



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

December 20, 2017

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

SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2 – STAFF  
ASSESSMENT OF FLOODING FOCUSED EVALUATION  
(CAC NOS. MG0090 AND MG0091; EPID L-2017-JLD-0001)

Dear Mr. Hanson:

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), "Conditions of Licenses" (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 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their 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). By letter dated March 12, 2013 (ADAMS Accession No. ML13078A010), Exelon Generation Company, LLC (the licensee) submitted its flood hazard reevaluation report (FHRR) for Calvert Cliffs Nuclear Power Plant, Units 1 and 2 (Calvert Cliffs), as supplemented by letters dated February 10, 2014, March 7, 2014, and September 23, 2015 (ADAMS Accession Nos. ML14052A052, ML14162A261, and ML15272A311, respectively.)

By letter dated April 16, 2015 (ADAMS Accession No. ML15077A103), the NRC issued a staff assessment of the licensee's FHRR for Calvert Cliffs. The NRC issued a supplement to that staff assessment by letter dated October 21, 2015 (ADAMS Accession No. ML15281A218). The letter provided the reevaluated flood hazards that exceeded the current design basis (CDB) for Calvert Cliffs and were suitable inputs for the mitigating strategies assessment (MSA) (i.e., defines the mitigating strategies flood hazard information described in Nuclear Energy Institute (NEI) guidance document NEI 12-06). As stated in the letter, because the local intense precipitation (LIP) and probable maximum storm surge (PMSS) flood-causing mechanisms at Calvert Cliffs are not bounded by the plant's CDB, additional assessments of the flood hazard mechanisms are necessary.

By letter dated September 23, 2015 (ADAMS Accession No. ML15272A311), the licensee submitted an amendment to the 2013 FHRR for Calvert Cliffs. The licensee revised its

reevaluations for LIP and storm surge, such that storm surge was now bounded by the CDB, by using a site-specific probable maximum precipitation for LIP and refined hydrodynamic modeling for storm surge. The NRC provided their review of the refined reevaluated hazard in its response to the licensee's MSA for flooding, which was issued by letter dated December 20, 2017 (ADAMS Accession No. ML17324B369). The NRC staff agreed with the licensee that the only remaining flood hazard mechanism not fully bounded by the CDB is LIP.

By letter dated January 5, 2017 (ADAMS Accession No. ML17006A158), the licensee submitted the focused evaluation (FE) for Calvert Cliffs. 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 Calvert Cliffs FE.

As set forth in the attached staff assessment, the NRC staff has concluded that the Calvert Cliffs 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 flood mechanism during a beyond-design-basis external flooding event at Calvert Cliffs. This closes out the licensee's response for Calvert Cliffs for the reevaluated flooding hazard portion of the 50.54(f) letter and the NRC's efforts associated with CAC Nos. MG0090 and MFG0091.

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

Sincerely,



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

Docket Nos. 50-317 and 50-318

Enclosure:  
Staff Assessment Related to the Flooding  
Focused Evaluation for Calvert Cliffs

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION  
RELATED TO THE FOCUSED EVALUATION FOR  
CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2  
AS A RESULT OF THE REEVALUATED FLOODING HAZARD NEAR-TERM TASK FORCE  
RECOMMENDATION 2.1 - FLOODING  
(CAC NOS. MG0090 AND MG0091)

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, the NRC staff issued COMSECY-15-0019, describing the closure plan for the reevaluation of flooding hazards for operating nuclear power plants (ADAMS Accession No. ML15153A104). 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 acceptable methods for demonstrating that Calvert Cliffs Nuclear Power Plant, Units 1 and 2 (Calvert Cliffs) 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 mitigation strategies assessment (MSA); and 3) the focused evaluation.

### Flood Hazard Reevaluation Report

By letter dated March 12, 2013 (ADAMS Accession No. ML13078A010), Exelon Generation Company, LLC (Exelon, the licensee) submitted its FHRR for Calvert Cliffs. The licensee supplemented its FHRR by letters dated February 10, 2014, and March 7, 2014 (ADAMS Accession Nos. ML14052A052 and ML14162A261, respectively). After reviewing the licensee’s response, the NRC staff issued a staff assessment of the FHRR by letter dated April 16, 2015 (ADAMS Accession No. ML15077A103). The NRC staff issued a supplement to that staff assessment by letter dated October 21, 2015 (ADAMS Accession No. ML15281A218). As stated in the staff assessment and supplement, because the local intense precipitation (LIP) and probable maximum storm surge (PMSS) flood-causing mechanisms at Calvert Cliff are not bounded by the plant’s CDB, additional assessments of the flood hazard mechanisms are necessary.

After the staff assessment was issued, the licensee submitted additional information. By letter dated September 23, 2015 (ADAMS Accession No. ML15272A311), the licensee provided an amended FHRR that took into account a site-specific metrological study for LIP and refined hydrodynamic modeling for storm surge. By letter dated October 4, 2016 (ADAMS Accession No. ML16278A530), the licensee submitted supplemental information about associated effects (AEs) and flood event duration (FED) parameters for multiple Exelon sites, including Calvert Cliffs. The NRC staff reviewed both of these submittals as part of its review of the MSA for flooding.

### Mitigation Strategies Assessment

By letter dated November 9, 2016 (ADAMS Accession No. ML16314A017) Exelon submitted the MSA for Calvert Cliffs 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 December 20, 2017 (ADAMS Accession No. ML17324B369), the NRC issued its assessment of the Calvert Cliffs MSA. The NRC staff concluded that the Calvert Cliffs 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 reasonably protected from reevaluated flood hazards conditions for beyond-design-basis external events. Furthermore, the NRC staff concluded that the 2015 amended FHRR is acceptable and that the amended PMSS is now bounded by the CDB. The LIP remains unbounded. The NRC staff also found it acceptable to no longer perform the interim actions described in the 2013 FHRR.

### Focused Evaluation

By letter dated January 5, 2017 (ADAMS Accession No. ML17006A158), the licensee submitted its FE for Calvert Cliffs. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the supplement to the staff assessment, 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 Calvert Cliffs FE.

## 3.0 TECHNICAL EVALUATION

Exelon stated that its FE followed Paths 1 and 2 of NEI 16-05, Revision 1 and utilized Appendices A and B for guidance on evaluating the site strategy. The Calvert Cliffs FE addresses the PMSS and LIP flooding mechanisms, which were found to exceed the plant's CDB in the staff's assessment of the 2013 FHRR. Subsequently, the staff found the 2015, amended FHRR to be acceptable for use in the MSA. Based on the 2015 FHRR, PMSS is bounded by the CDB. 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 AE and FED parameters were assessed by Exelon and have already been reviewed by the NRC, as summarized by letter dated December 20, 2017 (ADAMS Accession No. ML17324B369). Exelon used the AE and FED parameters as input to the Calvert Cliffs 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 and reliable flood protection features for LIP. In its MSA and FE for Calvert Cliffs, 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.

The Calvert Cliffs power block finished floor elevation is 45.0 feet (ft.) mean sea level (MSL). For the LIP mechanism, the stillwater elevation is not bounded by the Calvert Cliffs CDB; however, it does not exceed plant grade. The potential impacts from this flooding-causing mechanism were further evaluated by Exelon as part of the Calvert Cliffs FE.

Table 3.1 Summary of Reevaluated Flood Hazards Elevations Included in the Calvert Cliffs FE.

Flood-Causing Mechanism	Amended Reevaluated Flood Hazard (2015)			Plant Design or Licensing Basis	Bounded or Not Bounded
	Stillwater Elevation	Wind-Wave Runup Height	Maximum Flood Elevation		
Storm Surge (Combined-Effects Flood) (NGVD-29)	15.5 ft.	11.3 ft.	26.8 ft.	28.1 ft.	B
Local Intense Precipitation (MSL)	43.6 – 44.9 ft.	Minimal	43.6 – 44.9 ft.	44.81 ft.	NB

Flood elevations mentioned in the FE are based on a mixed vertical datum of MSL and National Geodetic Vertical Datum of 1929 (NGVD29), which is 0.64 ft. higher than the MSL value. This assessment preserves the licensee’s use of NGVD29 for storm surge and MSL for LIP.

In its cover letter for the FE, the licensee notes that the commitments that were made in the 2013 FHRR are no longer required and are being discontinued. The NRC staff agrees, as discussed in the letter dated December 20, 2017 (ADAMS Accession No. ML17324B369).

### 3.2 Evaluation of Flood Impact Assessment for Storm Surge

As discussed in the NRC’s letter dated December 20, 2017 (ADAMS Accession No. ML17324B369), the amended reevaluated flood hazard for storm surge is bounded by the CDB. Therefore, further evaluation was not required.

### 3.3 Evaluation of Flood Impact Assessment for LIP

#### 3.3.1 Description of Impact of Unbounded Hazard

The Calvert Cliffs FE noted that the CDB only addresses LIP at certain buildings (Emergency Diesel Generator and Station Blackout Buildings), and, at those buildings, the amended reevaluated hazard is bound. At the remaining locations for which LIP was analyzed, the water is lower than the plant grade elevation (or finish floor elevation at door entrance) of 45.0 ft. (MSL). These include the South Service Building, the Turbine Building, the Auxiliary Building, and the Diesel Generator Building.

#### 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 available margin using a deterministic approach. The minimum protection level is 45.0 ft. MSL, and the corresponding available physical margin to the plant grade varies from 1.86 ft. to 0.14 ft. The licensee did not consider ground infiltration and assumed that the site drainage system is non-functional. Furthermore, the door openings to structures containing SSCs have a 6-inch curb which was not included in the calculated available physical margin.

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. 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 the Electric Power Research Institute 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 Calvert Cliffs 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 BDB LIP 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 asking for clarification of the phrase "freeboard above entrance floor elevation" in Table 10 of the FE. The licensee confirmed that numbers given are the distance between the flood level and the entrance floor elevation, which is higher than the flood level in all cases. The licensee also noted a typo in the same table; the freeboard to the entrance floor elevation at the turbine building should be 0.36 ft. rather than 1.36 ft. 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 Calvert Cliffs 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 Calvert Cliffs 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: CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2 – STAFF ASSESSMENT OF FLOODING FOCUSED EVALUATION DATED December 20, 2017

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