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

June 16, 2014

Mr. Michael J. Pacilio
President and Chief Nuclear Office
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: THREE MILE ISLAND NUCLEAR STATION, UNIT 1 – 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. MF0290)

Dear Mr. Pacilio:

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, resultant tsunami, and subsequent accident at the Fukushima Dai-ichi nuclear power plant. The request addressed the methods and procedures for nuclear power plant licensees to conduct seismic and 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 19, 2012, Exelon Generation Company submitted a Flooding Walkdown Report as requested in Enclosure 4 of the 50.54(f) letter for Three Mile Island Nuclear Station, Unit 1. By letter dated January 31, 2014, Exelon provided a response to the NRC request for additional information dated December 23, 2013, 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. This concludes the NRC staff's efforts associated with TAC No. MF0290.

If you have any questions, please contact me at (301) 415-4090, or by e-mail at Jeffrey.Whited@nrc.gov.

Sincerely,

Jeffrey A. Whited, Project Manager
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-289

Enclosure:
Staff Assessment of Flooding Walkdown Report

cc w/encl: Distribution via Listserv

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

THREE MILE ISLAND NUCLEAR STATION, UNIT 1

DOCKET NO. 50-289

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*, 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.

Enclosure 4 of the 50.54(f) letter requested licensees to respond with the following information:

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 SSCs [systems, structures, and components] 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.

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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, 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, 2012,[3] 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. 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 to the 50.54(f) letter. By letter dated May 31, 2012,[4] the NRC staff endorsed the walkdown guidance.

By letter dated November 19, 2012,[5] Exelon Generation Company (Exelon, the licensee), provided a response to Enclosure 4 of the 50.54(f) letter Required Response Item 2, for Three Mile Island Nuclear Station (TMI). The NRC staff issued a request for additional information (RAI) to the licensee regarding the available physical margin (APM) dated December 23, 2013.[6] The licensee responded by letter dated January 31, 2014.[7]

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 for Nuclear Power Plants," Criterion 2: "Design Bases for Protection Against Natural Phenomena;" and Appendix A to 10 CFR Part 100, "Seismic and Geological Siting Criteria for Nuclear Plants." Criterion 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, tsunami, and seiches without loss of capability to perform their safety functions.

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3 ADAMS Package Accession No. ML121440522.
4 ADAMS Accession No. ML12144A142.
5 ADAMS Accession No. ML123250692.
6 ADAMS Accession No. ML13325A891.
7 ADAMS Accession No. ML14031A443.

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.

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), as defined in 10 CFR 54.3(a), 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

All elevations herein are referenced to the National Geodetic Vertical Datum of 1929 (NGVD-29).

3.1 Design Basis Flooding Hazard for Three Mile Island

The licensee reported that the design basis flood at the TMI site is a probable maximum flood (PMF) elevation of 313.3 ft based on a stage discharge relationship for a peak Susquehanna River flow of 1.624 million cubic feet per second (cfs) as evaluated in 2011. This was a reevaluation of the original design basis flood of 309 ft determined in 1970. A dike protects TMI from a limiting event dam break of Raystown Lake Dam, as considered in the original licensing basis and re-evaluated in 1986 by the U.S. Army Corps of Engineers. TMI equipment required for safe shutdown is flood protected to an elevation of 313.3 ft. By comparison, the design plant grade elevation for TMI is 304.5 ft.

The licensee stated groundwater ingress protection is not included in the CLB, but that features including walls, floors, seals, plugs and valves are credited with groundwater ingress protection. The licensee stated that the predicted PMF duration is 104 hours. The TMI CLB does not describe an analysis for local intense precipitation.

Based on the NRC staff's review, the licensee appears to have sufficiently described the design basis flood hazard level(s) 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 reported that the TMI CLB flood protection level and mitigation is at an elevation of 313.3 ft, based on the licensee's 2011 reevaluation. The flood-protection features are designed to protect the plant safety-related SSCs during all modes of operation. TMI flood protection and mitigation is initiated at a river elevation of 284.2 ft (200,000 cfs) per TMI flood emergency procedure OP-TM-AOP-002. A water-tight boundary up to 313.5 ft consisting of flood gates, seals, drain plugs and valves protects safe shutdown equipment. The flood protection and

mitigation features were designed using the following assumptions and inputs with discharge rates obtained from the National Weather Service (NWS) for the Susquehanna River gage at Harrisburg, PA:

- The flood protection procedure is initiated for a 36-hour forecast exceeding 350,000 cfs.
- Flood gates on noncritical access doors are installed for a 36-hour forecast exceeding 640,000 cfs.
- Emergency closure (flood barrier systems installed) will be initiated for a 36-hour forecast exceeding 900,000 cfs.
- The reactor will be shutdown if the measured river level at the Intake Structure reaches 300 ft.

The Intake Screen and Pump House, Fuel Handling Building, Control Building, Auxiliary Building, Intermediate Building, Diesel Generator Building, Air Intake Tunnel and Heat Exchanger Vault, and Reactor Building form an external flood barrier. Credited flood protection features include flood gates, seals, inflatable seals, plugs, valves and check valves. All penetrations below the PMF elevation are sealed, and a qualified seal of a seismic gap between the Reactor Building and interfacing buildings was made watertight.

The TMI flood protection design standard document requires the flood barrier system to be fully installed prior to the river reaching an elevation of 303 feet at the Intake Screen and Pump House. During a PMF event, the river flow would increase from 200,000 cfs (284.2 ft) to 1.175 million cfs (303 ft) in approximately 25 hours at the Intake Screen Pump House.

A total PMF event duration of 104 hours is based on the PMF hydrograph summed as follows: from emergency initiation (200,000 cfs) to the beginning of site inundation (304.5 ft site grade level) is 26 hours; from site inundation until water levels recede below site grade is 52 hours; and, the duration until the emergency procedure is terminated (i.e., river flow becomes less than 640,000 cfs), is 26 hours.

3.2.2 Incorporated and Exterior Barriers

The licensee reported that the site has incorporated passive interior/exterior barriers including walls, floors, penetration seals, and internal conduit seals permanently in place requiring no operator manual actions. The licensee included all of these features in the flooding walkdowns.

The licensee did not state that site grading and associated elevations are a credited flood-protection feature. Features including walls, floors, seals, plugs and valves are credited with protection against groundwater ingress. Local intense precipitation is not described in the TMI CLB.

3.2.3 Temporary Barriers and Other Manual Actions

The licensee reported that the TMI site has flood protection features consisting of temporary barriers and features that require manual action. These actions include closing missile shield doors and inflating door seals at the Fuel Handling Building. Flood gates will be installed at various locations around the plant including the Intake Screen Pump House (ISPH) where a hatch, drain seals and sump pumps are installed. The hatch prevents flood water from entering through the flood protection boundary while the sump pumps remove water that may leak past

the external flood boundary. Floor drain plugs are installed in the Turbine Building and the personnel hatch area of the Reactor Building.

The flood emergency procedure (OP-TM-AOP-002) is initiated for any of the following conditions: The Susquehanna River level at ISPH exceeds 284.2 ft (200,000 cfs); Susquehanna River level at the NWS Harrisburg Gage exceeds 12.63 ft (200,000 cfs); or, NWS Forecast Center forecasts a Susquehanna River flow greater than 350,000 cfs within the next 36 hours.

3.2.4 Reasonable Simulation and Results

The licensee conducted reasonable simulations and drills as part of its flooding walkdown, which included walking through the flood protection procedure steps for installation of temporary barriers and other manual actions as described above. The simulations and drills considered the targeted available time given minimum staff available to perform the actions. The licensee optimized steps in the reasonable simulations to fall within the targeted available time of 25 hours. Available time for actions was compared to a flood emergency procedure initiated in September 2011 for tropical storm Lee to further demonstrate the adequacy of the time allowed for action. Licensed Operators receive initial training on the flood emergency procedure and every 2 years thereafter and/or when significant changes are implemented to the procedure.

The licensee outlined flood protection features in addition to those in the CLB which, although are not the primary means of protection, offer defense in depth. These features include vital powered sump pumps and Station Blackout Diesels protected by Unit 2 flood barriers. A Severe Flood Mitigation System to account for a significant flood barrier breach or a beyond design basis event provides alternative water supplies from the spent fuel pool or flood water to maintain core cooling with each action powered by available alternative sources.

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 is consistent with the walkdown guidance.

3.3 Warning Systems

The CLB does not credit room water level warning systems for protection from external flooding.

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 the TMI site design basis PMF corresponds to a peak Susquehanna River flow of 1.624 million cfs and results in a CLB protection elevation up to 313.3 ft. The licensee's statements concluding that the credited flood protection features are effective are based on observations made during the walkdown, and reasonable simulations performed by the licensee. All features inspected that were not immediately acceptable were entered into the licensee's CAP.

The licensee used acceptance criteria consistent with the walkdown guidance. 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 is consistent with the walkdown guidance.

3.5 Walkdown Methodology

By letter dated June 11, 2012,[8] the licensee responded to the 50.54(f) letter indicating that it intended to utilize the NRC-endorsed walkdown guidance contained in NEI 12-07, Rev. 0-A, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features."[9]

The licensee's walkdown submittal dated November 19, 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 is consistent with the walkdown guidance.

3.6 Walkdown Results

3.6.1 Walkdown Scope

The licensee performed walkdowns of flood-protection features at the Intake Screen and Pump House, Fuel Handling Building, Control Building, Auxiliary Building, Intermediate Building, Diesel Generator Building, Air Intake Tunnel, Heat Exchanger Vault, and Reactor Building. Flood protection features walked down included doors, walls, floors, seals, valves and flood gates. In addition, the licensee performed reasonable simulations and drills including installation of flood gates, hatches and seals. The licensee stated that all operator actions to install flood-mitigation features could be completed within 25 hours. The licensee stated that under all plant configurations and modes of operation, flood response procedures are designed to protect the plant and those actions to establish the flood protection boundary would not be adversely affected by weather conditions associated with the flood.

The licensee used acceptance criteria consistent with NEI 12-07 supplemented with plant-specific procedures for site specific protection feature inspections.

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. Barrier walls were found to have no sign of degradation or cracks, interior surfaces did not show signs of water intrusion, no evidence of leakage through wall and floor penetrations were found, credited valves were found to be in good condition, and flood gates were found to be consistent with design drawings and free from obstructions. The licensee stated that no deficiencies exist that could adversely impact the design basis function(s) of external flood-protected features as credited in the CLB.

8 ADAMS Accession No. ML12164A569.
9 ADAMS Accession No. ML12173A215.

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 deficiencies because of the walkdowns which included spare plugs, sealing conduits, and new seal installations. These deficiencies were entered into the licensee's CAP and have been subsequently resolved.

NEI 12-07 requires licensees to identify observations/potential deficiencies in the CAP that were not yet dispositioned at the time the walkdown report was submitted. The licensee's observations awaiting disposition are repairs to concrete cracks in walls and ceilings in the Heat Exchanger Vault, Tendon Access Gallery and Air Intake Tunnel.

3.6.3 Flood-Protection and Mitigation Enhancements

The licensee discussed flood-protection and mitigation enhancements in the flooding walkdown report that include isolating air intake drains, pre-installation of flood gates, improved river level instrumentation, installing new seals, installing valves to isolate potential flow paths, raising the elevation of flood protection barriers to 313.3 ft and installing a qualified seal on the Reactor Building seismic gap.

Optimized procedures have been incorporated into the flood emergency procedures, flooding surveillance procedures and programmatic controls for flood barrier actions at the TMI site.

3.6.4 Planned or Newly Installed Features

The licensee described enhancements to improve TMI response to a flood including revising procedures based on reasonable simulation and drill experience, which included installation of hatch covers and supplemental flood gates. During the walkdown, the licensee identified an action for several corrections and enhancements to flood boundary drawings and the flood protection system design basis document. Flood design enhancements as identified in Section 3.6.3 were also entered into the licensee's CAP.

3.6.5 Deficiencies Noted and Actions Taken or Planned to Address

The licensee identified deficiencies and entered these features into the CAP and actions identified to resolve the conditions. Featured identified and subsequently dispositioned include issues with valves, seals, plugs and hoses. Items not yet dispositioned are repairs to cracks in walls and ceilings In the Heat Exchanger Vault, Tendon Access Gallery and Air Intake Tunnel.

Missing conduit internal sealing material for flood protection, in the Air Intake tunnel, was identified by the walkdown inspection. The cause was attributed to inadequate configuration management during original construction. Each conduit from the yard electrical vaults that is not sealed could potentially provide a leak path during flood conditions from the yard electrical vaults to the Auxiliary building. Flood water entering the Auxiliary Building could impact the decay heat removal safety function. Compensatory measures were enacted at the time of discovery.

The deficiency was considered reportable by the licensee, in accordance with 10 CFR 50.73, and a license event report (LER) LER- 2012-002-00 was submitted on October 09, 2012.[10]

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10 ADAMS Accession No ML12284A516.

In a subsequent update submittal on January 15, 2013,[11] the licensee completed the corrective action to modify the design deficiency, as identified in the flooding walkdown.

3.6.6 Staff Analysis of Walkdowns

The NRC staff reviewed the licensee's walkdown report dated November 19, 2012. The licensee provided an evaluation of flood-protection procedures in the walkdown report. The NRC staff found that the reasonable simulations conducted for these procedures were adequately described and met the intent of the walkdown guidance. The licensee provided detail related to its determination that all flood protection features that were immediately acceptable were performing their credited functions effectively, and deficiencies and potential deficiencies were entered into the licensee's CAP.

Based on the above assessment, 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 submittal, 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 available physical margin (APM) dated December 23, 2013.[12] The licensee responded with a letter dated January 31, 2014.[13] The licensee has reviewed their APM determination process, and entered any unknown APMs into their corrective action program. 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 staff concludes that the licensee has documented the information requested for any cliff-edge effects, as indicated in Requested Information item 2.g of the 50.54(f) letter consistent with Appendix D, Walkdown Report, of the walkdown guidance. Further, staff reviewed the response, and concludes 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 NRC staff reviewed the response, and concluded that the licensee met the intent of the APM determination per NEI 12-07.

3.7 NRC Oversight

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11 ADAMS Accession No ML13016A054.
12 ADAMS Accession No. ML13325A891.
13 ADAMS Accession No. ML14031A443.

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."[14] 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 report (05000289/2012005) dated February 11, 2013,[15] documents the results of this inspection.

Inspectors verified that non-compliances with current licensing requirements, and issues identified in accordance with the 10 CFR 50.54(f) letter, Item 2.g, of Enclosure 4, were entered in the licensee's CAP. Issues identified in response to Item 2.g that could challenge risk significant equipment and the licensee's ability to mitigate the consequences, will be subject to additional NRC evaluation.

4.0 Walkdowns Not Performed for Flood-Protection Features

The licensee identified inaccessible features but no restricted access features.

4.1 Restricted Access

The licensee identified no restricted access features.

4.2 Inaccessible Features

The licensee identified inaccessible features including the air intake tunnel, access galleries, exhaust ducts, conduits, and floor drains. The licensee provided a justification for assurance that these features are available based on design drawings and observations of adjacent features such as walls and conduits.

5.0 CONCLUSION

The NRC staff concludes that the licensee's implementation of the 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 by the licensee to be responsive to Enclosure 4 of the 50.54(f) letter, dated March 12, 2012.

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14 ADAMS Accession No. ML12129A108.
15 ADAMS Accession No. ML13042A277.