



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

June 26, 2014

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

SUBJECT: CLINTON POWER 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. MF0212)

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, as supplemented by letter dated June 19, 2013,² Exelon Generation Company, LLC, (Exelon) submitted a flooding walkdown report as requested in Enclosure 4, "Recommendation 2.3: Flooding," of the 50.54(f) letter for Clinton Power Station, Unit 1. By letter dated January 31, 2014,³ Exelon provided a response to the NRC request for additional information for the NRC 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.

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

² ADAMS Accession Nos. ML12332A304 and ML13171A273, respectively.

³ ADAMS Accession No. ML14031A443

M. Pacilio

- 2 -

If you have any questions, please contact me at (301) 415-1380 or by e-mail at blake.purnell@nrc.gov.

Sincerely,

A handwritten signature in black ink, appearing to read "Blake Purnell". The signature is fluid and cursive, with the first name "Blake" and last name "Purnell" clearly distinguishable.

Blake Purnell, Project Manager
Plant Licensing III-2 and
Planning and Analysis Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-461

Enclosure:
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, LLC
CLINTON POWER STATION, UNIT 1
DOCKET NO. 50-461

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), 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 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 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 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. 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, 2012,² the Nuclear Energy Institute (NEI) 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. By letter dated May 31, 2012,³ the staff endorsed the walkdown guidance.

By letter dated November 27, 2012,⁴ as supplemented by letter dated June 19, 2013,⁵ 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 the Clinton Power Station, Unit 1 (CPS). NRC staff issued a request for additional information to the licensee regarding the available physical margin (APM) by letter 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 flooding 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 defined by 10 CFR 50.2, "Definitions," 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

² ADAMS Package Accession No. ML121440522

³ ADAMS Accession No. ML12144A142.

⁴ ADAMS Accession No. ML12332A304.

⁵ ADAMS Accession No. ML13171A273.

⁶ ADAMS Accession No. ML13325A891.

⁷ ADAMS Accession No. ML14031A443

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

The flooding walkdown report states that the design basis flood hazard for the CPS site is the probable maximum flood (PMF); this condition is associated with Lake Clinton, the man-made cooling water lake located downstream from the reactor site. Lake Clinton was formed when a dam was constructed at the confluence of the North Fork of Salt Creek with Salt Creek. The walkdown report states that all the safety-related structures at the CPS site are protected against the design basis PMF event. The cooling lake is designed to withstand the effects of a probable maximum storm occurring over the entire drainage basin above the dam site. As described in Section 2.4.2.2 of the CPS Updated Safety Analysis Report,⁸ PMF-derived runoff into the lake routed through the spillways will create a backwater effect and raise the cooling lake water level at the dam site to an elevation of 708.8 feet (ft). The backwater effect will also raise the PMF level at the station site to an elevation of 708.9 ft. The walkdown report states that superimposing the wind wave effect due to a sustained 40 mile-per-hour wind acting on the probable maximum water level will result in wave run-up elevations of 711.9 ft for significant waves and 713.8 ft for the maximum (1 percent) waves at the CPS site.

The flooding walkdown report states that the PMF occurring in combination with wave run-up is well below the station grade elevation of 736 ft, which is the elevation of the main power block. The flooding walkdown report states that flood protection for the safety-related systems and components in the circulating water screen house is provided to an elevation of 714 ft.

The licensee stated that the normal pool elevation of Lake Clinton is 690 ft and the groundwater table elevation is conservatively taken as 730 ft. The licensee reports that all substructures below the 730-ft elevation at the site are designed to withstand a full hydrostatic head of groundwater.

The licensee provided a description of the design basis flood hazard level in response to Enclosure 4 of the 50.54(f) letter. Based on the NRC staff's review, this response appears to be consistent with the walkdown guidance.

3.2 Flood Protection and Mitigation

3.2.1 Flood Protection and Mitigation Description

The licensee stated that for the purpose of the flooding walkdowns the PMF was assumed to reach an elevation of 713.8 ft. The licensee stated that walls of the shutdown service water

⁸ All elevations discussed herein are mean sea level and refer to the U.S. Geological Survey 1929 topographic datum.

(SSW) pump rooms in the circulating water screen house are designed to be protected to an elevation of 714 ft. The licensee described several measures that protect the Seismic Category I systems and components in the circulating water screen house, including: water stops in construction joints below the PMF level, water seal rings for all exterior wall penetrations below the PMF level, watertight doors designed to withstand the hydrostatic head for all doorways of the SSW pump rooms, and an access hatch on the roof.

The flooding walkdown report identified local intense precipitation (LIP) as a potential source of external flooding of the main power block buildings. The maximum surface water elevation from LIP is estimated by the licensee to be 736.8 ft in the area where safety-related facilities are located. This elevation is lower than the plant floor elevation of 737 ft. The licensee stated that the areas surrounding the power block and other site buildings are graded to divert surface water away from these structures. In the case of the power block building, the licensee also stated that an existing floor drain system would passively remove any meteoric water that might enter that building following an LIP event.

The flooding walkdown report states that the surface water elevation from LIP on the northern portion of the site is estimated to be about 737.2 ft in areas enclosed by curved railroad tracks. In this area, the licensee estimates that a LIP event could result in about 0.2 ft of standing water outside of the power block buildings. However, the licensee also states that this is not expected to adversely affect any safety-related systems within these buildings. The licensee's basis for this conclusion is that there are no safety-related equipment or systems located in that portion of the plant below the 737 ft elevation and the existing floor drain system would remove any water that may enter the buildings.

The licensee stated that the scope of the walkdowns included: "The floors and exterior watertight walls (up to maximum water level due to local intense precipitation (LIP) resulting from PMP [probable maximum precipitation]) of all main power block buildings." The licensee states the floor of the containment building is credited with leak tightness based on the periodic integrated leak rate testing. The floor drain systems in the turbine and radwaste buildings are also credited in addressing postulated in-leakage due to the maximum LIP water level. The licensee noted that conduits at the CPS site do not provide a path for groundwater or rainwater to enter safety-related buildings. Evidence of groundwater or rainwater leakage through conduits into safety-related buildings at CPS has not been identified in the past and was not identified during the walkdowns.

The walkdown report states that all substructures below the 730 ft elevation at the CPS site are designed to withstand the full hydrostatic head of groundwater.

3.2.2 Incorporated and Exterior Barriers

The walkdown report identified the following incorporated barriers: site grading, watertight walls, doors, and floor drains. The licensee stated that the exterior walls of the main power block buildings are also designed to prevent groundwater ingress. The licensee did not identify any permanent incorporated or exterior barriers that require manual operator actions in the event of a flood.

The walkdown report states that the safety-related SSW pumps and associated equipment in the circulating water screen house are located in watertight compartments which provide flood protection to an elevation of 714 ft.

3.2.3 Temporary Barriers and Other Manual Actions

For the power block elevation, the licensee did not identify any credited temporary barriers that require operator action in the event of a flood threat. However, at the circulating water screen house, the licensee stated that the SSW "B" pump room is equipped with a floor hatch at elevation 699 ft to provide access to the SSW tunnel underneath. The licensee further noted that the open hatch cover must be installed prior to lake level reaching the 699 ft elevation to prevent flooding of the SSW "B" pump room. A CPS procedure requires monitoring of the SSW tunnel by the licensee for leakage when the lake water level reaches 694 ft.

3.2.4 Reasonable Simulation and Results

The licensee stated that it performed reasonable simulations to verify that the required flood protection procedures or activities can be executed as specified. Specifically, the flooding walkdown report describes the conduct of two reasonable simulations associated with the circulating water screen house.

The walkdown report states the first simulation was an exercise to install the watertight floor hatch in the SSW "B" pump room to demonstrate that a CPS abnormal lake level procedure could be implemented in the event of high lake water level. These procedural steps had not been previously performed, and the licensee stated the installation of the hatch was demonstrated successfully.

The second simulation was reported to have been performed to ensure the SSW pump room roof hatches could be opened, if needed, to provide personnel access to that room during a flood. The licensee stated that this simulation was successfully performed.

The licensee stated that the CPS procedure also requires sandbagging at the circulating water screen house in the event of flooding. However, since this action is for the protection of nonsafety-related items, the licensee considered reasonable simulation of this action to be outside the scope of the 50.54(f) letter.

3.2.5 Conclusion

The licensee provided a description of the protection and mitigation features in response to Enclosure 4 of the 50.54(f) letter. Based on the NRC staff's review, this response appears to be consistent with the walkdown guidance.

3.3 Warning Systems

The walkdown reports states that there are no rooms with credited warning systems to detect flooding from external sources. However, the licensee states that CPS does have level switches in each of the SSW pump rooms in the circulating water screen house that will alarm if high water level is detected, although this is not credited for external flood detection. Similarly, sumps in each of the main power block buildings will alarm if a high water level is detected.

The licensee provided a description of warning systems to detect water in rooms important to safety in response to Enclosure 4 of the 50.54(f) letter. Based on the NRC staff's review, this response appears to be consistent with the walkdown guidance.

3.4 Effectiveness of Flood Protection Features

The licensee reported that the design basis flood hazard for the CPS site is based on a postulated PMF (specifically a combined effects flood) at the circulating water screen house location.

The licensee also reported circulating water screen house containing the SSW pumps is the only CPS structure susceptible to flooding. The walkdown report indicates that screen house is designed for both a combined event flood as well as waves produced by a 40 mile-per-hour wind. The only active flood protection features identified are the sump pumps in the SSW pump rooms. The licensee reported that these sump pumps are not explicitly credited in the licensing basis, but would serve to protect the SSW pumps should a small amount of water leak into the SSW pump rooms.

The licensee provided a description of the effectiveness of flood protection features in response to Enclosure 4 of the 50.54(f) letter. Based on the NRC staff's review, this response appears to be consistent with the walkdown guidance.

3.5 Walkdown Methodology

By letter dated June 11 2012,⁹ the licensee stated that it would use the NRC-endorsed walkdown guidelines contained in NEI 12-07, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features." The licensee's 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.

The licensee provided a description of the implementation of the walkdown process in response to Enclosure 4 of the 50.54(f) letter. Based on the NRC staff's review, this response appears to be consistent with the walkdown guidance.

3.6 Walkdown Results

3.6.1 Walkdown Scope

The walkdown scope was developed by the licensee to confirm that flood protection features credited in the CLB were acceptable and capable of performing their credited flood protection functions. The licensee identified 49 visual inspections within the walkdown scope for CPS. The licensee reported that the walkdown scope consisted primarily of visual inspections of floors and exterior watertight walls of the circulating water screen house and the main power block. The scope included visual inspection of all applicable penetrations and associated seals. In addition, the licensee conducted an outdoor walkdown to confirm credited surface drainage provisions have not been impacted by changes. Further, the licensee performed a reasonable

⁹ ADAMS Accession No. ML12164A569.

reasonable simulation of manual actions at the circulating water screen house and determined that all operator actions to install flood-mitigation features could be completed.

The licensee stated that walkdowns of the CPS physical plant were conducted at several locations, including: (a) the exterior walls and floors the circulating water screen house; (b) all main power block buildings; and (c) the radwaste and turbine buildings. The licensee did not include the containment building in the inspection scope because the exterior walls and the floor are credited with leak tightness based on periodic integrated leak rate testing. Conduits associated with manholes or cable vaults were not considered by the licensee to be relevant to the walkdown scope because they did not provide a path for groundwater or rainwater to enter safety-related buildings.

The licensee also reported that visual inspections were performed at all exterior areas of the site to verify that plant modifications implemented since original construction, such as security barrier installation and changes to topography, do not adversely affect plant flooding protection.

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 CPS flood protection features. The licensee stated it verified that walls, floors, and penetrations credited as flood barriers are in place and appear capable of performing their intended functions. The walkdown report states that the licensee confirmed, through the performance of walkdowns and simulations, that flood protection features at CPS are in place, are in good condition (with a few exceptions), and will perform as credited in the CLB.

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 as a result of the flooding walkdowns.

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 made 17 observations during the walkdowns of credited flood protection features that were not immediately judged as acceptable. The licensee stated it entered these observations into its CAP but none were determined to be a deficiency that causes the feature to be unable to perform its intended flood protection function. Some of the observations were related to the installation of the SSW room floor hatch. The licensee stated it has taken actions to replace the degraded hatch gasket, protect the bolt holes with a cover, improve hatch storage, and enhance the hatch installation procedure.

3.6.3 Flood Protection and Mitigation Enhancements

As described above, the walkdown report states the licensee has taken action to enhance the SSW pump room floor hatch. The licensee states there are no other recently-implemented or planned flood protection enhancements at CPS considered to be necessary as a result of the flooding walkdowns.

3.6.4 Planned or Newly-Installed Features

The 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 did not identify any deficiencies during the walkdowns; hence, no actions were taken or are planned to address deficiencies.

3.6.6 NRC Staff Analysis of Walkdowns

The licensee provided a description of the results of the flooding walkdown, including potential improvements, in response to Enclosure 4 of the 50.54(f) letter. The NRC staff reviewed the licensee's walkdown report, as supplemented, with a focus only on those items related to the CPS CLB. Based on the staff's review, this response appears to be consistent with the walkdown guidance.

3.6.7 Available Physical Margin

The 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. In its walkdown report and January 31, 2014, letter, the licensee provided a description of the APM, as it relates to cliff-edge effects, in response to Enclosure 4 of the 50.54(f) letter. Based on the NRC staff's review, this response appears to be consistent with the walkdown guidance.

3.8 Independent Verification

On June 27, 2012, the NRC issued Temporary Instruction (TI) 2515/187, "Inspection of Near-Term Task Force Recommendation 2.3 Flooding Walkdowns."¹⁰ In accordance with the TI, NRC inspectors accompanied licensee personnel on a sample of walkdowns to independently verify that the licensee implemented the flooding walkdowns consistent with the walkdown guidance. Additionally, the inspectors independently performed walkdowns of a sample of flood protection features. The NRC inspection report dated April 23, 2013,¹¹ documents the results of this inspection; no findings of significance were identified.

4.0 SSCS NOT WALKED DOWN

4.1 Restricted Access Areas

The licensee identified the condenser pit floor area in the turbine building as a restricted access area as defined in NEI 12-07. Walkdown of this area was deferred until a March 7, 2013, outage, as occupational dose in this area is significantly reduced when the plant is not operating. The licensee provided the results of this walkdown in a supplemental response on June 19, 2013, and this information was considered in the NRC staff's review.

¹⁰ ADAMS Accession No. ML12129A108

¹¹ ADAMS Accession No. ML13114A117.

4.2 Inaccessible Features

The flooding walkdown report states that a small portion of the total floor and wall areas and a small portion of the penetrations within the walkdown scope were deemed inaccessible and were not inspected. These features are located in either locked high-radiation areas or were physically inaccessible (buried or blocked from visual inspection by an electrical junction box or other obstruction). The licensee stated it had reasonable assurance that the inaccessible walls and floors are acceptable because visual inspection of other walls and floors did not find any deficiencies or degradations that would prevent performance of the flood protection function. The licensee stated it had reasonable assurance that the inaccessible penetrations were acceptable since, in part, there were no indications of water leakage through these penetrations.

Based on the above, the NRC staff determined that the licensee provided adequate justification for not inspecting the features it identified as inaccessible.

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 flooding conditions; and verified the adequacy of monitoring and maintenance programs for protective features. Furthermore, the licensee's walkdown results, which were verified by the staff's inspection, identified no immediate safety concerns. The NRC staff reviewed the information submitted and determined that sufficient information was provided to be responsive to Enclosure 4 of the 50.54(f) letter.

M. Pacilio

- 2 -

If you have any questions, please contact me at (301) 415-1380 or by e-mail at blake.purnell@nrc.gov.

Sincerely,

/RA/

Blake Purnell, Project Manager
Plant Licensing III-2 and
Planning and Analysis Branch
Division of Operating Reactor Licensing
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Docket No. 50-461

Enclosure:
Staff Assessment of Flooding Walkdown Report

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