



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

June 30, 2014

Mr. Michael J. Pacilio
Senior Vice President
Exelon Generation Company, LLC
President and Chief Nuclear Officer (CNO)
Exelon Generation Company, LLC
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: BRAIDWOOD STATION, UNITS 1 AND 2 – 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 NOS. MF0198 AND MF0199)

Dear Mr. Pacilio:

On 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 letter per Title 10 of the *Code of Federal Regulations*, Paragraph 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 to 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 (ADAMS Accession No. ML12332A378), Exelon Generation Company, LLC submitted a flooding Walkdown Report as requested per Enclosure 4 of the 50.54(f) letter for the Braidwood Station, Units 1 and 2, as supplemented by letters dated May 21, 2013 (ADAMS Accession No. ML13142A443), and January 13, 2014 (ADAMS Accession No. ML14013A356). By letter dated January 31, 2014 (ADAMS Accession No. ML14031A443), Exelon provided a response to the NRC request for additional information for the staff to complete its assessments.

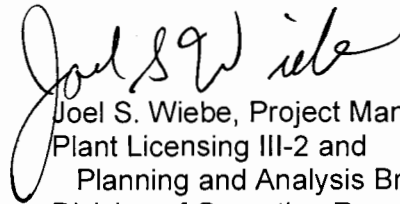
The NRC staff reviewed the information provided and, as documented in the enclosed staff assessment, determined sufficient information was provided to be responsive to Enclosure 4 of the 50.54(f) letter.

M. Pacilio

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If you have any questions, please contact me at (301) 415-6606 or by email at Joel.Wiebe@nrc.gov.

Sincerely,

A handwritten signature in black ink that reads "Joel S. Wiebe". The signature is written in a cursive style with a large, looping initial "J".

Joel S. Wiebe, Project Manager
Plant Licensing III-2 and
Planning and Analysis Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-456 and 50-457

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
EXELON GENERATION COMPANY
BRAIDWOOD STATION, UNITS 1 AND 2
DOCKET NOS. 50-456 AND 50-457

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), Paragraph 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.

1 Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340
2 ADAMS Accession No. ML12056A050

- 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,
- g. 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 (CAP).
- h. Document any cliff-edge effects identified and the associated basis. Indicate those that were entered into the CAP. Also include a detailed description of the actions taken or planned to address these effects.
- i. 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, 2012,³ the Nuclear Energy Institute (NEI) staff submitted NEI 12-07, Revision 0 A, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features," to the NRC staff to consider for endorsement. By letter dated May 31, 2012,⁴ the NRC staff endorsed the walkdown guidance.

By letter dated November 27, 2012,⁵ Exelon Generation Company, LLC (the licensee) provided a response for Braidwood Nuclear Power Station (Braidwood), Units 1 and 2. The licensee submitted supplements dated May 21, 2013,⁶ and January 13, 2014,⁷ in addition to the letter dated November 27, 2012. The NRC staff issued a request for additional information (RAI) to the licensee regarding the available physical margin (APM) dated December 23, 2013⁸. The licensee responded by letter dated January 31, 2014⁹.

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. 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

3 ADAMS Package Accession No. ML121440522
4 ADAMS Accession No. ML12144A142
5 ADAMS Accession No. ML12332A378
6 ADAMS Accession No. ML13142A443
7 ADAMS Accession No. ML14013A356
8 ADAMS Accession No. ML13325A891
9 ADAMS Accession No. ML14031A443

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.

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 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 for Braidwood

The licensee reports that the design basis flood hazard for the Braidwood site is described in Updated Final Safety Analysis Report (UFSAR), Section 2.4, as a probable maximum flood (PMF) for the plant's on-site cooling pond. The pond has an average depth of 8.21 feet (ft), and its normal pool elevation is 595 ft mean sea level (MSL). The design basis flood is initiated by a probable maximum precipitation (PMP) event over the pond's watershed, following an antecedent standard project flood that is equivalent to one-half the PMP. The cooling pond's maximum surface water elevation would reach 598.17 ft MSL as a result of this event. The cooling pond is contained by a dike with an elevation of 600.0 ft MSL, except for the area south of the plant where the dike elevation is 602.5 ft MSL. The potential run-up due to wind and wave action in this area during the PMP event is estimated to be 602.34 ft MSL.

The licensee's latest design basis calculation for the effects of local PMP and associated local intense precipitation event at the Braidwood site shows that the maximum flooding elevation at the exterior power block walls is predicted to be 601.91 ft MSL.

Based on the NRC staff's review, the licensee appears to have described the design basis flood hazard level(s) as requested in the 50.54(f) letter and 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 is to an elevation of 601.9 ft MSL. The licensee states that the flood protection features at the Braidwood site are based on all features being incorporated passive features; therefore, the current licensing basis does not explicitly address flood duration or adverse weather conditions concurrent with flooding. The licensee states that "All safety related equipment is protected from flood by virtue of its location above the highest PMF elevation and by being housed within flood-protected structures." The portion of the Braidwood plant's main power block buildings that is below grade is designed to prevent groundwater ingress up to an elevation of 600 ft MSL (which is the plant grade elevation).

The licensee reports that the make-up water is provided to the plant's cooling pond through an intake structure and river screen house located on the Kankakee River. While the river screen house could be affected by flooding on the Kankakee River, UFSAR, Section 2.4.2, indicates that the screen house is not a safety-related structure. In the event make-up water cannot be withdrawn at the river screen house during periods of flooding, the plant can continue to operate by using water in the cooling pond under a closed-cycle system. The licensee stated that the licensing basis does not explicitly address flood duration or adverse weather conditions.

3.2.2 Incorporated and Exterior Barriers

The licensee reports that the site has incorporated barriers that are permanently in-place, requiring no operator manual actions. At the Braidwood site, the structural features that provide flood protection include walls, floors, and ceilings of buildings that house safety-related equipment. In the below-grade portions of safety-related buildings, waterproof seals are provided for all penetrations, and waterstops are provided in all construction joints.

3.2.3 Temporary Barriers and Other Manual Actions

The licensee reports that the site has no temporary active or temporary passive flood protection barriers, and no procedures or actions require manual or operator action in the event of flooding. In addition, no manual or operator actions need to be implemented before any features can provide their intended flood protection function.

3.2.4 Reasonable Simulation and Results

No reasonable simulations were conducted by the licensee. As rationale, the licensee stated that all features are incorporated passive features.

3.2.5 Conclusion

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

3.3 Warning Systems

The licensing basis for the Braidwood does not require the collection of information related to flood predictions or advanced warnings of potential flooding.

The licensee reported that at the Braidwood site leak detection systems are employed. Leak detection instruments measure system flow and pressure drop, as well as, the presence of water in the sumps in the basement of the auxiliary building where the essential service water pumps are located. Although designed to detect the presence of water during an internal flooding event, the leak detection instrumentation should also be able to detect significant groundwater ingress into the basement of the auxiliary building.

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 reported that all flood barrier walkdown features credited for keeping water out of safety-related areas including walls, floors, seals, and ceilings, are capable of performing their intended flood-protection and/or mitigation functions. Additional features inspected included external hatches that provide access to refueling water storage tank piping tunnels and the interface between the radwaste building and the auxiliary building radwaste tunnel.

Observations as a result of the walkdowns and document reviews that were not immediately judged as acceptable were entered into the licensee's CAP. The licensee stated that all incident reports that were entered into the CAP have been dispositioned, resulting in no deficiencies.

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 11, 2012,¹⁰ the licensee responded to the 50.54(f) letter that they intended to utilize the NRC-endorsed walkdown guidelines contained in NEI 12-07. The licensee's walkdown submittal dated November 27, 2012, as supplemented May 21, 2013, and January 13, 2014, 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 features including walls, floors, seals, hatches, and ceilings. The licensee did not perform any reasonable simulations as part of the walkdown process. The licensee stated that Braidwood flood protection features are designed to function during any plant mode of operation. The licensing basis does not explicitly address flood duration or adverse weather conditions concurrent with flooding, presumably because the protection features are all incorporated passive.

The licensee stated that its walkdown scope consisted primarily of visual inspections that focused upon the floors and exterior watertight walls in the main power block and the applicable penetrations and seals, as well as an outdoor walkdown to confirm the credited surface water drainage had not been impacted by changes to topography. The licensee documented walkdowns for 31 flood protection features, including exterior walls, floors, penetrations, seals, and ceilings, credited for keeping water out of safety-related areas in its November 27, 2012,

report. Four additional features inside the fuel handling building were included in the licensee's supplemental May 21, 2013, letter, and included the spent fuel pump room, concrete curbs designed to contain/retain floodwaters, and penetrations, in the pump room blockwall. Walkdowns of the features located in the auxiliary feedwater (AFW) tunnel were documented in the licensee's January 13, 2014, supplement, included cleaning, coating and re-sealing concrete, and other surfaces. One remaining item involves cleaning surface deposits and mitigating groundwater in-leakage in the Unit 2 AFW tunnel which is scheduled for completion during refueling outage A2R17. No reasonable simulations were conducted by the licensee.

The licensee used and developed acceptance criteria consistent with the intent of NEI 12-07. The licensee developed its own "Walkdown Inspection Guidance" to supplement NEI 12-07 and to provide inspection guidance for specific features as identified in the licensee's walkdown report, as supplemented.

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. The licensee concluded that the credited flood barriers are all in place and that the flood protection features incorporated into the Braidwood design provide effective barriers for keeping external flooding from reaching safety-related systems and equipment.

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." While the licensee did not identify any deficiencies during the walkdowns, several observations resulting from the inspections could not immediately be judged as acceptable in the licensee's November 27, 2012, Walkdown Report, as supplemented. Items entered into the CAP included those identified as follows:

- Evidence of past groundwater intrusion (multiple instances/observations)
- Minor groundwater inleakage (multiple instances/observations)
- A mound of soil on north side of turbine building partially blocking the rainwater drainage pathway
- Small pipes inserted into expansion joint in outside containment wall (no evidence of water intrusion)
- Pipe drain protruding from the curb of a refueling water storage tank (RWST) tunnel manhole (however, the pipe was later determined not be a potential pathway for floodwaters)
- Water condensation on RWST hatch and water noted on the floor under the hatch
- Housekeeping issues identified during the flood walkdown not related to flood protection
- Degraded expansion joints
- Concrete spalling
- Potential low APM (approximately 0.1 ft) from predicted flood elevation to top of concrete barrier in the radwaste/service building tunnel
- Uncertainty as to whether the service building addition project was accounted for in the PMP calculation
- Deficiency tag found identifying groundwater inleakage
- Gaps in concrete curbs designed as flood protection barriers

- Missing caulk seals around blockwall penetrations

NEI 12-07 specifies that licensees identify observations in the CAP that were not yet dispositioned at the time the walkdown report was submitted. The licensee's walkdown report, as supplemented, states that all such corrective action requests have been dispositioned except for mitigating ground water in-leakage in the Unit 2 AFW tunnel, which is scheduled for disposition during refueling outage A2R17.

3.6.3 Flood Protection and Mitigation Enhancements

With the exception of the item identified and dispositioned in the CAP (as described in Section 3.6.2, above), the licensee determined that no changes to flood-protection and mitigation features were necessitated by the flood walkdowns.

3.6.4 Planned or newly installed features

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

3.6.5 Deficiencies Noted and Actions Taken or Planned to Address

As discussed in detail in Section 3.6.2, above, the licensee noted all deficiencies were dispositioned. One remaining item judged not immediately acceptable involves cleaning surface deposits and mitigating groundwater in-leakage in the Unit 2 AFW tunnel, and is scheduled for completion during refueling outage A2R17.

3.6.6 NRC staff analysis of walkdowns

The NRC staff reviewed the licensee's walkdown report dated November 27, 2012, as supplemented. As part of the walkdown effort, the licensee evaluated the capability of flood protection features by conducting a set of visual inspections. The features were confirmed to be in place and available and also to be capable of performing their intended flood protection or mitigation functions. No changes or enhancements to flood protection or mitigation features were identified as a result of the walkdowns. The licensee did not perform any reasonable simulations.

During the walkdowns, items were identified as not immediately acceptable; however, corrective actions were identified and entered into the site's CAP for each of these items. All of the items entered into the CAP have been dispositioned except one remaining item involving cleaning surface deposits and mitigating groundwater in-leakage in the Unit 2 AFW tunnel scheduled for completion during refueling outage A2R17.

Based on the NRC staff's review, the licensee appears to have provided results of the walkdown and described any other planned or newly installed flood protection systems or flood mitigation measures as requested in the 50.54(f) letter and consistent with 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

The NRC staff issued an RAI to the licensee regarding the APM dated December 23, 2013¹¹. The licensee responded in a letter dated January 31, 2014¹². The licensee has reviewed the APM determination process, and entered any unknown APMs into their CAP. The NRC 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, the 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 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 reports dated February 7, 2013,¹³ and May 9, 2013,¹⁴ document the results of these inspections. No findings were identified and one licensee-identified violation of very low safety significance was noted.

4.0 Walkdowns Not Performed for Flood Protection Features

The licensee identified restricted access features and no inaccessible features.

4.1 Restricted Access

Inspection of two items was deferred during the initial walkdown until the next refueling outage at each respective unit. The inspection of the Unit 2 AFW tunnel was completed subsequent to the walkdown during the refueling outage for Unit 2 in October 2012. The inspection of the AFW tunnel for Unit 1 was completed during the refuel outage A1R17 (fall 2013) for Unit 1. All actions judged not immediately acceptable have been closed except for one item involving cleaning surface deposits and mitigating groundwater in-leakage in the Unit 2 AFW tunnel which is scheduled for completion during refueling outage A2R17.

4.2 Inaccessible Features

No flood protection features at the Braidwood site are located in inaccessible access areas.

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

11 ADAMS Accession No. ML13325A891
12 ADAMS Accession No. ML14031A443
13 ADAMS Accession No. ML13038A635
14 ADAMS Accession No. ML13129A179

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 licensee's walkdown results, as verified by the staff's inspection, identified no immediate safety concerns. 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.

M. Pacilio

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If you have any questions, please contact me at (301) 415-6606 or by email at Joel.Wiebe@nrc.gov.

Sincerely,

/RA/

Joel S. Wiebe, Project Manager
Plant Licensing III-2 and
Planning and Analysis Branch
Division of Operating Reactor Licensing
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Docket No. 50-456 and 50-457

Enclosures:
Staff Assessment of Flooding Walkdown Report

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ADAMS Accession No.: ML14141A133

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