



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

February 21, 2018

Mr. Bryan C. Hanson
Senior Vice President
Exelon Generation Company, LLC
President and Chief Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: OYSTER CREEK NUCLEAR GENERATING STATION - STAFF ASSESSMENT
OF FLOODING FOCUSED EVALUATION (CAC NO. MF9694; EPID L-2017-
JLD-0007)

Dear Mr. Hanson:

By letter dated March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information pursuant to Title 10 of the *Code of Federal Regulations*, Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The request was issued as part of implementing lessons learned from the accident at the Fukushima Dai-ichi nuclear power plant. Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood-causing mechanisms using present-day methodologies and guidance. By letter dated March 12, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15085A046), Exelon Generation Company, LLC (Exelon, the licensee) responded with a revised response to this request for Oyster Creek Nuclear Generating Station (Oyster Creek).

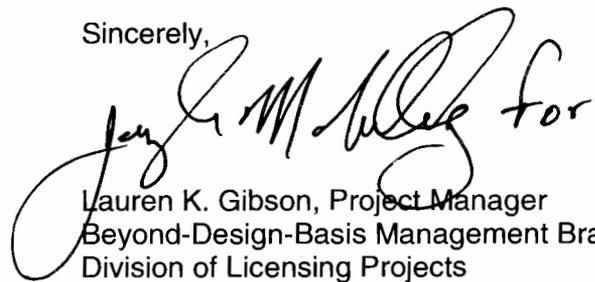
By letter dated February 9, 2016 (ADAMS Accession No. ML16035A266), the NRC staff sent the licensee a summary of the staff's review of the licensee's reevaluated flood-causing mechanisms. A staff assessment that provides the documentation supporting the NRC staff's conclusions summarized in the February 9, 2016, letter was issued on February 21, 2018 (ADAMS Accession No. ML18033B744). As stated in the letter and the staff assessment, the reevaluated flood hazard result for the following mechanisms were not bounded by the Oyster Creek current design basis (CDB) flood hazard: local intense precipitation (LIP) and storm surge. The NRC staff notes that for the flood-causing mechanisms that are not bounded by the CDB, the licensee has submitted a mitigating strategies assessment (MSA) by letter December 16, 2016 (ADAMS Accession No. ML16351A219). The NRC staff responded to the MSA by letter dated May 18, 2017 (ADAMS Accession No. ML17082A271).

By letter dated April 28, 2017 (ADAMS Accession No. ML17118A003), the licensee submitted the focused evaluation (FE) for Oyster Creek. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the staff assessment for the reevaluated flood hazard, that: 1) a flood mechanism is bounded based on further reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is local intense precipitation. The purpose of this letter is to provide the NRC's assessment of the Oyster Creek FE.

As set forth in the enclosed staff assessment, the NRC staff has concluded that the Oyster Creek FE was performed consistent with the guidance described in Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178). Guidance document NEI 16-05, Revision 1, has been endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation" (ADAMS Accession No. ML16162A301). The NRC staff has further concluded that the licensee has demonstrated that effective flood protection exists for the LIP and storm surge flood mechanisms during a beyond-design-basis external flooding event at Oyster Creek. This closes out the licensee's response for Oyster Creek for the reevaluated flooding hazard portion of the 50.54(f) letter and the NRC's efforts associated with CAC No. MF9694.

If you have any questions, please contact me at (301) 415-1056 or by electronic mail at Lauren.Gibson@nrc.gov.

Sincerely,

A handwritten signature in black ink, appearing to read "Lauren K. Gibson for". The signature is written in a cursive style and is positioned above the typed name and title.

Lauren K. Gibson, Project Manager
Beyond-Design-Basis Management Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket No. 50-219

Enclosure:
Staff Assessment of Flood Hazard
Reevaluation Report

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE FOCUSED EVALUATION FOR

OYSTER CREEK NUCLEAR GENERATING STATION

AS A RESULT OF THE REEVALUATED FLOODING HAZARD NEAR-TERM TASK FORCE

RECOMMENDATION 2.1 - FLOODING

(CAC NO. MF9694; EPID L-2017-JLD-0007)

1.0 INTRODUCTION

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807).

Enclosure 2 of the 50.54(f) letter requested that licensees reevaluate flood hazards for their respective sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). If the reevaluated hazard for any flood-causing mechanism is not bounded by the plant's current design basis (CDB) flood hazard, an additional assessment of plant response would be necessary. Specifically, the 50.54(f) letter stated that an integrated assessment should be submitted, and described the information that the integrated assessment should contain. By letter dated November 30, 2012 (ADAMS Accession No. ML12311A214), the NRC staff issued Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2012-05, "Guidance for Performing the Integrated Assessment for External Flooding."

On June 30, 2015 (ADAMS Accession No. ML15153A104), the NRC staff issued COMSECY-15-0019, describing the closure plan for the reevaluation of flooding hazards for operating nuclear power plants. The Commission approved the closure plan on July 28, 2015 (ADAMS Accession No. ML15209A682). COMSECY-15-0019 outlines a revised process for addressing cases in which the reevaluated flood hazard is not bounded by the plant's CDB. The revised process describes a graded approach in which licensees with hazards exceeding their CDB flood will not be required to complete an integrated assessment, but instead will perform a focused evaluation (FE). As part of the FE, licensees will assess the impact of the hazard(s) on their site and then evaluate and implement any necessary programmatic, procedural, or plant modifications to address the hazard exceedance.

Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178), has been endorsed by the NRC as an appropriate methodology for licensees to perform the focused evaluation in response to the 50.54(f) letter. The NRC's endorsement of NEI 16-05, including exceptions, clarifications, and additions, is

described in NRC JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation" (ADAMS Accession No. ML16162A301). Therefore, NEI 16-05, Revision 1, describes, as endorsed, acceptable methods for demonstrating that Oyster Creek Nuclear Generating Station (Oyster Creek) has effective flood protection.

2.0 BACKGROUND

This provides the final NRC staff assessment associated with the information that the licensee provided in response to the reevaluated flooding hazard portion of the 50.54(f) letter. Therefore, this background section includes a summary description of the reevaluated flood information provided by the licensee and the associated assessments performed by the NRC staff. The reevaluated flood information includes: 1) the flood hazard reevaluation report (FHRR); 2) the mitigating strategies assessment (MSA); and 3) the focused evaluation.

Flood Hazard Reevaluation Report

By letter dated March 12, 2015 (ADAMS Accession No. ML15085A046), Exelon Generation Company, LLC (Exelon, the licensee) responded with a revised FHRR for Oyster Creek. The licensee supplemented the FHRR by e-mail dated January 14, 2016 (ADAMS Accession No. ML16015A001), and by letter dated April 15, 2016 (ADAMS Accession No. ML16120A015).

After reviewing the licensee's response, the NRC staff issued an interim staff response letter to the licensee on February 9, 2016 (ADAMS Accession No. ML16035A266), that provided the flood hazard information suitable for the assessment of mitigating strategies developed in response to Order EA-12-049 and the additional assessments associated with Recommendation 2.1: Flooding. The NRC staff issued a staff assessment documenting the basis for the conclusions in the ISR letter by letter dated February 21, 2018 (ADAMS Accession No. ML18033B744). As stated in the staff assessment and supplement, because the local intense precipitation (LIP) and probable maximum storm surge (PMSS) flood-causing mechanisms at Oyster Creek are not bounded by the plant's CDB, additional assessments of the flood hazard mechanisms are necessary.

Mitigation Strategies Assessment

By letter dated December 16, 2016 (ADAMS Accession No. ML16351A219), Exelon submitted the MSA for Oyster Creek for review by the NRC staff. The MSAs are intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigation strategies for beyond-design-basis external events. By letter dated May 18, 2017 (ADAMS Accession No. ML17082A271), the NRC issued its assessment of the Oyster Creek MSA. The NRC staff concluded that the Oyster Creek MSA was performed consistent with the guidance described in Appendix G of Nuclear Energy Institute 12-06, Revision 2, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide" (ADAMS Accession No. ML16005A625). The NRC's endorsement of NEI 12-06, Revision 2, is described in JLD-ISG-2012-01, Revision 1, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML15357A163). The NRC staff also concluded that the licensee has demonstrated that the mitigation strategies, if appropriately implemented, are not affected by the impacts from reevaluated flood hazards conditions for beyond-design-basis external events.

Focused Evaluation

By letter dated August 28, 2017 (ADAMS Accession No. ML17118A003), the licensee submitted its FE for Oyster Creek. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the interim staff response letter, that: 1) a flood mechanism is bounded based on further reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is local intense precipitation. These 3 options associated with performing an FE are referred to as Path 1, 2, or 3, as described in NEI 16-05, Revision 1. The purpose of this staff assessment is to provide the results of the NRC's evaluation of the Oyster Creek FE.

3.0 TECHNICAL EVALUATION

Exelon stated that its FE followed Path 2 of NEI 16-05, Revision 1 and utilized Appendix B for guidance on evaluating the site strategy. The Oyster Creek FE addresses the LIP and PMSS (combined effects) flooding mechanisms, which were found to exceed the plant's CDB in the staff's assessment of the 2015 FHRR and supplements. Subsequently, the staff found the FHRR to be acceptable for use in the MSA. This technical evaluation will address the following topics: characterization of flood parameters; evaluation of flood impact assessments; evaluation of available physical margin; reliability of flood protection features; and overall site response.

3.1 Characterization of Flood Parameters

The associated effects (AE) and flood event duration (FED) parameters were assessed by Exelon and have already been reviewed by the NRC, as summarized by letter dated May 18, 2017 (ADAMS Accession No. ML17082A271). Exelon used the AE and FED parameters as input to the Oyster Creek FE and concluded that the site's flood strategy is effective in protecting structures, systems, and components (SSCs) that support key safety functions (key SSCs). Exelon supported its conclusion of adequate flood protection by demonstrating adequate available physical margin for LIP and storm surge (combined effects). In its MSA and FE for Oyster Creek, Exelon indicated that the site does not require additional manual actions by plant personnel to protect key SSCs; therefore, an evaluation of the overall site response was not necessary.

Table 3.1 Summary of Reevaluated Flood Hazards Elevations Included in the Oyster Creek FE.

| Flood-Causing Mechanism | Reevaluated Flood Hazard (2015) | | | Plant Design or Licensing Basis | Bounded or Not Bounded |
|--|---------------------------------|------------------------|-------------------------|---------------------------------|------------------------|
| | Stillwater Elevation | Wind-Wave Runup Height | Maximum Flood Elevation | | |
| Local Intense Precipitation mean sea level (MSL) | 24.4 feet (ft.) MSL | Minimal | 24.4 ft. MSL | 23.5 ft. MSL | NB |
| Storm Surge (Combined-Effects Flood) at: | | | | 23.0 ft. MSL | NB |
| Site Emergency Building | 22.9 ft. MSL | 3.7 ft. MSL | 26.6 ft. MSL | | |
| Turbine Building | 23.2 ft. MSL | 2.7 ft. MSL | 25.9 ft. MSL | | |
| Intake Structure | 23.2 ft. MSL | 1.4 ft. MSL | 24.6 ft. MSL | | |
| Reactor Building | 22.8 ft. MSL | 0.7 ft. MSL | 23.5 ft. MSL | | |

Flood elevations mentioned in the FE are based on a vertical datum of MSL.

3.2 Evaluation of Flood Impact Assessment for LIP

3.2.1 Description of Impact of Unbounded Hazard

The unbounded LIP hazard exceeds the threshold at two doors to the Reactor Building. Although water will ingress through Door #9 and #14, the licensee has demonstrated that the ingressed water will not affect SSCs necessary to maintain key safety features.

3.2.2 Evaluation of Available Physical Margin and Reliability of Flood Protection Features

The licensee performed a consequential and interior drainage analysis to determine the in-leakage and flood depths. The NRC audited this calculation, *Exelon Generation, OCNCS Calculation OYS-16-001 Revision 1, Consequential and Interior Flooding Analysis, dated April 7, 2017*. The licensee identified two areas (which are connected by a non-watertight double airlock door) that would be subject to water ingress. Door #9 leads to the 480 vital switchgear room. The licensee calculated that the maximum flood depth in the room would be 1.2 inches if the water equalizes between the two areas (and less if it did not). The vital switchgear itself, however, is elevated at least 2.5 inches above the finished floor elevation. Therefore, it would not be affected by the water ingress due to available physical margin.

The maximum flood depth would occur in the inner area for Door #14 if water were assumed not to flow through the airlock door into the vital switchgear room. The flood depth would be 1.7 inches. This water would then flow down staircases to the basement, where it would be stopped by installed 3 inch berms or ramps at the bottom of the staircases. Therefore, the equipment in the reactor building basement, containment spray and core spray, would not be affected by the water ingress due to available physical margin.

Furthermore, the licensee evaluated the hydrostatic and dynamic loads on Doors #9 and #14. The licensee determined that the loads from the reevaluated hazard levels were significantly bounded by the design-basis for wind load for those doors.

The NRC staff concludes, based on the information provided by Exelon, that adequate margin exists for the reevaluated LIP mechanism. The NRC staff agrees that the licensee's estimation of available physical margin is conservative. Therefore, the NRC staff concludes that the licensee has demonstrated that adequate passive features exist to provide flood protection of key SSCs.

Because increased focus has been placed on flood protection since the accident at Fukushima, licensees and NRC inspectors have identified deficiencies with equipment, procedures, and analyses relied on to either prevent or mitigate the effects of external flooding at a number of licensed facilities. Recent examples include those found in Information Notice 2015-01, "Degraded Ability to Mitigate Flooding Events" (ADAMS Accession No. ML14279A268).

In addition, the NRC is cooperatively performing research with the Electric Power Research Institute (EPRI) to develop flood protection systems guidance that focuses on flood protection feature descriptions, design criteria, inspections, and available testing methods in accordance with a memorandum of understanding dated September 28, 2016 (ADAMS Accession No. ML16223A495). The NRC staff expects that licensees will continue to maintain flood protection features in accordance with their current licensing basis. The NRC staff further expects that continued research involving flood protection systems will be performed and shared with licensees in accordance with the guidance provided in Management Directive 8.7, "Reactor Operating Experience Program" (ADAMS Accession No. ML122750292), as appropriate.

The NRC staff concludes that the Oyster Creek flood protection feature described above is reliable to maintain key safety functions as defined in Appendix B of NEI 16-05, Rev 1.

3.2.3 Overall Site Response

The licensee does not rely on any personnel actions or new modifications to the plant in order to respond to the beyond-design-basis LIP event. As described above, the licensee's evaluation relied on available physical margin; therefore, there is no need to review overall site response.

3.3 Evaluation of Flood Impact Assessment for Storm Surge

3.3.1 Description of Impact of Unbounded Hazard

The Oyster Creek FE notes that the reevaluated storm surge (combined effects) exceeds the CDB. However, of the places where it is exceeded, only the Reactor Building houses key SSCs needed to maintain key safety functions. The maximum wave run-up at the Reactor Building is equal to the finished flood elevation of 23.5 ft. MSL.

3.3.2 Evaluation of Available Physical Margin and Reliability of Flood Protection Features

The licensee relies on a passive feature, the plant grade, to justify that there is an acceptable amount of available physical margin using a deterministic approach. The maximum wave run-up is equal to the finished flood elevation of 23.5 ft. MSL, meaning there is zero available physical margin. However, the licensee deemed it adequate for several reasons, including that the maximum wave run-up occurs only intermittently and that the waves are likely to attenuate

in the approximately 300 ft. between the canal and the Reactor Building. In addition, Exelon notes that the site procedures provide for sandbags as additional defense-in-depth at certain locations.

The NRC staff concludes, based on the information provided by Exelon, that adequate margin exists for the reevaluated storm surge (combined effects) mechanism. The NRC staff agrees that the licensee's estimation of available physical margin is conservative. Therefore, the NRC staff concludes that the licensee has demonstrated that adequate passive features exist to provide flood protection of key SSCs. Plant-grade (or finish floor elevation at door entrance) is considered a reliable flood protection feature.

Because increased focus has been placed on flood protection since the accident at Fukushima, licensees and NRC inspectors have identified deficiencies with equipment, procedures, and analyses relied on to either prevent or mitigate the effects of external flooding at a number of licensed facilities. Recent examples include those found in Information Notice 2015-01, "Degraded Ability to Mitigate Flooding Events" (ADAMS Accession No. ML14279A268). In addition, the NRC is cooperatively performing research with EPRI to develop flood protection systems guidance that focuses on flood protection feature descriptions, design criteria, inspections, and available testing methods in accordance with a memorandum of understanding dated September 28, 2016 (ADAMS Accession No. ML16223A495). The NRC staff expects that licensees will continue to maintain flood protection features in accordance with their current licensing basis. The NRC staff further expects that continued research involving flood protection systems will be performed and shared with licensees in accordance with the guidance provided in Management Directive 8.7, "Reactor Operating Experience Program" (ADAMS Accession No. ML122750292), as appropriate.

The NRC staff concludes that the Oyster Creek flood protection feature described above is reliable to maintain key safety functions as defined in Appendix B of NEI 16-05, Rev 1.

3.3.3 Overall Site Response

The licensee does not rely on any personnel actions or new modifications to the plant in order to respond to the beyond-design-basis storm surge (combined effects) event. As described above, the licensee's evaluation relied on site grade to demonstrate adequate flood protection; therefore, there is no need to review overall site response.

4.0 AUDIT REPORT

The July 18, 2017, generic audit plan describes the NRC staff's intention to issue an audit report that summarizes and documents the NRC's regulatory audit of the licensee's FE. The audit consisted of the NRC staff reviewing Reference 11, *Exelon Generation, OCNCS Calculation OYS-16-001 Revision 1, Consequential and Interior Flooding Analysis, dated April 7, 2017*, through an electronic reading room. Because this staff assessment appropriately summarizes the results of the audit, the NRC staff concludes a separate audit report is not necessary, and that this document serves as the audit report described in the staff's July 18, 2017, letter.

5.0 CONCLUSION

The NRC staff concludes that Exelon performed the Oyster Creek FE in accordance with the guidance described in NEI 16-05, Revision 1, as endorsed by JLD-ISG-2016-01, and that the licensee has demonstrated that effective flood protection exists against the reevaluated flood

hazards. Furthermore, the NRC staff concludes that Oyster Creek screens out of performing an integrated assessment based on the guidance found in JLD-ISG-2016-01. As such, in accordance with Phase 2 of the process outlined in the 50.54(f) letter, additional regulatory actions associated with the reevaluated flood hazard, beyond those associated with the MSA, are not warranted. The licensee has satisfactorily completed providing responses to the 50.54(f) activities associated with the reevaluated flood hazards.

SUBJECT: OYSTER CREEK NUCLEAR GENERATING STATION - STAFF ASSESSMENT OF FLOODING FOCUSED EVALUATION (CAC NO. MF9694; EPID L-2017-JLD-0007) DATED February 21, 2018

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