's evaluation relied on passive existing flood protection features to demonstrate adequate flood protection; therefore, there is no need to review overall site response.

3.3 Evaluation of Flood Impact Assessment for Streams and Rivers

3.3.1 Description of Impact of Unbounded Hazard

As described in the FE, the maximum flood elevation from the streams and rivers flooding mechanism is 767.8 ft. MSL. The CDB maximum water elevation is 767.0 ft. MSL however, based on UFSAR Chapter 3.4 and as stated above, additional protection up to the following levels is provided: elevation 770.5 feet MSL on the northerly side of safety-related buildings; elevation 773.7 ft. MSL on the southerly side of safety-related buildings, and to 769 ft. MSL on all other sides of safety-related buildings.

The NRC staff confirmed the flood parameters used for the calculation of water ingress and water accumulation were consistent with previous information reviewed by the staff for the DAEC FHRR and MSA. The staff also confirmed the flood protection elevations were consistent with the current design and licensing basis information provided in UFSAR Section 3.4.

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

Duane Arnold relies on the incorporated active and passive and temporary active and passive protection features to provide protection from the streams and rivers conditions to the levels mentioned in Section 3.3.1 of this staff assessment. Specifically, in addition to doors and walls, the licensee relies on stoplogs for entry doors to plant protected areas, sandbags and plastic sheeting to augment the stoplogs and control in-leakage, and sump pumps. The licensee calculated the APM from the reevaluated total water elevations and the CLB flood protection levels. As shown on page 13 of the FE, the APM for the streams and rivers flooding mechanisms was estimated to range from 2.3 ft. to 5.9 ft. The staff concludes that this APM is acceptable because it meets the guidance found in NEI 16-05, Revision 1 Section B.1, regarding the use of conservative assumptions, inputs, and methods, in the estimation of APM.

Since the site's flood protection for streams and rivers flood event is already credited as part of the DAEC's design-basis flood protection and these flood protection features were also verified as part of NTTF Recommendation 2.3 Flooding Walkdowns (ADAMS Accession No. ML12342A004) and reviewed by the staff in the Flooding Walkdown staff assessment (ADAMS Accession No. ML14162A176) 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.

3.3.3 Overall Site Response

As stated in its FE, the licensee relies on temporary barriers and other manual actions that require operator action to provide flood protection against the reevaluated stream and rivers flooding event. The licensee emphasized that the current flood protection response strategy is identical to the response to the design-basis flood described in UFSAR Section 3.4. As part of the NTTF Recommendation 2.3 Flooding Walkdowns the licensee performed simulations of flood protection procedures in order to demonstrate that design-basis flood protection activities

are feasible. The simulations concluded that the estimated time to complete all flood mitigation is 3.67 days, which meets the 6.4 day requirement of the UFSAR (time to peak water level). In the MSA the licensee described warning time as the required time for flood water to reach plant grade and estimated it to be 4 days and 17 hours. The licensee stated that there are no time critical actions or prescribed critical path given the existing margin and that most tasks can be performed in any sequence.

The NRC staff has previously reviewed the simulations included as part of the flooding walkdowns as documented in the Flooding Walkdown staff assessment. In the Flooding Walkdown staff assessment, the staff concluded that the licensee appears to have described protection and mitigation features as requested in the 50.54(f) letter, and consistent with the walkdown guidance "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features" (ADAMS Accession No. ML12144A401). The staff has also previously reviewed the licensee estimation of warning time as part of the MSA review. In its MSA staff assessment, the staff concluded that the licensee's FED parameters are reasonable and acceptable. The staff reviewed the information provided by the licensee in its FE and the MSA and agrees that there will be sufficient warning time to ensure all flood preparation activities would be completed before the onset of severe weather. The staff concludes that the licensee should be able to place the temporary features into place consistent with the FE description.

4.0 AUDIT REPORT

The July 18, 2017, generic audit plan (ADAMS Accession No. ML17192A452) 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 DAEC 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 that a separate audit report is not necessary, and that this document serves as the audit report described in the staff's July 18, 2017, letter.

5.0 CONCLUSION

The NRC staff concludes that NextEra performed the DAEC 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, if appropriately implemented, exists for the reevaluated flood hazards. Furthermore, the NRC staff concludes that DAEC 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 following completion of the licensee's regulatory commitments, are not warranted. The licensee has satisfactorily completed providing responses to the 50.54(f) activities associated with the reevaluated flood hazards.

SUBJECT: DUANE ARNOLD ENERGY CENTER – STAFF ASSESSMENT OF FLOODING FOCUSED EVALUATION DATED April 18, 2018

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