Exelon Generation.

RS-17-005 10 CFR 50.54(f)

March 17, 2017

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Peach Bottom Atomic Power Station, Units 2 and 3
Renewed Facility Operating License Nos. DPR-44 and DPR-56
NRC Docket Nos. 50-277 and 50-278

Subject: Exelon Generation Company, LLC Response to March 12, 2012, Request for Information Enclosure 2, Recommendation 2.1, Flooding, Required Response 3, Flooding Focused Evaluation Summary Submittal

References:

1. NRC Letter, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident; dated March 12, 2012

2. Exelon Generation Company, LLC Letter to USNRC, Response to March 12, 2012 Request for Information Enclosure 2, Recommendation 2.1, Flooding, Required Response 2, Flooding Hazard Reevaluation Report, dated August 12, 2015 (RS-15-163)

3. Exelon Generation Company, LLC Letter to USNRC, Supplemental Response to NRC Audit Review Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report, dated April 4, 2016 (RS-16-066)

4. Exelon Generation Company, LLC Letter to USNRC, Response to Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report, dated October 4, 2016 (RS-16-186)

5. NRC Letter, Supplemental Information Related to Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Flooding Hazard Reevaluations for Recommendation 2.1 of the Near Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated March 1, 2013

6. NRC Staff Requirements Memoranda to COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards", dated March 30, 2015

7. NRC Letter, Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events, dated September 1, 2015

8. Nuclear Energy Institute (NEI) Report, NEI 16-05, Revision 1, External Flooding Assessment Guidelines, dated June 2016

9. U.S. Nuclear Regulatory Commission, JLD-ISG-2016-01, Revision 0, Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation; Focused Evaluation and Integrated Assessment, dated July 11, 2016

10. NRC Letter, Peach Bottom Atomic Power Station, Units 2 and 3 – Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation (CAC Nos. MF6598 and MF6599), dated March 31, 2016

On March 12, 2012, the NRC issued Reference 1 to request information associated with Near-Term Task Force (NTTF) Recommendation 2.1 for Flooding. One of the Required Responses in Reference 1 directed licensees to submit a Flood Hazard Reevaluation Report (FHRR). For Peach Bottom Atomic Power Station, Units 2 and 3 the FHRR was submitted on August 12, 2015 (Reference 2). Additional information was provided with References 3 and 4. Per Reference 5, the NRC considers the reevaluated flood hazard to be "beyond the current design/licensing basis of operating plants".

Following the Commission's directive to NRC Staff (Reference 6), the NRC issued a letter to industry (Reference 7) indicating that new guidance is being prepared to replace instructions (Reference 6), and provide for a "graded approach to flooding reevaluations" and "more focused evaluations of local intense precipitation and available physical margin in lieu of proceeding to an integrated assessment".

The Nuclear Energy Institute (NEI) prepared NEI 16-05, "External Flooding Assessment Guidelines" (Reference 8). The NRC endorsed NEI 16-05 (Reference 9) and recommended changes, which have been incorporated into NEI 16-05, Revision 1. NEI 16-05 indicates that each flood-causing mechanism not bounded by the Design Basis (DB) flood (using only stillwater and/or wind-wave runup levels) should follow one of the following five assessment paths:

- Path 1: Demonstrate Flood Mechanism is Bounded Through Improved Realism
- Path 2: Demonstrate Effective Flood Protection
- Path 3: Demonstrate a Feasible Response to LIP
- Path 4: Demonstrate Effective Mitigation
- Path 5: Scenario Based Approach

Non-bounded flood-causing mechanisms in Paths 1, 2, or 3 would only require a Focused Evaluation to complete the actions related to external flooding required by the March 12, 2012 10 CFR 50.54(f) letter. Mechanisms in Paths 4 or 5 require an Integrated Assessment.

The enclosure to this letter provides the Flooding Focused Evaluation Summary Report for the Peach Bottom Atomic Power Station, Units 2 and 3.

The flooding analysis documented in Reference 10 (NRC MSFHI letter) was utilized as input to this Flooding Focused Evaluation. The Flooding Focused Evaluation reaffirms that the Peach Bottom Atomic Power Station site has reliable, passive protection of Key Structures, Systems, and Components (Key SSCs) to maintain Key Safety Functions (KSFs). For the storm surge, seiche, ice-induced, and LIP floods, passive protection features are solely relied upon to maintain KSFs. The Peach Bottom Atomic Power Station site does not require human actions to protect Key SSCs so an evaluation of the overall site response is not necessary.

The Flooding Focused Evaluation follows Path 2 of NEI 16-05, Revision 1 (Reference 8), and utilized Appendix B for guidance on evaluating the site protection features. This submittal completes the actions related to external flooding required by the March 12, 2012 10 CFR 50.54(f) letter.

This letter contains no new regulatory commitments. If you have any questions regarding this report, please contact David J. Distel at (610) 765-5517.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 17th day of March 2017.

Respectfully submitted,

D. P. Helker

David P. Helker
Manager - Licensing & Regulatory Affairs
Exelon Generation Company, LLC

Enclosure: Peach Bottom Atomic Power Station, Units 2 and 3, Flooding Focused Evaluation Summary, dated March 17, 2017

cc: Director, Office of Nuclear Reactor Regulation
NRC Regional Administrator - Region I
NRC Senior Resident Inspector – Peach Bottom Atomic Power Station
NRC Project Manager, NRR – Peach Bottom Atomic Power Station
Ms. Tekia Govan, NRR/JLD/JHMB, NRC
Director, Bureau of Radiation Protection – Pennsylvania Department of Environmental Resources
S. T. Gray, State of Maryland
R. R. Janati, Chief, Division of Nuclear Safety, Pennsylvania Department of Environmental Protection, Bureau of Radiation Protection

Enclosure

Peach Bottom Atomic Power Station, Units 2 and 3

Flooding Focused Evaluation Summary

dated March 17, 2017

(25 Pages)

Exelon Generation

THE PEACH BOTTOM ATOMIC POWER STATION FLOODING FOCUSED EVALUATION SUMMARY

MARCH 17, 2017

RS-17-005

ENCLOSURE

TABLE OF CONTENTS

THE PEACH BOTTOM ATOMIC POWER STATION FLOODING FOCUSED EVALUATION SUMMARY

1 EXECUTIVE SUMMARY

The Peach Bottom Atomic Power Station (PBAPS) has reevaluated its flooding hazard in accordance with the NRC's March 12, 2012, 10 CFR 50.54(f) Request for Information (RFI). The RFI was issued as part of implementing lessons learned from the Fukushima Dai-ichi accident; specifically, to address Recommendation 2.1 of the NRC's Near-Term Task Force report. This information was submitted to NRC in a Flood Hazard Reevaluation Report (FHRR) on August 12, 2015 and is provided in the Mitigating Strategies Flood Hazard Information (MSFHI) documented in NRC's "Interim Staff Response to Reevaluated Flood Hazards" letter dated March 31, 2016. No changes to the flooding analysis have been performed since the issuance of the MSFHI letter and this flooding analysis will serve as the input to this Focused Evaluation (FE). There are four (4) mechanisms that were not addressed, and therefore not bounded by, the PBAPS Design Basis. The FE concludes that during preparation of the FHRR, detailed analyses were developed for these mechanisms to determine flood elevations. These mechanisms are listed below and included in this FE:

- Storm Surge
- Seiche
- Ice Induced Flooding
- Local Intense Precipitation (LIP)

Re-evaluated storm surge, seiche, and ice-induced flooding elevations are below grade and there is no impact to the plant or any Key Safety Function (KSF). Parameters are not being revised as part of the Flooding Impact Assessment Process. Further development of these parameters is not required.

The FE reaffirms that the site has reliable, passive protection of Key Structures, Systems, and Components (Key SSCs) to maintain KSFs. The site does not require human actions to protect Key SSCs so an evaluation of the overall site response is not necessary. This FE follows Path 2 of NEI 16-05, Rev. 1 and utilized Appendix B for guidance on evaluating the site protection features. This submittal completes the actions related to external flooding required by the March 12, 2012 10 CFR 50.54(f) letter.

2 BACKGROUND

On March 12, 2012, the NRC requested information associated with Near-Term Task Force (NTTF) Recommendation 2.1 for flooding. The RFI (Reference 1) directed licensees, in part, to submit a FHRR to reevaluate the flood hazards for their sites using present-day methods and guidance used for early site permits and combined operating licenses. For PBAPS, Units 2 and 3, the FHRR was submitted on August 12, 2015 (Reference 2). Additionally, follow-up information was provided (References 3, 4, and 5).

Following the Commission's directive to NRC Staff (Reference 6), the NRC issued a letter to industry (Reference 7) indicating that new guidance is being prepared to replace instructions (Reference 6) and provide for a "graded approach to flooding reevaluations" and "more focused evaluations of local intense precipitation and available physical margin in lieu of proceeding to an integrated assessment". The Nuclear Energy Institute (NEI) prepared the new "External Flooding Assessment Guidelines" in NEI 16-05 (Reference 10). The NRC endorsed 16-05 (Reference 11) and recommended changes, which have been incorporated into 16-05 revision 1. NEI 16-05 indicates that each flood-causing mechanism not bounded by the Design Basis (DB) flood (using only stillwater and/or wind-wave runup level) should follow one of the following five assessment paths:

- Path 1: Demonstrate Flood Mechanism is Bounded Through Improved Realism
- Path 2: Demonstrate Effective Flood Protection
- Path 3: Demonstrate a Feasible Response to LIP
- Path 4: Demonstrate Effective Mitigation
- Path 5: Scenario Based Approach

Non-bounded flood-causing mechanisms in Paths 1, 2, or 3 would only require an FE to complete the actions related to external flooding required by the March 12, 2012 10 CFR 50.54(f) letter. Mechanisms in Paths 4 or 5 require an Integrated Assessment.

3 REFERENCES

1. NRC Letter, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated March 12, 2012.
2. Exelon Generation Company, LLC Letter to USNRC, Response to March 12, 2012 Request for Information Enclosure 2, Recommendation 2.1, Flooding, Required Response 2, Flooding Hazard Reevaluation Report, dated August 12, 2015 (RS-15-163).
3. Exelon Generation Company, LLC Letter to USNRC, Supplemental Response to NRC Audit Review Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report, dated April 4, 2016 (RS-16-066).
4. Exelon Generation Company, LLC Letter to USNRC, Mitigating Strategies Flood Hazard Assessment (MSFHA) Submittal, dated June 30, 2016 (RS-16-103).
5. Exelon Generation Company, LLC Letter to USNRC, Response to Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report, dated October 4, 2016 (RS-16-186).
6. NRC Staff Requirements Memoranda to COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards", dated March 30, 2015.
7. NRC Letter, Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events, dated September 1, 2015.
8. U.S. Nuclear Regulatory Commission, JLD-ISG-2012-01, Revision 1, Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events, dated January 22, 2016.
9. NRC Letter, Peach Bottom Atomic Power Station, Units 2 and 3 – Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation (CAC NOS. MF6598 and MF6599), dated March 31, 2016.
10. Nuclear Energy Institute (NEI), Report NEI 16-05 [Rev 1], External Flooding Assessment Guidelines, dated June 2016.
11. NRC JLD-ISG-2016-01, Guidance for Activities Related to Near-Term Task Force Recommendation; Focused Evaluation and Integrated Assessment.
12. NUREG/CR-7046 Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United States of America dated November 2011.
13. Technical Evaluation 2522427-03, Assessment of LIP, dated 08/05/2015.

14. Exelon Generation Company, LLC Letter to USNRC, 180-day Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Flooding Aspects of Recommendation 2.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident – Flooding Walkdown Report, dated November 27, 2012 (RS-12-174).
15. TRIP Procedure T-103 sheet 1, revision 21, Secondary Containment Control.
16. PB DWG M-520 (M-553), Plumbing and Drainage Reactor Building Plan Unit 2 (Unit 3) at Elevation 135 feet.
17. PEAS-FLOOD-10, revision 0, BDBEE – Flood Re-Evaluation – Seiche and Surge Analysis.
18. PB Procedure SE-4, revision 41, Flood – Procedure.
19. PB Procedure OP-PB-111-1001 revision 16, Preparation for Severe Weather.
20. PB Drawing C-67-F-2 Sheet 1, revision 0, Dredging Intake and Discharge Basins.
21. Passport issue 2711402 assignment 03, Determine in-leakage into the Emergency Pump Structure.
22. PEAS-FLOOD-06, revision 0, BDBEE – Flood Re-Evaluation – HEC-RAS Model of Susquehanna River Development and Calibration.

4 TERMS AND DEFINITIONS

APM – Available Physical Margin
C.D. – Conowingo Datum (= NAVD88 + 0.13 feet)
DB – Design Basis
ECT – Emergency Cooling Tower
EDG – Emergency Diesel Generator
FE – Focused Evaluation
FHRR – Flood Hazard Reevaluation Report
FIAP – Flood Impact Assessment Process
FLEX – Diverse and flexible coping strategies covered by NRC order EA-12-049
HEC-RAS - Hydrologic Engineering Center's River Analysis System
HPCI – High Pressure Coolant Injection (System)
Key SSC – System, Structure, or Component relied upon to fulfill a Key Safety Function
KSF – Key Safety Function - core cooling, spent fuel pool cooling, or containment
LIP – Local Intense Precipitation
MSA – Mitigating Strategies Assessment as described in NEI 12-06 Rev 2, App G
MSFHI – Mitigating Strategies Flood Hazard Information
NAVD88 – North American Vertical Datum of 1988 (= C.D. - 0.13 feet)
NEI – The Nuclear Energy Institute
NRC – Nuclear Regulatory Commission
NTTF – Near Term Task Force commissioned by the NRC to recommend actions following the Fukushima Dai-ichi accidents
PBAPS – Peach Bottom Atomic Power Station
RB – Reactor Building
RFI – Request for Information
RHR – Residual Heat Removal (System)
SC – Secondary Containment
TRIP - Transient Response Implementation Plan (Procedure)
U2 – Unit 2
U3 – Unit 3

5 FLOOD HAZARD PARAMETERS FOR UNBOUNDED MECHANISMS

The NRC has completed the "Interim Staff Response to Reevaluated Flood Hazards", which contains the MSFHI related to the PBAPS's FHRR (Reference 9). The NRC states that the "staff has concluded that the licensee's reevaluated flood hazards information, as summarized in the Enclosure, is suitable for the assessment of mitigation strategies developed in response to Order EA-12-049 (i.e., defines the mitigating strategies flood hazard information described in Nuclear Energy Institute (NEI) guidance document NEI 12-06, 'Diverse and Flexible Coping Strategies (FLEX) Implementation Guide') for Peach Bottom. Further, the NRC staff has concluded that the licensee's reevaluated flood hazard information is suitable input for other assessments associated with Near-Term Task Force Recommendation 2.1 'Flooding.'"

The Interim Staff Response enclosure includes a summary of the current DB and reevaluated flood hazard parameters. In Table 1 of the enclosure, the NRC lists the following flood-causing mechanisms for the DB flood:

- Local Intense Precipitation
- Streams and Rivers
- Failure of Dams and Onsite Water Control/Storage Structures
- Storm Surge
- Seiche
- Tsunami
- Ice Induced Flooding
- Channel Migrations/Diversions

In Table 2 of the enclosure, the NRC lists flood hazard information (specifically stillwater elevation and wind-wave runup elevation) for the following flood-causing mechanisms that are not addressed in, and therefore not bounded by, the PBAPS DB hazard flood level:

- Storm Surge
- Seiche
- Ice-Induced Flooding
- Local Intense Precipitation

These are the reevaluated flood-causing mechanisms that were addressed in the external flooding assessment. The non-bounding flood mechanisms for PBAPS are described in detail in the FHRR and Mitigating Strategy Assessment (MSA) submittals. The following summarizes how each of these unbounded mechanisms was addressed in this external flooding assessment:

Table 1 – Summary of Flood Impact Assessment

Flood mechanism	Summary of assessment
Storm Surge	The Flooding Impact Assessment Process (FIAP) Path 2 was determined to be the appropriate path since site grade bounds this mechanism and protects Key SSCs. See FIAP Path Determination Table, Section 6.3.3 of NEI 16-05. Available Physical Margin (APM) can be demonstrated to be adequate to protect Key SSCs and maintain KSF's. Parameters are not being revised as part of the FIAP.
Seiche	FIAP Path 2 was determined to be the appropriate path since site grade bounds this mechanism and protects Key SSCs. See FIAP Path Determination Table, Section 6.3.3 of NEI 16-05. APM can be demonstrated to be adequate to protect Key SSCs and maintain KSF's. Parameters are not being revised as part of the FIAP.
Ice-Induced Flooding	FIAP Path 2 was determined to be the appropriate path since site grade bounds this mechanism and protects Key SSCs. See FIAP Path Determination Table, Section 6.3.3 of NEI 16-05. APM can be demonstrated to be adequate to protect Key SSCs and maintain KSF's. Parameters are not being revised as part of the FIAP.
Local Intense Precipitation	FIAP Path 2 was determined to be the appropriate path since, while minor ingress does occur, no actions are taken and passive, permanent protection features can be demonstrated to protect Key SSCs. See FIAP Path Determination Table, Section 6.3.3 of NEI 16-05. APM can be demonstrated to be adequate to protect Key SSCs and maintain KSF's. Parameters are not being revised as part of the FIAP.

6 OVERALL SITE FLOODING RESPONSE

6.1 DESCRIPTION OF OVERALL SITE FLOODING RESPONSE

In this FE the elevations are referenced to the North American Vertical Datum of 1988 (NAVD88) for consistency with the FHRR, unless otherwise noted. NAVD88 is 0.13 feet lower than Conowingo Datum (C.D.).

The finished grade at the plant has been established at 115.87 feet. Grade slopes up around the south and north sides of the Reactor Buildings (RBs) to 134.87 feet west of the RBs. The normal elevation of Conowingo Pond, which is the section of the Susquehanna River adjacent to and east of PBAPS, is between 104 feet and 109.1 feet.

The distance from the Conowingo Pond shore to the plant protected area is more than 400 feet (Reference 20). The Conowingo Pond shore is protected with riprap revetment, topped by a paved roadway at approximate elevation 115.87. At the shore is a non-safety related Outer Screen Structure, which screens the river water prior to its entrance into the east-west running intake basins. On the west side of the intake basins lie the rock-lined boundary of the plant protected area and a non-safety related Inner Screen Structure. These features can be seen in FHRR Figures 3.1.2.3.1 and 3.1.3.1.

The shore and Outer Screen Structure isolate the intake basins from potential wind-generated waves in the Conowingo Pond. Any wind generated waves originating in the intake basins would be much smaller due to their relatively shorter fetch lengths, and would be not impact any Key SSCs due to protection by the rock-lined, plant protected area boundary and Inner Screen Structure.

PBAPS plant protected area encompasses two operating units: Unit 2 (U2) and Unit 3 (U3). The PBAPS key systems and components are housed in safety-related structures, including the Emergency Cooling Tower (ECT), the Emergency Diesel Generator (EDG) Building, the Emergency Pump Structure, and the RBs. All of these structures have DB passive, permanent external-flood barriers up to at least 134.87 feet for protection against postulated external flood stillwater and wave runup. The primary features protecting Key SSCs from the external-flood mechanisms are passive, permanent features including site elevations and topography; concrete structures (walls and floors); penetration seals in walls and floors; and watertight doors. Each penetration seal is designed for a differential water pressure of 134.87 feet minus the seal elevation, for the DB river flood. The DB river flood height and duration bounds the re-evaluated river flood, as well as the mechanisms described in this FE.

Storm Surge Flooding:
Storm surge flooding is not addressed in, and therefore not bounded by, the PBAPS DB. Re-evaluated storm surge flood elevation is the below grade, excluding wind-wave runup that dissipates at the river shore, and there is no impact to the plant or any KSF. Parameters are not being revised as part of the FIAP. Further development of this parameter is not required.

Seiche Flooding:
Seiche flooding is not addressed in, and therefore not bounded by, the PBAPS DB. Re-evaluated seiche flood elevation is below grade and there is no impact to the plant or any KSF. Parameters are not being revised as part of the FIAP. Further development of this parameter is not required.

Ice Induced Flooding:
Ice-induced flooding is not addressed in, and therefore not bounded by, the PBAPS DB. Re-evaluated ice-induced flood elevation is below grade and there is no impact to the plant or any KSF. Parameters are not being revised as part of the FIAP. Further development of this parameter is not required.

LIP Flooding:
LIP flooding is not addressed in, and therefore not bounded by, the PBAPS DB. Re-evaluated LIP flood elevation is below the level of passive, permanent protection for the ECT, EDG Building, and Emergency Pump Structure, and there is no impact to the plant or any KSF. In addition to the credited passive protection, the ECT, EDG Building, and Emergency Pump Structure all have sump pumps with redundant power supplies backed by the EDGs. . The pumps automatically start based on sump level and require no operator actions to be placed in service. Functional tests are performed regularly on these sump pumps.

The RBs were determined to be potentially impacted because of their protection level relative to the modeled LIP runoff. As indicated previously, the nominal plant grade west of the RBs is 134.87 feet, same elevation as the passive, permanent external-flood barriers. The RBs are reliably protected by passive, permanent, external-flood barriers; with the exception of three (3) RB doors on each unit. Potential LIP in-leakage into the RBs via these doors is evaluated by technical evaluation, which is described in Section 7.4.1. The technical evaluation concluded that potential LIP in-leakage would not accumulate to a depth that would adversely impact equipment operation, and would not result in consequential impacts to any Key SSCs.

Table 2 – Flood Hazard Elevations for PBAPS

Mechanism	DB	Reevaluated flood height (feet)	Protection level (feet)
Storm Surge	Not included	110.2, consisting of: Antecedent: 109.1 Wind Setup: 1.1 [1]	115.9
Seiche	Not included	110.2, consisting of: Antecedent: 109.1 Seiche Height: 1.1 [2]	115.9
Ice-Induced Flooding	Not included	Maximum stillwater: 111.5 Maximum wave run-up: n/a	115.9
LIP – ECT	Not included	Maximum stillwater: 127.0 Maximum wave run-up: minimal	137.4
LIP – EDG Building (SW Corner)	Not included	Maximum stillwater: 132.0 Maximum wave run-up: minimal	137.4
LIP – Emergency Pump Structure	Not included	Maximum stillwater: 117.5 Maximum wave run-up: minimal	137.4

[1] See Section 3.4.2.1 of Reference 2, Enclosure 1, and Reference 17 Table 7.19
[2] See Table 3.4.3.2.4 of Reference 2, Enclosure 1, and Reference 17 Table 8.1

Table 3 – LIP Flood Hazard Elevations for PBAPS RB Doors

Mechanism	DB	Reevaluated flood height (feet)	Protection level (feet)
LIP – U3 RB Door 246	Not included	Maximum stillwater: 135.17 Maximum wave run-up: minimal	134.87
LIP – U3 RB Door 244	Not included	Maximum stillwater: 135.43 Maximum wave run-up: minimal	134.87
LIP – U3 RB Door 239	Not included	Maximum stillwater: 135.91 Maximum wave run-up: minimal	134.87
LIP – U2 RB Door 183	Not included	Maximum stillwater: 135.53 Maximum wave run-up: minimal	134.87
LIP – U2 RB Door 198	Not included	Maximum stillwater: 135.23 Maximum wave run-up: minimal	134.87
LIP – U2 RB Door 188	Not included	Maximum stillwater: 135.85 Maximum wave run-up: minimal	134.87

6.2 Summary of Plant Modifications and Changes

There have been no necessary actions to implement the flood strategy described, and there are no remaining necessary actions. There have been no plant modifications, procedural changes or procurement activities, and none remaining.

7 FLOOD IMPACT ASSESSMENT

7.1 STORM SURGE

7.1.1 Description of Storm Surge Flood Impact

The storm surge flood is not addressed in, and therefore not bounded by, the PBAPS DB. The primary feature protecting the site from the re-evaluated storm surge flood mechanism is 'site topography and grading'. This is the only feature that is potentially challenged by the storm surge flood, which is below grade. Table 4 provides the reevaluated flood heights and the APM for the storm surge flood mechanism. Maximum stillwater is the combination of Antecedent and Wind Setup (Reference 17 Figure 6.1), or 110.2 feet. Wave Setup and Wave Runup are not included because they dissipate at the river shore, which is greater than 400 feet away from the plant protected area, as documented in Section 6.1.

The Storm Surge reevaluated flood height in Table 4 includes the maximum Antecedent Level and Wind Setup. It does not include Wave Setup (1.1 feet) and Wave Runup (7.2 feet) because these effects dissipate at the Conowingo Pond shoreline and do not impact the PBAPS protected area. If one were to include the dissipated Wave Setup and Wave Runup (total elevation = 118.5 feet) and compare to passive, permanent features (134.87 feet), the resulting APM would be 16.4 feet. The more conservative, lower APM method of comparison was chosen by engineering judgment because it would more accurately reflect the physical phenomena of this mechanism in relation to site protected area.

Table 4 – Storm Surge APM

Mechanism	Reevaluated flood height (feet)	Passive protection (feet)	APM (feet)
Storm Surge	110.2, consisting of: Antecedent: 109.1 Wind Setup: 1.1 [1]	115.9	5.7

[1] See Table 2 footnotes.

7.1.2 Adequate APM Justification and Reliability Flood Protection

The site grade and topography, with a nominal grade elevation of 115.87 feet, is reliable in protecting the plant from the reevaluated storm surge flood. The APM was determined to be adequate with the following justifications:

- The reevaluated level includes Wind Setup that was determined in the Conowingo Pond. The plant protected area is separated from Conowingo Pond by an intake basin that has a much shorter fetch length. Therefore, Wind Setup would smaller and the referenced value is conservative.
- The APM is judged to be well within the natural and modeling uncertainties and input parameter sensitivities for the surge calculation.
- The storm surge analysis included the following conservative inputs in developing the maximum flood elevation:
  - Antecedent water level for Conowingo Pond was assumed to be 109.1 feet, which is the maximum controlled water elevation.
  - Overwater wind speed equal to 100 mph is selected conservatively from the guidance outlined in ANSI/ANS-2.8-1992.

The associated effects due to the storm surge flood mechanism were determined to have no impact on the site because the maximum water elevation does not reach the site grade. All flood event duration parameters, including warning time, period of site preparation, period of inundation, and period of recession, are not applicable because the protection features are passive and permanent, requiring no manual actions.

7.1.3 Adequate Overall Site Response

This section applies only when manual actions are required to implement the protection strategy. No manual actions are required to implement the protection strategy and it is unlikely the station would perform any manual actions as a result of this mechanism.

The station would enter Special Event procedure SE-4, Flooding (Reference 18) if river elevation is 111 feet and flow is greater than 600,000 cubic feet per second and predicted to rise. The elevation criterion is not expected to be met for this mechanism, even using conservative antecedent and wind setup values. The flow criterion would not be met for this mechanism. An input to this mechanism is a wind speed equal to 100 mph. PB utilizes procedure OP-PB-108-1001, Preparation for Severe Weather (Reference 19), in the event the station is expected to be impacted by 'severe storms with winds in excess of 40 mph'. The station will utilize procedural guidance to take appropriate actions in response to potential flood and severe weather events.

7.2 SEICHE

7.2.1 Description of Seiche Flood Impact

The seiche flood is not addressed in, and therefore not bounded by, the PBAPS DB. The primary feature protecting the site from the re-evaluated seiche flood is 'site topography and grading'. This is the only feature that is potentially challenged by the seiche flood, which is below grade. Table 5 provides the reevaluated flood heights and the APM for the seiche flood mechanism. Maximum stillwater is the combination of Antecedent and Seiche Height, or 110.2 feet. Wave Setup and Wave Runup are not included because they dissipate at the river shore, which is greater than 400 feet away from the plant protected area, as documented in Section 6.1.

The Seiche reevaluated flood height in Table 5 includes the maximum Antecedent Level and Seiche Height. It does not include Wave Setup (.3 feet) and Wave Runup (2.3 feet) because these effects dissipate at the Conowingo Pond shoreline and do not impact the PBAPS protected area. If one were to include the dissipated Wave Setup and Wave Runup (total height = 112.8 feet) and compare to passive, permanent features (134.87 feet), the resulting APM would be 22.1 feet. The more conservative, lower APM method of comparison was chosen by engineering judgment because it would more accurately reflect the physical phenomena of this mechanism in relation to site protected area.

Table 5 – Seiche APM

Mechanism	Reevaluated flood height (feet)	Passive protection (feet)	APM (feet)
Seiche	110.2, consisting of: Antecedent: 109.1 Seiche Height: 1.1 1	115.9	5.7

[1] See Table 2 footnotes.

7.2.2 Adequate APM Justification and Reliability Flood Protection

The site grade and topography, with a nominal grade elevation of 115.87 feet, is reliable in protecting the plant from the reevaluated seiche flood. The APM was determined to be adequate, with the following justifications:

- The reevaluated level includes Seiche Height that was determined in the Conowingo Pond. The plant protected area is separated from Conowingo Pond by an intake basin that has a much shorter fetch length. Therefore the referenced value is conservative.
- The APM is judged to be well within the natural and modeling uncertainties and input parameter sensitivities for the seiche calculation.
- The seiche analysis included the following conservative inputs in developing the maximum flood elevation:
    - Antecedent water level for Conowingo Pond was assumed to be 109.1 feet, which is the maximum controlled water elevation.
    - Overwater wind speed equal to 100 mph is selected conservatively from the guidance outlined in ANSI/ANS-2.8-1992.

The associated effects due to the seiche flood mechanism were determined to have no impact because the maximum water elevation does not reach a level that would reach site grade. All flood event duration parameters, including warning time, period of site preparation, period of inundation, and period of recession, are not applicable because the protection features are passive and permanent, requiring no manual actions.

7.2.3 Adequate Overall Site Response

This section applies only when manual actions are required to implement the protection strategy. No manual actions are required to implement the protection strategy and it is unlikely the station would perform any manual actions as a result of this mechanism.

The station would enter Special Event procedure SE-4, Flooding (Reference 18) if river elevation is 111 feet and flow is greater than 600,000 cubic feet per second and predicted to rise. The elevation criterion is not expected to be met for this mechanism, even using conservative antecedent and wind setup values. The flow criterion would not be met for this mechanism. An input to this mechanism is a wind speed equal to 100 mph. PB utilizes procedure OP-PB-108-1001, Preparation for Severe Weather (Reference 19), in the event the station is expected to be impacted by 'severe storms with winds in excess of 40 mph'. The station will utilize procedural guidance to take appropriate actions in response to potential flood and severe weather events.

7.3 ICE-INDUCED FLOOD

7.3.1 Description of Ice-Induced Flood Impact

The ice-induced flood is not addressed, and therefore not bounded by, the PBAPS DB. The primary feature protecting the site from the re-evaluated ice-induced flood mechanism is 'site topography and grading'. This is the only feature that is potentially challenged by the ice-induced flood, which is below grade. Table 6 provides the reevaluated flood heights and the APM to site grade for the ice-induced flood mechanism.

Table 6 – Ice-Induced Flood APM

Mechanism	Reevaluated flood height (feet)	Passive protection (feet)	APM (feet)
Ice-Induced Flooding	Maximum stillwater: 111.5 Maximum wave run-up: n/a	115.9	4.4

7.3.2 Adequate APM Justification and Reliability Flood Protection

The site grade and topography, with a nominal grade elevation of 115.87 feet, is reliable in protecting the plant from ice-induced flooding in the Conowingo Pond. The APM was determined to be adequate, with the following justifications:

- The Hydrologic Engineering Center's River Analysis System (HEC-RAS) hydraulic model, used to calculate the ice-induced flood level, was calibrated to past flood events, with an accuracy that's well within the APM (Reference 22).
- The ice-induced flood analysis included the following conservatisms in developing the maximum flood elevation:
  - The largest historic event (ice jam height = 25 feet) was relocated to the Holtwood Dam (6 miles upstream of PBAPS), which is breached at the peak flow of a 25-year flood.
  - The length of the ice jam is conservatively assumed to be the entire length of the dam, which is assumed to entirely fail.

The associated effects due to the ice-induced flood mechanism were determined to have no impact because the maximum water elevation does not reach the site grade. All flood event duration parameters, including warning time, period of site preparation, period of inundation, and period of recession, are not applicable because the protection features are passive and permanent, requiring no manual actions.

7.3.3 Adequate Overall Site Response

This section applies only when manual actions are required to implement the protection strategy. No manual actions are required to implement the protection strategy and it is unlikely the station would perform any manual actions as a result of this mechanism.

The station would enter Special Event procedure SE-4, Flooding (Reference 18) if river elevation is 111 feet and flow is greater than 600,000 cubic feet per second and predicted to rise. The elevation criterion is not expected to be met for this mechanism, considering the conservativism incorporated into arriving at the reevaluated height. The flow criterion would not be met for this mechanism. The station will utilize procedural guidance to take appropriate actions in response to potential flood and severe weather events.

7.4 Local Intense Precipitation (LIP)

7.4.1 Description of LIP Flood Impact

LIP Flood at ECT, EDG Building, and Emergency Pump Structure:
The LIP flood is not addressed, and therefore not bounded by, the PBAPS DB. The primary features protecting Key SSCs from the re-evaluated LIP flood mechanism are passive, permanent features including site elevations and topography; concrete structures (walls and floors); penetration seals in walls and floors; and watertight doors. Table 7 provides the reevaluated flood heights and the APM for the LIP flood mechanism at the ECT, EDG Building, and Emergency Pump Structure.

In addition to the credited passive protection, the ECT, EDG Building, and Emergency Pump Structure all have sump pumps with redundant power supplies backed by EDGs. The pumps automatically start based on sump level and require no operator actions to be placed in service. Functional tests are regularly performed on these sump pumps. Of these three structures, the Emergency Pump Structure is at the lowest plant grade, elevation 115.87 feet. The permanent flood protection features, including the penetration seals, are designed for the differential pressure of a DB river flood, which is much higher than a LIP flood. Structural leakage through cracks, cold joints in concrete, and penetration seals in the Emergency Pump Structure have been considered, but there is no basis to quantify the leakage. The leakage is not a DB input to the sump and is expected to be accommodated by the margin between the designed inputs and the capacity of the Class 1E-powered sump pumps (Reference 21).

Table 7 – LIP (ECT, EDG Building, and Emergency Pump Structure) APM

Mechanism	Reevaluated flood height (feet)	Passive protection (feet)	APM (feet)
LIP – ECT	Maximum stillwater: 127.0 Maximum wave run-up: minimal	137.4	10.4
LIP – EDG Building (SW Corner)	Maximum stillwater: 132.0 Maximum wave run-up: minimal	137.4	5.4
LIP – Emergency Pump Structure	Maximum stillwater: 117.5 Maximum wave run-up: minimal	137.4	19.9

LIP Flood at RB:

LIP flood elevation is above the protection level of passive, permanent features at the RBs' Secondary Containment (SC) doors, which are weather-tight, but not watertight. A technical evaluation has been performed to demonstrate that LIP in-leakage past these doors cannot result in consequential impacts to any PBAPS Key SSCs or KSFs. Table 8 provides the reevaluated flood heights and the APM for the LIP flood mechanism at RB doors.

Table 8 – Duration Exceeding Flood Protection Level for LIP at RB Doors

Mechanism	Reevaluated flood height (feet)	Passive protection (feet)	APM (feet)	Duration of exceedance above protection level (minutes)
LIP – U3 RB Door 246	135.17	134.87	- 0.30	29.4
LIP – U3 RB Door 244	135.43	134.87	- 0.56	10.8
LIP – U3 RB Door 239	135.91	134.87	- 1.04	58.8
LIP – U2 RB Door 188	135.85	134.87	- 0.98	49.8
LIP – U2 RB Door 183	135.53	134.87	- 0.66	57.0
LIP – U2 RB Door 198	135.23	134.87	- 0.36	14.4

The RBs' Elevation 135 Feet (C.D.) has three external doors per unit: one door provides access to a truck bay and the other two doors provide emergency egress. The RB doors are weathertight, SC rated-barriers, but are not watertight. Technical Evaluation 2522427-03 (Reference 13) computed LIP flood in-leakage past these doors. The technical evaluation considered both the LIP flood height above protection level (door threshold) and duration of the exceedance. The technical evaluation computed in-leakage volumes and resulting depths inside of the RB rooms. It concluded that LIP in-leakage volume is insufficient to pool to any depth that could adversely impact equipment operation. Therefore, LIP in-leakage at RB doors does not result in consequential impacts to any Key SSCs. Parameters are not being revised as part of the FIAP. Further development of these parameters is not required. See discussion below for additional details on Technical Evaluation 2522427-03.

Summary of Technical Evaluation 2522427-03

The RB doors are SC barriers, rated for 0.2 cubic feet per minute, per lineal foot of seal perimeter per psi differential. PBAPS nominal RB SC pressure is 0.25 inch of water, in-leakage.

The flood in-leakage past each RB SC door was determined by multiplying:

(1) The SC barrier rating (0.2 cubic feet per minute, per lineal foot, per psi)
(2) The door width plus twice the exceedance height (lineal feet of seal perimeter)
(3) The SC nominal pressure differential plus the exceedance height (psi differential)
(4) The duration of exceedance above the protection level (minutes).

Table 9 summarizes lineal feet of seal perimeter, flood in-leakage volume, and the worst-case potential in-leakage destination (RB elevations and rooms).

Table 9: Potential LIP Flood In-Leakage into RBs

Door	Lineal Feet of Seal Perimeter (feet)	Flood In-Leakage	Flood In-Leakage Destination in RB at Floor Elevations 135, 116, 91, and 88 feet (C.D.)
U3 Door 246 U2 Door 198	26.6	25 cubic feet = 188 gallons	135 = Truck Bay Airlock
U3 Door 244	4.12	2.2 cubic feet = 17 gallons	135 = Open hatch to U3 B Residual Heat Removal (RHR) Room 116 = Grating, Upper U3 B RHR Room 91 = Lower U3 B RHR Room
U2 Door 183	4.32	14.4 cubic feet = 107 gallons	135 = Open Hatch to U2 C RHR Room 116 = Grating, Upper U2 C RHR Room 91 = Lower U2 C RHR Room
U3 Door 239	5.08	27.3 cubic feet = 204 gallons	135 = Open Stairwell 116 = Open Stairwell 88 = Door to U3 HPCI Room
U2 Door 188	4.96	21.2 cubic feet = 159 gallons	135 = Open stairwell 116 = Open stairwell 88 = Door to U2 HPCI Room

Doors 246 and 198 are (exterior) truck bay airlock doors. Each unit has an exterior airlock door that is 26 feet wide. At opposite end of the 90-foot airlock is an interior airlock door. Either airlock door alone can maintain RB SC. The truck bay allows movement of large shipments and objects, such as fuel, into and out of the RB without breaking SC. The truck bay is normally empty and contains no Key SSCs. Inside of the RB interior airlock door is the RB proper at elevation 135 feet C.D., an adjacent open floor space similar in area to the truck bay, with multiple 4-inch floor and equipment drains (Reference 16) to the RB Sumps at elevation 88 feet C.D. Overhead to this space is a series of hatches to allow vertical movement of large objects through the RB.

The technical evaluation conservatively combined the worst-case exceedance (U2) with the worst-case duration (U3) to conservatively estimate that 25 cubic feet of water can leak past either unit's (outer) airlock door during a LIP event.

Dividing 25 cubic feet of water by the 2340 square foot airlock floor space, results in 0.13-inch average depth of water. By engineering judgment, 0.13-inch depth of water is insufficient to leak past an interior SC airlock door into the RB. The exterior airlock doors face north-south and PBAPS is sloped west-east. Because there are no Key SSCs in the truck bay, further APM development and evaluation are not required.

Doors 244 and 183 are emergency exit doors at the bottom of the U3 northwest and U2 southwest stairwells, respectively. Inside of each door on RB elevation 135 feet C.D., under the stairwell, is an open hatch to the U3 B and U2 C RHR Rooms on RB elevation 116 feet C.D. Each upper RHR Room on elevation 116 feet C.D. is separated from its lower RHR Room on elevation 91 feet C.D. by open grating.

Worst case in-leakage to an RHR hatch is U2 Door 183, at 107 gallons over 57 minutes. Assuming all in-leakage flows down the hatch to the lowest elevation, the in-leakage would be stored in the U2 C RHR room. The RHR Room has a sump with a capacity of 130 gallons and a sump pump rated at 80 gallons per minute. The RHR Room is at least 800 square feet. If in-leakage did not drain to the RHR Sump, and instead puddled in RHR Room, then the depth of the puddle would be less than 0.22 inch {(14.4 cubic feet/ 800 square feet per room) * 12 inches/foot}.

Transient Response Implementation Plan (TRIP) Procedure T-103 Secondary Containment Control (Reference 15) provides alarm and action levels for water in lower level RB rooms. For the U2 C RHR room, the alarm level is 6-inches and the action level is 1-foot, 3-inches. This provides a margin of 1-foot, 2.78-inches prior to action. Equating this to previously-described in-leakage (107 gallons = 0.22 inches) results in a volume prior to action of approximately 7,200 gallons and a margin of 7,100 gallons.

Therefore, potential LIP in-leakage is minimal and would not pool to a depth that could adversely impact equipment operation, even when not crediting sump or sump pump operation.

Doors 239 and 188 are emergency exit doors at the top of the U3 southwest and U2 northwest stairwells, respectively. Inside of each door on RB elevation 135 feet C.D., these stairwells continue down to RB elevations 116, 91, and 88 feet C.D. The stairwell is open-grated, ending at the High-Pressure Coolant Injection (HPCI) Room on elevation 88 feet C.D.

Worst case in-leakage to an open stairwell is U3 Door 239, at 204 gallons over 58 minutes. Assuming all in-leakage flows down the open-grated stairwell to the lowest elevation, where there is a watertight door to the RHR Rooms and a door to the HPCI Room, and that all in-leakage passes under the HPCI Room door, the in-leakage would be stored in the HPCI Room. The HPCI Room has normally plugged floor drains to the RB Sump Room, which has a 1000-gallon capacity floor drain sump, and redundant floor drain sump pumps rated at 100 gpm each.

The HPCI Room is at least 2000 square feet. Not crediting the floor drain, and assuming all in-leakage puddled in HPCI Room, the depth of the puddle would be less than 0.16 inches {(27.3 cubic feet/2000 square feet per room) * 12 inches/foot}.

The T-103 HPCI alarm level is 6-inches and the action level is 2-foot, 2-inches. This provides a margin of 2-foot, 1.84-inches prior to action. Equating this to previously-described in-leakage (204 gallons = 0.16 inches) results in a volume prior to action of approximately 32,500 gallons and a margin of 32,300 gallons.

Therefore, potential LIP in-leakage is minimal and would not pool to a depth that could adversely impact equipment operation.

The associated effects were determined to have no impact or are not applicable for the LIP flood (References 2 and 5). All flood event duration parameters, including warning time, period of site preparation, period of inundation, and period of recession, are not applicable since the protection features are passive and permanent, requiring no manual actions.

7.4.2 Adequate APM Justification and Reliability Flood Protection

The PBAPS passive, permanent external-flood protection features including concrete structures (walls and floors); penetration seals in walls and floors; and watertight doors, with a minimum protection level of 134.87 feet, are reliable in protecting the plant from LIP at the ECT, EDG Building and Emergency Pump Structure. The APM for LIP was determined to be adequate, because the LIP analysis included the following conservatisms in developing the maximum flood elevation:

- The site drainage system is assumed to be nonfunctional at the time of the LIP event.
- No ground infiltration was considered. The entire model area was assumed to be impervious to maximize the runoff.
- The 1-hour/1-sq-mile rainfall input from the National Weather Service Hydrometeorological Report No. 52 is judged to be conservative.

Furthermore, an error/uncertainty analysis was conducted for uncertainties in the Manning n-value and topography, which showed a potential error/uncertainty range that would produce minimal additional ingress volume and is within the available margin described above.

For LIP at the RB, the PBAPS passive, permanent external-flood protection features including concrete structures (walls and floors); penetration seals in walls and floors; and watertight doors, with a minimum protection level of 134.87 feet, are reliable. A technical evaluation addressed the LIP flood elevation above the level of protection of the passive, permanent features and determined that LIP in-leakage would not result in consequential impacts to any PBAPS Key SSCs or KSFs. The APM was determined to be adequate because, in addition to the conservatisms built into the LIP analysis and sensitivity (error/uncertainty) evaluations (discussed above), the technical evaluation included the following conservatisms:

- For in-leakage to the truck bays, the worst-case exceedance (U2) was combined with the worst-case duration (U3).
- For in-leakage to the RHR Rooms, the RHR Room Sumps were not considered.
- For in-leakage to the HPCI Rooms, the floor drains and the HPCI Room door were not considered.

7.4.3 Adequate Overall Site Response

This section applies only when manual actions are required to implement the protection strategy. No manual actions are required to implement the protection strategy and it is unlikely the station would perform any manual actions as a result of this mechanism.

8 CONCLUSION

The reevaluated storm surge, seiche, and ice-induced flood mechanisms are not addressed, and therefore not bounded by, the PBAPS DB. The primary feature protecting the site from these mechanisms is site topography and grading. The FIAP, specifically a Path 2 FE, resulted in finding that site topography and grading provides effective flood protection against the applicable flood parameters with adequate margin.

The reevaluated LIP flood mechanism at the ECT, EDG Building, and Emergency Pump Structure are not addressed, and therefore not bounded by, the PBAPS DB. The primary features protecting the site from this mechanism are passive and permanent features including site elevations and topography; concrete structures (walls and floors); penetration seals in walls and floors; and watertight doors. The FIAP, specifically a Path 2 FE, resulted in finding that these passive and permanent features provide effective flood protection against the applicable external-flood parameters with adequate margin.

The reevaluated LIP flood at the RB is not addressed and not bounded by the PBAPS DB. The primary features protecting the site from this mechanism are passive and permanent features including concrete structures (walls and floors); penetration seals in walls and floors; and watertight doors. A technical evaluation addressed the LIP flood elevation above the level of protection of these passive, permanent features. The FIAP, specifically a Path 2 FE, resulted in finding that the flood exceedance of these features would not impact Key SSCs or KSFs with adequate margin.

This submittal completes the actions related to External Flooding required by the March 12, 2012 10 CFR 50.54(f) letter.