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

June 25, 2014

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

SUBJECT: QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2 – STAFF ASSESSMENT OF RESPONSE TO 10 CFR 50.54(F) INFORMATION REQUEST – FLOODING WALKDOWNS (TAC NOS. MF0270 AND MF0271)

Dear Mr. Pacilio:

On March 12, 2012,[1] the U.S. Nuclear Regulatory Commission (NRC) issued a letter requesting information pursuant to Title 10 of the *Code of Federal Regulations*, 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," 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 process, verify the adequacy of monitoring and maintenance procedures, and report the results to the NRC.

By letter dated November 27, 2012[2], Exelon Generation Company, LLC submitted a flooding walkdown report for Quad Cities Nuclear Power Station, Units 1 and 2, as requested by Enclosure 4 of the 50.54(f) letter.

The NRC staff has reviewed the information provided and, as documented in the enclosed staff assessment, determined that you have provided sufficient information to be responsive to the 50.54(f) letter. This closes out the NRC's efforts associated with TAC Nos. MF0270 and MF0271.

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

If you have any questions, please contact me at (301) 415-2020 or by email at Brenda.Mozafari@nrc.gov.

Sincerely,

Brenda M. Mozafari, Senior Project Manager
Plant Licensing III-2 and
Planning and Analysis Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-254 and 50-265

Enclosure:
Staff Assessment of Flooding Walkdown

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO FLOODING WALKDOWN REPORT

QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-254 AND 50-265

1.0 INTRODUCTION

On March 12, 2012,[1] the U.S. Nuclear Regulatory Commission (NRC) issued a letter requesting information pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), aragraph 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," 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.

Enclosure 4 to the 50.54(f) letter requested licensees to submit a final report which includes the following (Requested Information item 2):

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 systems, structures, 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 NRC Regulatory Issues Summary 2005-20, 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 CAP.

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

g. Document any cliff-edge effects identified and the associated basis. Indicate those that were entered into the CAP. 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, 2012[2], the Nuclear Energy Institute (NEI) staff submitted NEI 12-07, Revision 0, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features" (walkdown guidance), to the NRC staff to consider for endorsement. NEI 12-07 describes a methodology for performing walkdowns in a manner that will address requested information items 1.a through 1.j of Enclosure 4 of the 50.54(f) letter. By letter dated May 31, 2012[3], the NRC staff found that the performance and reporting of flooding protection walkdowns in accordance with the guidance would be responsive to the 50.54(f) letter.

By letter dated November 27, 2012,[4] Exelon Generation Company, LLC (the licensee), provided a flooding walkdown report in response to Required Response Item 2 of Enclosure 4 to the 50.54(f) letter for Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2.

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 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, "Definitions," identify the specific functions that an SSC of a facility must perform, 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.

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[2] ADAMS Package Accession No. ML121440522
[3] ADAMS Accession No. ML12144A142.
[4] ADAMS Accession No. ML12332A307.

The current licensing basis is the set of NRC requirements applicable to a specific plant, including the licensee's docketed commitments for ensuring compliance with and operation within, applicable NRC requirements and the plant-specific design basis, including all modifications and additions to such commitments over the life of the facility operating license.

3.0 TECHNICAL EVALUATION

3.1 Design Basis Flooding Hazard

The design basis flood hazard for the QCNPS site is described in the Updated Final Safety Analysis Report (UFSAR), Section 2.4.3, and is based on a 200-year (yr) flood of the adjacent Mississippi River, resulting in a peak flood stage of 589 feet (ft) above mean sea level (MSL; 1912 basis). However, the UFSAR acknowledges that river levels exceeding the 200-yr flood are plausible during flooding events. At the QCNPS site, the protective actions to be initiated in response to the design basis flood occur when the water level in the Mississippi River exceeds 586 ft MSL or when the river level is predicted to exceed 594 ft MSL in less than 72 hours. The plant grade elevation at the QCNPS site is 594.5 ft MSL.

3.2 Flood Protection and Mitigation

3.2.1 Flood Protection and Mitigation Description

UFSAR Section 3.4.1.1, "External Flood Protection Measures," describes the flood protection and relevant flood mitigation features at the QCNPS site. The QCNPS site would be inundated by the design basis flood reaching the plant grade elevation. As discussed in the walkdown report, the flood protection for a potential design basis flood at the QCNPS site is primarily based on the implementation of the flood emergency procedure. UFSAR Section 3.4, "Water Level (Flood) Design," describes how QCNPS, Units 1 and 2, can be safely shutdown and maintained in a safe condition for flood levels up to 603 ft MSL. For flood levels up to the plant grade cf 594.5 ft MSL, any mode of operation is possible with no additional protective measures. For flood levels between 594.5 ft and 603 ft, the plant would be maintained in a safe condition by shutting down both reactor units, flooding the plant buildings to match the river elevation, and establishing residual heat removal by means of evaporative cooling.

No additional floodwater initiating events (such as lock/dam failure, locally intense precipitation, ice jams, and groundwater ingress) are considered in the UFSAR as part of the design basis flood. However, the licensee did address groundwater ingress in its walkdown report forms.

3.2.1 Incorporated and Exterior Barriers

There are no structural external flood protection barriers or systems in place for the QCNPS to protect against a flood greater than 594.5 ft MSL.

3.2.2 Temporary Barriers and Other Manual Actions

The QCNPS site has no temporary flood protection barriers. The response to a potential design basis flood is to implement its flood emergency procedure that includes the following manual actions:

- Enter the flood emergency procedure based either on observed river levels (586 ft MSL) or levels predicted to occur within 72 hours (594 ft MSL);
- Place the mobile makeup demineralizer system into operation to fill existing water storage tanks and to provide additional water as required;
- Move and stage a portable, gasoline-fueled pump (i.e., the "Darley pump") to provide make-up water for the water evaporated from the reactors and spent fuel storage pools throughout the duration of the flood;
- Implement normal shutdown of both reactor units;
- Initiate and complete the disassembly of both reactor units;
- Add water to tori/drywells;
- Fill reactor cavities and dryer-separator pools with water;
- Fill radwaste tanks with water;
- De-energize station loads;
- Place drywell loads in pull-to-lock status;
- Seal the diesel oil storage tank vents; and
- Open plant doors to permit the free flow of flood waters.

3.2.2.1 Reasonable Simulation and Results

NEI 12-07 describes the use of "reasonable simulations" as one method licensees can use to address items in Enclosure 4 of the 50.54(f) letter. A total of 12 reasonable simulations were performed by the licensee for the procedural steps of the flood emergency procedure. These simulations included each of the items discussed in Section 3.2.2, above. The results of these reasonable simulations were documented on worksheet forms developed by the licensee.

Based on the results of the reasonable simulations, the licensee found that the total time to implement the flood emergency procedure was 71.5 hours; thereby, allowing only a small margin for error in order to satisfy the required 72-hour response from the time of the initial flood warning prediction.

The NRC staff review has determined that the intent of the walkdown guidance has been met; therefore, the licensee has responded to the 50.54(f) letter.

3.3 Warning Systems

The walkdown report states the river level is monitored daily by personnel at the QCNPS site through visual inspection. In addition, shift operations personnel at the site monitor the weather

and the predicted river levels by using information available from sources such as the National Weather Service, the U.S. Army Corps of Engineers, and the licensee's internal weather monitoring system.

The NRC staff review has determined that the intent of the walkdown guidance has been met; therefore, the licensee has responded to the 50.54(f) letter.

3.4 Effectiveness of Flood Protection Features

The walkdown report states that there are no structural external flood protection barriers or systems in place for the QCNPS to protect against a flood greater than 594.5 ft MSL. The QCNPS site also does not have any temporary flood protection barriers. UFSAR Section 3.4.1.1 states: "In the highly unlikely event that a maximum probable flood is predicted, the plant will be shut down and cooled a minimum of three days prior to the predicted time at which the water will go above plant grade elevation of 594.5 feet." As discussed in the walkdown report, the licensee determined, through the reasonable simulation of each step, that the flood emergency procedure could be completed within 71.5 hours, with the critical path steps being the shutdown and disassembly of both reactors.

The NRC staff review has determined that the intent of the walkdown guidance has been met; therefore, the licensee has responded to the 50.54(f) letter.

3.5 Walkdown Methodology

By letter dated June 11, 2012,[5] the licensee responded to the 50.54(f) letter that they intended to use the NRC-endorsed walkdown guidelines contained in NEI 12-07. The licensee's flooding walkdown report 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.

3.6 Walkdown Results

3.6.1 Walkdown scope

The licensee prepared walkdown report forms for several flood protection items, including those associated with the actions to be taken as part of the flood emergency procedure, as well as, passive features such as exterior below-grade structures of the reactor and turbine buildings, below-grade walls and basement floor slabs, and penetrations/seals. In addition, the licensee performed 12 reasonable simulations (including physical simulations, tabletop exercises, and complex simulations which were combinations of physical simulations and table exercises) of the manual actions and procedural steps required in the flood emergency procedure. The reasonable simulations considered concurrent environmental conditions (e.g., high winds, heavy rainfall, wet or inundated ground surfaces), as well as, the modes of operation and status of the reactor units during the flooding event.

[5] ADAMS Accession No. ML12164A569.

The licensee used acceptance criteria in accordance with NEI 12-07. The licensee also developed its own walkdown inspection guidance to supplement NEI 12-07 and provide inspection guidance for specific features as identified in the licensee's walkdown report.

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 and concluded that: (1) execution of the flood emergency procedure was feasible and could be completed within the required 72-hour response period and (2) passive barriers, such as penetrations/seals, were judged to be functional for their intended flood-protection features.

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 did not identify any deficiencies during the flood walkdowns.

NEI 12-07 requires licensees to identify observations in the CAP that were not yet dispositioned at the time the walkdown report was submitted. The licensee did not identify any observations awaiting disposition.

3.6.3 Flood Protection and Mitigation Enhancements

Subsequent to the walkdown, the licensee stated in the walkdown report it is investigating enhancements that would improve or increase flood protection or mitigation. Upon completion of the investigation, enhancements will be incorporated if deemed necessary.

3.6.4 Planned or newly installed features

The licensee's walkdown report did not identify any planned or newly installed features resulting from the flood walkdowns.

3.6.5 Deficiencies Noted and Actions Taken or Planned to Address

The licensee's walkdown report noted no deficiencies during the walkdowns; hence, no actions were taken or are planned to address deficiencies. Subsequent to the walkdowns, the licensee modified the time needed to implement its flood emergency procedure and entered a few other issues related to the flood walkdowns into the CAP. These issues are noted in the NRC staff's audit report[6] (see Section 3.8 below).

3.6.6 Walkdowns Not Performed for Flood Protection Features

3.6.6.1 Restricted Access

The walkdown report states that no flood protection features at the QCNPS site are located in restricted access areas.

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[6] ADAMS Accession No. ML13326A263.

3.6.6.2 Inaccessible Features

Seven penetrations/seals were identified by the licensee as passive flood protection features and were also described as being located in inaccessible areas; hence, these penetrations/ seals were not visually inspected during the walkdowns. The licensee states that reasonable assurance exists that these features would provide the necessary flood protection based on the licensee's review of available drawings and by the absence of visible water seepage below these penetrations.

3.6.7 Staff Assessment of Walkdowns

The NRC staff reviewed the licensee's walkdown report dated November 27, 2012, and conducted a site audit at the QCNPS site the week of July 9, 2013 (see Section 3.8). Based on the review of the walkdown report and the site audit, the NRC staff concludes that the licensee performed the walkdowns consistent with the intent of NEI 12-07, and responded to the information and actions requested by the 50.54(f) letter.

3.6.8 Available Physical Margin

The available physical margin (APM) for each applicable flood protection feature is the difference between the licensing basis flood height and the flood height at which water could affect an SSC important to safety. The NRC staff reviewed the licensee's walkdown report discussion of the APM. In addition, during the site audit discussed in Section 3.8, the staff reviewed the processes used to calculate and address the APM for flood protection features. The staff concluded that the licensee met the intent of the APM process, which provides adequate information in response to the request regarding cliff-edge effects within the 50.54(f) letter.

3.7 Independent Verification

On June 27, 2012,[7] the NRC issued Temporary Instruction (TI) 2515/187, "Inspection of Near-Term Task Force Recommendation 2.3 Flooding Walkdowns." The TI directed NRC inspectors to independently verify that licensees were implementing the flooding walkdowns in accordance with the NRC-endorsed walkdown methodology by accompanying licensee personnel on a sample of walkdowns. Additionally, the TI directed the inspectors to independently perform walkdowns of a sample of flood protection features. In Inspection Reports 05000254/2012005 and 0500265/2012005, dated February 11, 2013,[8] the results of this inspection were documented; no findings of significance were identified.

3.8 Staff Audit

The NRC staff performed an audit of QCNPS during the week of July 9, 2013. During the audit, the staff gained a better understanding of the process used by the licensee to perform the walkdowns, including the APM determinations. The staff identified and conveyed to the licensee the specific issues to be addressed. The staff also noted that the licensee discussed

[7] ADAMS Accession No. ML12129A108
[8] ADAMS Accession No. ML13031A617

several self-identified issues. The audit report dated November 18, 2013, provides the results of this audit for QCNPS.

3.9 SSCs to be Walked Down at a Later Date

The licensee did not identify restricted access features; therefore, there are no further scheduled walkdowns.

4.0 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 verified the plant configuration with the current flooding licensing basis; addressed degraded, nonconforming, or unanalyzed seismic 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 concludes that the licensee responded appropriately to Enclosure 4 of the 50.54(f) letter dated March 12, 2012.

If you have any questions, please contact me at (301) 415-2020 or by email at Brenda.Mozafari@nrc.gov.

Sincerely,

/RA/

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Planning and Analysis Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-254 and 50-265

Enclosure:
Staff Assessment of Flooding Walkdown

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