



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

June 17, 2014

Richard L. Anderson
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SUBJECT: DUANE ARNOLD ENERGY CENTER – STAFF ASSESSMENT OF THE FLOODING WALKDOWN REPORT SUPPORTING IMPLEMENTATION OF NEAR-TERM TASK FORCE RECOMMENDATION 2.3 RELATED TO THE FUKUSHIMA DAI-ICHI NUCLEAR POWER PLANT ACCIDENT (TAC NO. MF0225)

Dear Mr. Anderson:

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information letter per Title 10 of the *Code of Federal Regulations*, Section 50.54(f) (50.54(f) letter). The 50.54(f) letter was issued to power reactor licensees and holders of construction permits requesting addressees to provide further information to support the NRC staff's evaluation of regulatory actions that may be taken in response to lessons learned from Japan's March 11, 2011, Great Tōhoku Earthquake and subsequent tsunami. The request addressed the methods and procedures for nuclear power plant licensees to conduct flooding hazard walkdowns to identify and address degraded, nonconforming, or unanalyzed conditions through the corrective action program, and to verify the adequacy of the monitoring and maintenance procedures.

By letter dated November 27, 2012, NextEra Energy Resources (NextEra) submitted a Flooding Walkdown Report as requested in Enclosure 4 of the 50.54(f) letter for the Duane Arnold Energy Center (DAEC) site. By letter dated January 29, 2014, NextEra provided a response to the NRC request for additional information for the staff to complete its assessments.

The NRC staff reviewed the information provided and, as documented in the enclosed staff assessment, determined sufficient information was provided to be responsive to Enclosure 4 of the 50.54(f) letter.

R. L. Anderson

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If you have any questions, please contact me at (301) 415-8371 or by e-mail at Mahesh.Chawla@nrc.gov.

Sincerely,



Mahesh Chawla, Project Manager
Plant Licensing Branch III-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-331

Enclosures:
Staff Assessment of Flooding Walkdown Report

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STAFF ASSESSMENT OF FLOODING WALKDOWN REPORT
NEAR-TERM TASK FORCE RECOMMENDATION 2.3 RELATED TO
THE FUKUSHIMA DAI-ICHI NUCLEAR POWER PLANT ACCIDENT
NEXTERA ENERGY RESOURCES
DUANE ARNOLD ENERGY CENTER
DOCKET NO. 50-331

1.0 INTRODUCTION

On March 12, 2012,¹ the U.S. Nuclear Regulatory Commission (NRC) issued a request for information per Title 10 of the *Code of Federal Regulations*, (10 CFR) Section 50.54(f) (50.54(f) letter) to all power reactor licensees and holders of construction permits in active or deferred status. The request was part of the implementation of lessons learned from the accident at the Fukushima Dai-ichi nuclear power plant. Enclosure 4, "Recommendation 2.3: Flooding,"² to the 50.54(f) letter requested licensees to conduct flooding walkdowns to identify and address degraded, nonconforming, or unanalyzed conditions using the corrective action program (CAP), verify the adequacy of monitoring and maintenance procedures, and report the results to the NRC.

The 50.54(f) letter requested licensees to include the following:

- a. Describe the design basis flood hazard level(s) for all flood-causing mechanisms, including groundwater ingress.
- b. Describe protection and migration features that are considered in the licensing basis evaluation to protect against external ingress of water into structures, systems, and components (SSCs) important to safety.
- c. Describe any warning systems to detect the presence of water in rooms important to safety.
- d. Discuss the effectiveness of flood protection systems and exterior, incorporated, and temporary flood barriers. Discuss how these systems and barriers were evaluated using the acceptance criteria developed as part of Requested Information item 1.h.
- e. Present information related to the implementation of the walkdown process (e.g., details of selection of the walkdown team and procedures) using the documentation template discussed in Requested Information item 1.j, including actions taken in response to the peer review.
- f. Results of the walkdown including key findings and identified degraded, nonconforming, or unanalyzed conditions. Include a detailed description of the actions taken or planned to address these conditions using guidance in Regulatory Issues Summary 2005-20,

1 Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340

2 ADAMS Accession No. ML12056A050

Revision 1, Revision to the NRC Inspection Manual Part 9900 Technical Guidance, "Operability Conditions Adverse to Quality or Safety," including entering the condition in the corrective action program.

- g. Document any cliff-edge effects identified and the associated basis. Indicate those that were entered into the corrective action program. Also include a detailed description of the actions taken or planned to address these effects.
- h. Describe any other planned or newly installed flood protection systems or flood mitigation measures including flood barriers that further enhance the flood protection. Identify results and any subsequent actions taken in response to the peer review.

In accordance with the 50.54(f) letter, Enclosure 4, Required Response Item 2, licensees were required to submit a response within 180 days of the NRC's endorsement of the flooding walkdown guidance. By letter dated May 21, 2012³, the Nuclear Energy Institute (NEI) staff submitted NEI 12-07, Revision 0, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features" to the NRC staff to consider for endorsement. By letter dated May 31, 2012⁴, the NRC staff endorsed the walkdown guidance.

By letter dated November 27, 2012⁵, NextEra Energy Resources (NextEra, the licensee), provided a response to Enclosure 4 of the 50.54(f) letter Required Response Item 2, for the Duane Arnold Energy Center (DAEC). The NRC staff issued a request for additional information (RAI) to the licensee regarding the available physical margin (APM) dated December 23, 2013⁶. The licensee responded by letter dated January 29, 2014⁷.

The NRC staff evaluated the licensee's submittals to determine if the information provided in the walkdown report met the intent of the walkdown guidance and if the licensee responded appropriately to Enclosure 4 of the 50.54(f) letter.

2.0 REGULATORY EVALUATION

The SSCs important to safety in operating nuclear power plants are designed either in accordance with, or meet the intent of Appendix A to 10 CFR Part 50, General Design Criteria (GDC) 2: "Design Bases for Protection Against Natural Phenomena," and Appendix A "Seismic and Geological Criteria for Nuclear Plants," to 10 CFR Part 100, "Reactor Site Criteria." GDC 2 states that SSCs important to safety at nuclear power plants shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunamis, and seiches without loss of capability to perform their safety functions.

For initial licensing, each licensee was required to develop and maintain design bases that, as defined by 10 CFR 50.2, identify the specific functions to be performed by an SSC, and the specific values or ranges of values chosen for controlling parameters as reference bounds for the design.

3 ADAMS Package Accession No. ML121440522

4 ADAMS Accession No. ML12144A142

5 ADAMS Accession No. ML12342A004

6 ADAMS Accession No. ML13325A891

7 ADAMS Accession No. ML14031A146

The design bases for the SSCs reflect appropriate consideration of the most severe natural phenomena that have been historically reported for the site and surrounding area. The design bases also reflect sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The current licensing basis (CLB) is the set of NRC requirements applicable to a specific plant, and a licensee's written commitments for ensuring compliance with, and operation within, applicable NRC requirements and the plant-specific design basis, that are in effect

3.0 TECHNICAL EVALUATION

3.1 Design Basis Flooding Hazard (Duane Arnold Energy Center)

The licensee reported that the design basis flood hazard for the DAEC is a probable maximum flood (PMF) of the Cedar River in combination with wind generated waves. The PMF on the Cedar River is based on field reconnaissance and mapping, flood discharge data from the USGS, flood hydrograph analysis of previous floods, rainfall losses and retention rates, and application of probable maximum storm. The flood elevation of Cedar River as a result of the flooding analysis is 764.1 ft. mean sea level (MSL) and a flow rate of 316,000 cfs on the Cedar River. Sustained wind of 45 miles per hour (mph) over a 1.5 mile stretch of the river was added to the PMF, resulting in a total maximum flood elevation of 767 ft.

The licensee's walkdown report also considered design basis flooding as a result of the probable maximum precipitation (PMP) event. The licensee states that the DAEC safety related structures are capable of supporting water accumulation on their roofs as a result of a PMP event, and roof penetrations extend above the parapets. Additionally, site topography prevents local intense precipitation from flooding safety related structures. Therefore, the licensee concluded the DAEC is not susceptible to PMP flooding events.

The licensee states several other flooding factors were screened out. These events include floods as a result of dam failure, ice damming, surges, seiches and tsunamis. There are twelve low head dams located on the Cedar River upstream of the site. During a PMF event, these dams are submerged and, as a result, flooding due to a failure of these dams would be less than that of the PMF. Additionally, due to local topography, flooding events as a result of ice damming would be less than that of the PMF event. The DAEC site is not in a location subject to floods as a result of surges, seiches, and tsunamis.

The licensee indicated that ground water ingress is not specifically mentioned in the CLB in the UFSAR. However, the UFSAR requires that walls of buildings be coated with waterproofing material below grade and joints of concrete slabs be fitted with water stops.

Based on the NRC staff's review, the licensee appears to have described the design basis flood hazard level requested in the 50.54(f) letter, consistent with the walkdown guidance.

3.2 Flood Protection and Mitigation

3.2.1 Flood Protection and Mitigation Description

The licensee reports that the current licensing basis for flood protection at the DAEC site is the combined effects of the PMF of the Cedar River and the wind generated waves. The licensee stated that the site's CLB includes flood protection to an elevation of 767 feet and additional protection is provided at openings to safety related buildings up to 773.7 ft on the southern side, 770.5 ft on the northern side, and 769 ft on the eastern and western sides. The maximum river level is reached 6.4 days after the beginning of the storm that will cause the PMF. The flood will remain above grade for about 3 days after the peak discharge is reached. The flood protection procedure calls for the installation and implementation of both active and passive incorporated and temporary flooding protection features.

3.2.2 Incorporated and Exterior Barriers

The licensee reported that the site has incorporated and exterior barriers that are permanently in-place, requiring no operator manual actions. Incorporated active features include sump pumps for pumping out water from sump pits resulting from seepage of flood protection features, as well as a watertight door in the pump house to protect the ESW and RHR pumps.

Incorporated passive features include the following: floor drains, sumps; and building walls, floors, roofs, and associated penetrations that resist the effects of the CLB flood including hydrostatic pressure and uplift. Penetrations below the flood height are sealed against water ingress, and roof penetrations extend above the parapet. Bulb type water-stops and waterproofing membranes are embedded in the concrete slabs at joints to prevent water ingress between wall panels and the seismic gaps between buildings.

The licensee stated that Seismic Category I structures are credited as being able to withstand the effects of the CLB flooding including the effects of hydrostatic loading and uplift.

The CLB does not state any weather conditions present as part of the flooding mitigation features description; however the licensee, as part of its reasonable simulations, considered adverse weather conditions likely to occur with the PMF, such as wind, rain, mud; etc.

3.2.3 Temporary Barriers and Other Manual Actions

The licensee reported that the site has temporary barriers and other manual actions that require operator action. The temporary active features include temporary sump pumps that are placed in sump pits and catch basins behind specified exterior doors in the plant to control in-leakage per the station flood protection procedure.

The site also has temporary passive features. Stoplogs are available for entry doors to plant protected areas to resist CLB flood waters, and sandbags and plastic sheeting are used to augment the stoplogs and control in-leakage. The exhaust ports of the diesel generators have welded extensions to raise the height of the exhaust ports to the CLB flood level including wave and run-up. A steel plate would be bolted and caulked over the auxiliary boiler louver. Bracing would be installed in the seismic gaps at entry ways between seismically qualified buildings to prevent ingress if the embedded water stops and sealing material between the buildings fail.

Hatch covers in the pump house to the Emergency Service Water (ESW) and Residual Heat Removal (RHR) pits would be welded, sealed, and braced shut. Hatch covers to High Pressure Coolant Injection (HPCI) and Reactor Core Isolation Cooling (RCIC) would also be sealed shut.

3.2.4 Reasonable Simulation and Results

The licensee reported that reasonable simulations were performed to verify execution times and identify any hindrances in installation of the features. The necessary staff, equipment, and materials were involved. The simulations were done on Door 154, Door 805, the Auxiliary Boiler Cover, the Standby Diesel Generator Exhaust Extension, and Low Level Radwaste Processing and Storage Facility (LLRPSF) Temporary Sump Pumps. They included inspecting the installation of stoplogs, plastic sheeting and sandbags; sealing louvers, welding extensions to diesel exhaust ports; and setting up temporary sump pumps. With the exception of Door 805, the simulations aligned with their estimated times. The stoplog for door 805 was found to have fit up issues and the license was not able to install the stoplog on the bolts around the door frame. The license entered this issue into the site's CAP and completed a procedure change request to incorporate the guidance into the station flood protection procedure for direction on how to install this feature.

A tabletop simulation of flood protection procedures was conducted with staff from operations, maintenance, and systems engineering to discuss execution times and to identify problems. The simulation concluded that the estimated time to complete all flood mitigation is 3.67 days, which meets the 6.4-day requirement of the UFSAR. The simulation also included consideration of adverse weather.

The licensee employed additional SSC and procedures, not part of the DAEC CLB for external flooding, that aid in the flood mitigation on site, such as water level indication systems, Structures Monitoring program, site drainage system and the implementation of a temporary diesel generator to the Intake Structure and the River Water Supply system.

3.2.5 Conclusion

Based on the NRC staff's review, the licensee appears to have described protection and mitigation features as in the 50.54(f) letter, and consistent with the walkdown guidance.

3.3 Warning Systems

The licensee reported that flood procedures are triggered when a flash flood advisory is received from the National Weather Service. Monitoring of the river level begins when it reaches 753 feet, and actions are taken if the river level reaches 757 feet.

There are no credited room water level warning systems for external flooding at DAEC. Room water level indicators for internal flooding are present at several safety structures (HPCI, RCIC, "A" RHR, "B" RHR, and TORUS). These provide a secondary notification of a flood condition if external flood barriers fail.

Based on the NRC staff's review, the licensee appears to have provided information to describe any warning systems as requested in the 50.54(f) letter, and consistent with the walkdown guidance.

3.4 Effectiveness of Flood Protection Features

The licensee stated that visual inspections of external flood protection features were performed. The licensee found the flood protection features meet the acceptance criteria, with the exception of features determined to be deficient and entered into the corrective action program. The licensee reported deficiencies included two louvers that are open to an elevation less than the required 769 feet, as well as issues installing a steel stoplog for Door 805. These issues led to corrective actions, including an alternative method for managing the door and adoption of a procedure to protect the louvers with sandbags and plastic sheeting.

Credited walls and floors and their associated penetrations, conduit penetration seals, concrete structures, floor drains, sump pumps, doors, roofs, and temporary features were all inspected and found to meet the acceptance criteria. The licensee stated the walkdown process indicated the capability for timely preparation for flooding, the adequacy of the staff, and the condition of the materials.

Based on the NRC staff's review, the licensee appears to have discussed the effectiveness of flood protection features as requested in the 50.54(f) letter, and consistent with the walkdown guidance.

3.5 Walkdown Methodology

By letter dated June 8, 2012,⁸ the licensee responded to the 50.54(f) letter that it intended to utilize the NRC endorsed walkdown guidelines contained in NEI 12-07, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features."⁹ The licensee's walkdown submittal dated November 14, 2012, indicated that the licensee implemented the walkdowns consistent with the intent of the guidance provided in NEI 12-07. The licensee did not identify any exceptions from NEI 12-07.

Based on the NRC staff's review, the licensee appears to have presented information related to the implementation of the walkdown process as requested in the 50.54(f) letter, and consistent with the walkdown guidance.

3.6 Walkdown Results

3.6.1 Walkdown Scope

The licensee performed walkdowns of flood protection feature SSCs, portable flood mitigation equipment, and site topography. In addition, the licensee performed reasonable simulation of manual actions, including installation of stoplogs, plastic sheeting, and sandbags; sealing of louvers; welding extensions to diesel exhaust ports; and setup of temporary sump pumps. A tabletop simulation of flood protection procedures was also conducted with staff from operations, maintenance, and systems engineering to discuss execution times and to identify problems.

The CLB does not state specific plant modes (shutdown, refuel, startup, online) during a flood

8 ADAMS Accession No. ML12165A468

9 ADAMS Accession No. ML12173A215

event. Therefore, the walkdown took into consideration all modes of operation. The licensee used acceptance criteria consistent with the intent of NEI 12-07.

3.6.2 Licensee evaluation of flood protection effectiveness, key findings, and identified deficiencies

The licensee performed an evaluation of the overall effectiveness of the plant's flood protection features. DAEC's flood protection features are available, functional, and properly maintained relative to their CLB functions, with the exception of three features determined to be deficient and entered into the corrective action program

NEI 12-07 defines a deficiency as follows: "a deficiency exists when a flood protection feature is unable to perform its intended function when subject to a design basis flooding hazard." The licensee identified two deficiencies during the course of the flood walkdowns.

The licensee reported two louvers located on the western wall of the intake structure. The western wall is required to resist flood waters of 764.1 feet and waves and freeboard of 769 feet. The louvers are open to the floor elevation of 767 feet, which is below the required 769 feet. This issue was entered into the DAEC corrective action program (CAP), and a procedure change request was initiated to protect the louvers with sandbags and plastic sheeting.

The licensee also reported that during the reasonable simulation, the steel stoplog for Door 805 was found to have fit up issues and its installation on bolts around the door frame was not completed. It was entered into the DAEC CAP and a procedure change request completed to incorporate the guidance for direction on how to install this feature using an alternative method of installing barriers for door 805.

NEI 12-07 specifies that licensees identify observations/potential deficiencies in the CAP that were not yet dispositioned at the time the walkdown report was submitted. The licensee entered into the CAP and reported the deficiencies discovered during the walkdown. The licensee stated that a permanent solution for the two deficiencies described above is being evaluated in the DAEC CAP.

3.6.3 Flood Protection and Mitigation Enhancements

The licensee identified recommendations to site procedures to further enhance the efficiency and effectiveness of the implementation of flood protection features including: enhancing human factors for the station flood protection procedure to streamline its implementation, and enhancing rigging capability for the diesel generator exhaust extensions by designing and installing lifting lugs.

3.6.4 Planned or newly installed features

The licensee determined that changes were not necessary by the flood walkdowns.

3.6.5 Deficiencies Noted and Actions Taken or Planned to Address

The licensee noted the deficiencies described in Section 3.6.2, above, and actions taken or planned to address the deficiencies:

The licensee indicated in its walkdown report that functionality assessments and compensatory actions or procedures changes were implemented for these deficiencies.

3.6.6 Staff Analysis of Walkdowns

NRC staff reviewed the licensee walkdown report dated November 14, 2012. The licensee evaluated the capability of flood protection features and found the majority of the features are available, functional, and implementable. Those features that were found to be degraded or non-conforming were entered into the DAEC CAP and the licensee has identified actions to address the deficiencies. The licensee described operating procedures for obtaining warnings and implementing flood protection activities. The walkdown report indicated that DAEC staff are trained on implementing flood protection activities. The licensee documented APM and instances of small APM. The licensee's walkdown report indicated reasonable simulations were performed consistent with NEI guidance.

Based on the NRC staff's review, the staff concludes that the licensee has provided results of the walkdown and described any other planned or newly installed flood protection systems or flood mitigation measures as indicated in Requested Information items 2.f and 2.h of the 50.54(f) letter consistent with Appendix D, Walkdown Report, of the walkdown guidance. Based on the information provided in the licensee's submittals, the NRC staff concludes that the licensee's implementation of the walkdown process meets the intent of the walkdown guidance.

3.6.7 Available Physical Margin

NRC staff issued a RAI to the licensee regarding the APM dated December 23, 2013¹⁰. The licensee responded with a letter dated January 29, 2014¹¹. The licensee has reviewed their APM determination process, and entered any unknown APMs into their CAP. Staff reviewed the response, and concluded that the licensee met the intent of the APM determination per NEI 12-07.

Based on the NRC staff's review, the licensee appears to have documented the information requested for any cliff-edge effects, as requested in the 50.54(f) letter, and consistent with the walkdown guidance. Further, staff reviewed the response, and concludes that the licensee met the intent of the APM determination per NEI 12-07.

3.7 NRC Oversight

3.7.1 Independent Verification by Resident Inspectors

On June 27, 2012, the NRC issued Temporary Instruction (TI) 2515/187 "Inspection of Near-Term Task Force Recommendation 2.3 Flooding Walkdowns." In accordance with the TI, NRC inspectors independently verified that the DAEC licensee implemented the flooding walkdowns consistent with the intent of the walkdown guidance. Additionally, the inspectors independently performed walkdowns of a sample of flood protection features. The inspection report dated January 30, 2013¹², documents the results of this inspection. No findings of significance were

10 ADAMS Accession No. ML13325A891

11 ADAMS Accession No. ML14031A146

12 ADAMS Accession No. ML13030A468

identified.

4.0 SSCs NOT WALKED DOWN

The licensee identified inaccessible features but no restricted access features.

4.1 Restricted Access

The licensee identified no restricted access items during the flooding walkdowns.

4.2 Inaccessible Features

The licensee provided a basis for reasonable assurance that inaccessible access features are available and will perform credited functions. The licensee identified the following inaccessible features during the walkdowns: the turbine building louver platform drains, and the water stops and membranes.

The turbine building louver platform drains are located 773.7 feet up on the south wall of the turbine building and inside each are two drains located at 772 feet. The licensee stated that there are no means to access the plenary platform and therefore a visual inspection was not possible. The licensee provided reasonable assurance that these drains are functioning properly. The licensee stated that the drain piping can be seen from below the platform, which confirms the drains are installed. In addition, there were no signs of water ingress from the louver, and the louver openings meet the wave and freeboard height of 773.7, which provide indication that water entry from flood waters is unlikely.

The water stops are installed between concrete slabs below grade and between adjacent buildings during construction to prevent water ingress. Because they are imbedded between concrete slabs, there are no reasonable means to access the water stops. The licensee provided reasonable assurance that they are installed and functional, indicating that during the visual inspections of floors, walls, and seismic gaps no signs of water ingress at joints between slabs or gaps between buildings were encountered.

The waterproof membranes are applied to concrete structures and penetrations below grade. There are no reasonable means to access the membranes because they are installed below grade on the exterior side of concrete walls. The licensee provided reasonable assurance that they are installed and functional indicating there is no evidence of water ingress between slabs.

5.0 CONCLUSION

The NRC staff concludes that the licensee's implementation of flooding walkdown methodology meets the intent of the walkdown guidance. The staff concludes that the licensee, through the implementation of the walkdown guidance activities and, in accordance with plant processes and procedures, verified the plant configuration with the current flooding licensing basis; addressed degraded, nonconforming, or unanalyzed flooding conditions; and verified the adequacy of monitoring and maintenance programs for protective features. Furthermore, the staff notes that no immediate safety concerns were identified. The NRC staff reviewed the information provided and determined that sufficient information was provided to be responsive to Enclosure 4 of the 50.54(f) letter.

R. L. Anderson

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If you have any questions, please contact me at (301) 415-8371 or by e-mail at Mahesh.Chawla@nrc.gov.

Sincerely,

/RA/

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Plant Licensing Branch III-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-331

Enclosures:
Staff Assessment of Flooding Walkdown Report

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