



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 Nuclear  
4300 Winfield Road  
Warrenville, IL 60555

SUBJECT: BYRON STATION, UNIT NOS. 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. MF0205 AND MF0206)

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*, 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 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 27, 2012, as supplemented by a May 21, 2013, letter, the Exelon Generation Company, LLC, submitted a Flooding Walkdown Report as requested in Enclosure 4 of the 50.54(f) letter for the Byron Station, Unit Nos. 1 and 2, (Byron) site. By letter dated January 31, 2014, Exelon Generation Company, LLC, provided a response to the NRC request for additional information in order 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 e-mail 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 initial "J" and a long horizontal stroke at the end.

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 Nos. 50-454 and 50-455

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, LLC

BYRON STATION, UNIT NOS. 1 AND 2

DOCKET NOs. 50-454 and 50-455

1.0 INTRODUCTION

On March 12, 2012,<sup>1</sup> 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,"<sup>2</sup> 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 provide 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.

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<sup>1</sup> Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340.

<sup>2</sup> ADAMS Accession No. ML12056A050.

Enclosure

- d. Discuss the effectiveness of flood protection systems and exterior, incorporated, and temporary flood barriers. Discuss how these systems and barriers were evaluated using the acceptance criteria developed as part of Requested Information Item 1.h.
- e. Present information related to the implementation of the walkdown process (e.g., details of selection of the walkdown team and procedures) using the documentation template discussed in Requested Information Item 1.j, including actions taken in response to the peer review.
- f. Results of the walkdown including key findings and identified degraded, nonconforming, or unanalyzed conditions. Include a detailed description of the actions taken or planned to address these conditions using guidance in Regulatory Issues Summary 2005-20, Revision 1, to the NRC Inspection Manual Part 9900 Technical Guidance, "Operability Conditions Adverse to Quality or Safety," including entering the condition in the CAP.
- 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<sup>3</sup>, 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<sup>4</sup>, the NRC staff endorsed the walkdown guidance.

By letter dated November 27, 2012<sup>5</sup>, as supplemented by a May 21, 2013, letter<sup>6</sup>, Exelon Generation Company, LLC (Byron, the licensee), provided a response to Enclosure 4 of the 50.54(f) letter Required Response Item 2, for Byron, Unit Nos. 1 and 2. The NRC staff issued a request for additional information (RAI) to the licensee regarding the available physical margin (APM) dated December 23, 2013<sup>7</sup>. The licensee responded by letter dated January 31, 2014.<sup>8</sup>

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<sup>3</sup> ADAMS Package Accession No. ML121440522.

<sup>4</sup> ADAMS Accession No. ML12144A142.

<sup>5</sup> ADAMS Accession No. ML12332A380.

<sup>6</sup> ADAMS Accession No. ML13141A594.

<sup>7</sup> ADAMS Accession No. ML13325A891.

<sup>8</sup> ADAMS Accession No. ML14031A443

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, 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. The current licensing basis (CLB) 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 for Byron

The licensee reports that there are two design basis flood hazards for the Byron site. In the case of the nuclear block, located on a bluff overlooking the Rock River, the worst hydrological condition is caused by a local intense precipitation (LIP) event. In the case of the screen house location, adjacent to the Rock River proper and housing the essential service water (SX) make-up pumps, the worst hydrological condition is a combined flood event.

The grade and floor elevation for the Byron power block is 869.0 feet (ft) and 870 ft above mean sea level (MSL), respectively (all elevations herein refer to the 1929 U.S. Geological Survey datum.) The licensee reports that the LIP event is expected to generate a maximum surface water flood elevation of 870.82 ft MSL, in the form of local ponding, in areas immediately adjacent to safety-related structures. The licensee estimates that this flood elevation would cause only minor local flooding at the site.

The makeup water system for the Byron ultimate heat sink consists of a combination of SX make-up pumps located along the Rock River and deep ground-water wells located within the reactor site footprint. The SX make-up pumps are installed at an elevation is 702 ft MSL; the pumps are housed within a 4-ft high fire wall. Superimposing the maximum wave run-up height

on the river still-water elevation yields a combined event flood stage elevation of 703.39 ft MSL for the river screen house location.

Based on the NRC staff's review, the staff concludes that the licensee has described the design basis flood hazard level(s) as indicated in Requested Information Item 2.a of the 50.54(f) letter, consistent with Appendix D, Walkdown Report, of the walkdown guidance.

### 3.2 Flood Protection and Mitigation

#### 3.2.1 Flood Protection and Mitigation Description

The CLB for flood protection at the Byron site is a LIP event within the main power block yard and the combined flood event on the Rock River at the river screen house location.

Both reinforced concrete curbs and steel barriers have been incorporated into the Byron design at elevations above 870.82 ft MSL to prevent any sheet flow associated with the LIP from entering critical areas. All Byron Station substructures below an elevation of 869 ft MSL are designed to withstand full hydrostatic pressure associated with groundwater.

The river screen house structure enclosing the SX pumps has been designed for the combined event flood as well as waves produced by a 40 mile per hour (mph) wind. To prevent damage to the screen house due to the combined event flood, the floor elevation for this structure is 702 ft MSL. A 4-ft-high fire wall has also been constructed to enclose the area where safety-related equipment is located. Sump pumps are located within the enclosed area to remove any water associated with external leaks into the SX rooms.

#### 3.2.2 Incorporated and Exterior Barriers

The site has incorporated and/or exterior barriers that are permanently in-place, generally requiring no operator manual actions. Such barriers are passive and include walls and penetration seals that were incorporated into the original Byron design. Water entering these areas would generally be removed using the existing floor drain system. Grading and drainage at the Byron site are designed to ensure that no flooding of safety-related facilities will occur for events as severe as the LIP.

To prevent damage to the screen house containing the SX pumps due to the combined event flood, a 4-ft-high fire wall has been constructed to enclose the area where safety-related equipment is located.

#### 3.2.3 Temporary Barriers and Other Manual Actions

The site has no temporary barriers and other manual actions that require operator action in the event of a flood threat.

#### 3.2.4 Reasonable Simulation and Results

The purpose of performing reasonable simulations is to verify that the required flood protection procedures or activities can be executed as specified /as written. The licensee noted that flood protection features at Byron do not include any temporary or active features that would require the implementation of a procedure for the performance of those manual/operator actions necessary for the flood protection feature in question to perform its intended flood protection function. Therefore, the licensee reported that no procedure, walk-through, or 'Reasonable Simulation', was conducted at Byron.

However, the licensee has noted that there is a Station Structural Monitoring Program that provides ongoing verification of flood barrier effectiveness by identifying and trending areas of potential groundwater ingress.

#### 3.2.5 Conclusion

Based on the NRC staff's review, the staff concludes that the licensee has described protection and mitigation features as indicated in Requested Information Item 2.b of the 50.54(f) letter consistent with Appendix D, Walkdown Report, of the walkdown guidance.

#### 3.3 Warning Systems

An automated internal leak detection system is located in the basement of the building containing SX water pumps. These pumps are compartmentalized and each has its own sump. This alarm system, though, is not credited in the licensing basis for detecting groundwater ingress although it is capable of doing so.

Based on the NRC staff's review, the staff concludes that the licensee has provided information to describe any warning systems as indicated in Requested Information item 2.c of the 50.54(f) letter, consistent with Appendix D, Walkdown Report, of the walkdown guidance.

#### 3.4 Effectiveness of Flood Protection Features

The worst hydrological condition at Byron is a flood caused by: (a) a LIP event, in the case of the nuclear block, or (b) a postulated probable maximum precipitation (specifically a combined effects flood), in the case of the river screen house location.

By its very nature, the LIP event and associated runoff is a limited, short-duration event affecting the power block yard. All flood protection features at the Byron power block yard are intended to protect safety-related structures and equipment against the LIP are passive design features, such as grading, walls, doors, penetration seals, and floor drains. All buildings with exterior walls below grade are also designed to be water tight up to an elevation of 870 ft MSL, the floor elevation of the reactor power block.

The Rock River screen house containing the SX pumps is the only structure susceptible to floods. The screen house is designed for both a combined event flood as well as waves produced by a 40 mph wind. The only active flood protection features are the sump pumps in

the SX rooms associated with the river screen house. These are credited in the CLB as protecting against internal flooding but also provide an additional function of removing water leaks from external sources in the SX rooms. As a consequence, they were not included in the flooding walkdown scope.

Based on the NRC staff's review, the staff concludes that the licensee has discussed the effectiveness of flood protection features as indicated in Requested Information Item 2.d of the 50.54(f) letter consistent with Appendix D, Walkdown Report, of the walkdown guidance.

### 3.5 Walkdown Methodology

By letter dated June 8, 2012,<sup>9</sup> the licensee responded to the 50.54(f) letter that they intended to utilize the NRC-endorsed walkdown guidelines contained in NEI 12-07, "Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features." The licensee's walkdown submittal dated November 26, 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 staff concludes that the licensee has presented information related to the implementation of the walkdown process as indicated in Requested Information Item 2.e of the 50.54(f) letter, consistent with Appendix D, Walkdown Report, of the walkdown guidance.

### 3.6 Walkdown Results

#### 3.6.1 Walkdown Scope

The licensee performed walkdowns of currently-credited flood protection features; the exact number of as-built features inspected was approximately 40. The scope of the flooding walkdown was developed following a detailed review of all relevant licensing documents. The licensee reported that walkdowns of the Byron physical plant consisted of four main parts:

- The walls, floors and penetrations through the walls and floors in the river screen house SX make-up pump diesel drive cubicles were inspected.
- The main steam isolation valve (MSIV) rooms, radwaste truck bay, fuel handling building and the refueling water storage tank (RWST) tunnel exterior hatches were inspected to ensure runoff from LIP is kept out of the safety-related buildings.

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<sup>9</sup> ADAMS Accession No. ML12159A395.

- An outdoor walkdown was conducted 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.
- The below-grade structures (i.e., basement walls and basement slabs and penetrations through these walls and floors) in the main power block were inspected. These areas are credited in the CLB to keep groundwater and runoff from LIP out of the safety related buildings.

The licensee also reported that visual inspections of walls, floors, and penetrations through the walls and floors were conducted to verify there are no observable structural deficiencies that may impact the structure's ability to perform its intended flood protection function.

As mentioned earlier, the licensee noted that flood protection features at Byron do not include any temporary or active features that would require the implementation of a procedure for the performance of those manual/operator actions necessary for the flood protection feature in question to perform its intended flood protection function. Consequently, no reasonable simulation of manual actions at the site was conducted.

The licensee reported that the containment building was not included in the inspection scope because the exterior walls and the floor are credited with leak tightness based on both periodic integrated leakage rate tests, and the fact that the lowest elevation of the building is above the maximum estimated groundwater elevation. Conduits associated with manholes or cable vaults were not considered relevant to the walkdown scope because they did not provide a path for groundwater or meteoric (rain) water to enter safety-related buildings.

The licensee used acceptance criteria consistent with the intent of NEI 12-07.

### 3.6.2 Licensee Evaluation of Flood Protection Effectiveness, Key Findings, and Identified Deficiencies

The licensee performed an evaluation of the overall effectiveness of the Byron flood protection features. By virtue of its walkdown inspections, the licensee verified that permanent safety-related SSCs at the Byron site were acceptable, not degraded, and capable of performing their intended design function as credited in the CLB. No Byron operator actions are credited for external flood protection.

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 reported that it did not identify deficiencies during the course of the flood walkdowns.

NEI 12-07 specifies that licensees identify observations that were not yet dispositioned at the time the walkdown report was submitted, and that were placed in the CAP. The licensee placed a total of 15 items in the CAP, two of which were determined to be deficient per the current licensing basis. These are:

- (1) A small slab that serves as an LIP curb between the radwaste truck bay and the auxiliary building was observed as “not per design.” The slab was found to have been installed 12 inches below the designed elevation (0.82 ft below the LIP flood level).
- (2) The licensee also reported that the caulking around the LIP curb located in the 1A/1D MSIV room was considered to be “degraded.”

### 3.6.3 Flood Protection and Mitigation Enhancements

There are no recently-implemented or planned enhancements to the Byron site that are intended to improve or increase flood protection and/or mitigation.

### 3.6.4 Planned or Newly Installed Features

The licensee identified two planned changes to the Byron site as a result of the flooding walkdown. These include:

- Modification of the LIP curb between the radwaste truck bay and the auxiliary building to reflect existing design drawings.
- Replacement of the caulking on the 1A/1D MSIV room LIP curb.

### 3.6.5 Deficiencies Noted and Actions Taken or Planned to Address

Two items were determined by the licensee to be deficient per the CLB, and were entered into the Byron CAP for disposition. These were:

- 1) A small slab that serves as an LIP curb between the radwaste truck bay and the auxiliary building was observed as “not per design.” The slab was found to have been installed 12 inches below the designed elevation (0.82 ft below the LIP flood level).
- 2) The licensee also reported that the caulking around the LIP curb located in the 1A/1D MSIV room was considered to be “degraded.” NRC staff reviewed the licensee’s walkdown report dated November 27, 2012. Based on the above assessment, staff concludes that that the licensee performed the walkdowns consistent with the intent of the guidance provided in NEI 12-07.

### 3.6.6 NRC Staff Analysis of Walkdowns

The NRC staff reviewed the licensee’s walkdown report dated November 27, 2012, and supplemental letter dated May 21, 2013. Staff reviewed this additional information in conjunction with the submitted walkdown report and supplements.

As part of the walkdown effort, the licensee evaluated the capability of flood protection features by conducting a set of visual inspections. Two deficiencies were noted, but are being corrected through the site CAP. 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.

During the walkdowns, items were identified as not immediately acceptable; however, corrective actions were identified and taken.

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

### 3.6.7 Available Physical Margin

The NRC staff issued an RAI to the licensee regarding the APM dated December 23, 2013. The licensee responded in a letter dated January 31, 2014. The licensee has reviewed their APM determination process, and entered any unknown APMs into their CAP. The 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, are 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.

## 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 at Byron consistent with the intent of the walkdown guidance. Additionally, the inspectors independently performed walkdowns of a sample of flood protection features. The inspection report dated February 5, 2013, documents the results of this inspection. No findings of significance were identified.

## 4.0 SSCS NOT WALKED DOWN

The licensee did not identify any SSCs as restricted access; therefore, no SSCs will be walked down at a later date.

#### 4.1 Restricted Access

The licensee identified no restricted access features or areas within the Byron site.

#### 4.2 Inaccessible Features

The licensee reported that a portion of the exterior wall located directly behind their cycle holdup tanks (0AB01TA/TB) and the regeneration waste drain tank (0WX25T) was deemed inaccessible due to the close proximity of those tanks to the wall. Nevertheless, the licensee reported that it has reasonable assurance that the walls in question are water-tight based on the fact that visual inspection of the walls and floors adjacent to these tanks and throughout the balance of the plant revealed no deficiencies or evidence of degradation that would prevent performance of flood protection functions. The licensee reported that there are no conduit or piping penetrations located within these areas, and water stops are provided in all horizontal and vertical construction joints in all exterior walls.

#### 5.0 CONCLUSION

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

M. Pacilio

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If you have any questions, please contact me at (301) 415-6606 or by e-mail 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  
Office of Nuclear Reactor Regulation

Docket Nos. 50-454 and 50-455

Enclosures:  
Staff Assessment of Flooding Walkdown Report

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