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Dominion Energy®

February 10, 2020

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

Serial No.:	19-475
NRA/SS:	R0
Docket Nos.:	50-336
	50-423
License Nos.:	DPR-65
	NPF-49

DOMINION ENERGY NUCLEAR CONNECTICUT, INC
MILLSTONE POWER STATION UNITS 2 AND 3
RESPONSE TO MARCH 12, 2012 REQUEST FOR INFORMATION ENCLOSURE 2, RECOMMENDATION 2.1, FLOODING FOCUSED EVALUATION / INTEGRATED ASSESSMENT SUBMITTAL

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the United States 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, Recommendation 2.1 of the 50.54(f) letter requires licensees to perform a flood hazard reevaluation 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). Dominion Energy Nuclear Connecticut, Inc (DENC) provided this information to the NRC for Millstone Power Station (MPS) in a flood hazard reevaluation report (FHRR) on March 12, 2015 (Serial No. 15-106/ADAMS Accession No. ML15078A203), and later supplemented the information on January 4, 2019 (Serial Number 18-447/ML19011A109).

In September 2015, subsequent to the FHRR submittal, the NRC issued a letter to the industry indicating that new guidance was being prepared to provide for a graded approach to flooding reevaluations, allowing for more focused evaluations of local intense precipitation (LIP) and available physical margin (APM) in lieu of an integrated assessment. The guidance, prepared by Nuclear Energy Institute as NEI 16-05, Revision 1 (ADAMS Accession No. ML16165A178), was endorsed by the NRC in JLD-ISG-2016-01 (ADAMS Accession No. ML16162A301). The guidance directs that each flood-causing mechanism not bounded by the design basis flood should follow the appropriate flooding evaluation path.

DENC's responses to the NRC March 2012 NTTF 10 CFR 50.54(f) request for information are captured in Flooding Focused Evaluation (FE) / Integrated Assessment (IA) summaries in alignment with the guidance provided in NEI 16-05. The Flooding FE / IA summaries document the MPS response to the unbounded reevaluated flood hazard mechanisms.

Attachment 1 provides the MPS Unit 2 Flooding FE / IA Summary. Attachment 2 provides the MPS Unit 3 Flooding FE / IA Summary. Attachment 3 provides a list of commitments related to the MPS Flooding FE / IA summaries.

If you have any questions regarding this information, please contact Shayan Sinha at (804) 273-4687.

Sincerely,

Mark D. Sartain
Vice President – Nuclear Engineering & Fleet Support

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Mark D Sartain, who is Vice President – Nuclear Engineering & Fleet Support of Virginia Electric and Power Company. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 10th day of February, 2020.

My Commission Expires: August 31, 2023

Notary Public

Commitments made in this letter: See Attachment 3

Attachments:
1. Millstone Power Station Unit 2 Flooding Focused Evaluation / Integrated Assessment Summary
2. Millstone Power Station Unit 3 Flooding Focused Evaluation / Integrated Assessment Summary
3. List of Commitments

GARY DON MILLER
Notary Public
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My Commission Expires August 31, 2023

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ATTACHMENT 1

MILLSTONE POWER STATION UNIT 2 FLOODING FOCUSED EVALUATION / INTEGRATED ASSESSMENT SUMMARY

DOMINION ENERGY NUCLEAR CONNECTICUT, INC
MILLSTONE POWER STATION UNIT 2

Millstone Unit 2 Power Station
Flooding Focused Evaluation / Integrated Assessment Summary

January 2020
Letter Serial #19-475
Attachment 1

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1 EXECUTIVE SUMMARY

Dominion has reevaluated the flooding hazards at Millstone Power Station Unit 2 (MPS2) in accordance with the Nuclear Regulatory Commission's (NRC) March 12, 2012, 10 CFR 50.54(f) request for information (RFI) (Ref. 1). 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 (NTTF) report. This information was submitted to the NRC in a flood hazard reevaluation report (FHRR) on March 12, 2015 (Ref. 13). The NRC's assessment of the FHRR (with the exception of storm surge) is documented in the NRC's letter to Dominion, "Staff Assessment of Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation" dated October 3, 2018 (Ref. 17). The storm surge is assessed in the NRC's letter to Dominion, "Supplement to Staff Assessment of Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation" dated October 7, 2019 (Ref. 20).

In all, eight flooding mechanisms were evaluated to determine if any challenged the Current Licensing Basis (CLB); and, three mechanisms were found to exceed the CLB at MPS2. The mechanisms are listed below:

1. Local Intense Precipitation (LIP)
2. Tsunami
3. Storm Surge

Associated effects (AE) and flood event duration (FED) parameters were assessed and submitted as a part of the FHRR. No changes to the LIP or tsunami flooding analysis have been performed since the issuance of the FHRR Staff Assessment (Ref. 17), thus the FHRR analyses provide the input to the Focused Evaluation (FE) process. However, it should be noted that additional analyses have been utilized to evaluate the Storm Surge flooding mechanism.

This Flooding FE evaluated the impact of the unbounded reevaluated LIP and tsunami flood-causing mechanism in accordance with Path 3 and Path 2, respectively, of NEI 16-05, (Ref. 5) guidance. NEI 16-05, Rev. 1, Appendix B includes guidance for evaluation of passive and active flood protection features and Appendix C for the evaluation of site response. The Flooding FE concludes that the strategies for maintaining key safety functions (KSFs) during the reevaluated LIP and tsunami flood hazard provide effective flood protection through the demonstration of adequate Available Physical Margin (APM), reliable flood protection features, and feasible overall site response.

This Flooding Integrated Assessment (IA) evaluated the impact of the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard in accordance with Path 5 of NEI 16-05, Rev. 1 (Ref. 5) guidance. The Flooding IA demonstrates that effective flood protection is available for the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard scenario; that effective mitigation / feasible response strategies are available for the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard scenario.

Submittal of this FE/IA completes the Dominion response to external flooding evaluations required by the March 12, 2012 10 CFR 50.54(f) letter for the MPS2 tsunami, LIP and storm surge flood-causing mechanisms.

2 BACKGROUND

On March 12, 2012, the NRC issued Ref. 1 to request information associated with Near-Term Task Force (NTTF) Recommendation 2.1 for flooding. The RFI directed licensees, in part, to submit a Flood Hazard Reevaluation Report (FHRR) to reevaluate the flood hazards for their sites using present-day methods and guidance used for early site permits and combined operating licenses. In its March 12, 2015 letter to the NRC, Serial No. 15-106 (Ref. 13), Dominion Nuclear Connecticut, Inc. (DNC, now known as Dominion Energy Nuclear Connecticut, Inc. or DENC) submitted the, "Millstone Power Station Units 2 and 3 Flood Hazard Reevaluation Report in Response to March 12, 2012 Information Request Regarding Flooding Aspects of Recommendation 2.1." Additional information was provided to the NRC in Refs. 16 and 18.

The reevaluated flood hazard information in the FHRR was confirmed as appropriate input to additional assessments supporting plant response (except for storm surge) in the NRC's letter to Dominion "Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation" dated December 21, 2016 (Ref. 15) and the storm surge was confirmed as such in the NRC's letter to Dominion, "Millstone Power Station, Units 2 and 3 – Supplement to Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation" (Ref. 19). The NRC's letter to Dominion, "Staff Assessment of Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation" dated October 3, 2018 (Ref. 17) and "Millstone Power Station, Units 2 and 3 – Supplement to Staff Assessment of Response to 10 CFR50.54(f) Information Request – Flood – Causing Mechanism Reevaluation" dated October 7, 2019 (Ref. 20) provided documentation supporting the conclusions summarized in the interim staff responses.

In all, eight flood-causing mechanisms were evaluated to determine if any challenged the Current Licensing Basis (CLB); and three mechanisms (LIP, tsunami and storm surge) were found to exceed the CLB at MPS2 and required further evaluation.

During the NRC's review of the reevaluated storm surge flood hazard information submitted in the FHRR, Dominion and the NRC concluded that in order to reduce the uncertainty around the FHRR's reevaluated 1E-6 Annual Exceedance Probability (AEP) probabilistic storm surge analysis, a more frequent 1E-4 AEP probabilistic storm surge analysis would be performed. Thus, the NRC did not include a review of the reevaluated storm surge flood hazard information in the Staff Assessment of the FHRR. Dominion performed a reevaluated 1E-4 AEP probabilistic storm surge analysis and submitted the results of the analysis in a supplement to the FHRR (Ref. 18). The NRC's assessment of the supplemental FHRR is documented in the NRC's letter to Dominion, "Supplement to Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation," dated April 3, 2019 (Ref. 19).

Associated effects (AE) and flood event duration (FED) parameters were assessed and submitted as a part of the FHRR. Additional analyses were developed for the supplemental FHRR and a lower probability storm surge scenario analysis to evaluate the storm surge flood-causing mechanism was also prepared. However, no additional LIP or tsunami analyses have been performed since the issuance of the FHRR Staff Assessment (Ref. 17).

Following the Commission's directive to NRC Staff in Ref. 9, the NRC issued a letter to the industry (Ref. 10) indicating that new guidance is being prepared to replace instructions in Ref. 9 and provide for a "graded approach to flooding reevaluations." This "graded approach" modified the requirements for plants and allowed for "more focused evaluations of local intense precipitation and available physical margin in lieu of proceeding to an integrated assessment." NEI prepared the new "External Flooding Assessment Guidelines" in NEI 16-05 (Ref. 5), which was endorsed by the NRC in Ref. 3. NEI 16-05 indicates that each flood-causing mechanism not bounded by the design basis 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 Flood Mitigation
- Path 5: Scenario Based Approach

Non-bounded flood-causing mechanisms in Paths 1, 2, or 3 require a Focused Evaluation (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 (IA).

The reevaluated LIP flood-causing mechanism is appropriately evaluated in accordance with NEI 16-05 (Ref. 5), Path 3 guidance by a Flooding FE of the site strategy for a feasible response to LIP. NEI 16-05 (Ref. 5), Appendix B includes guidance for evaluation of passive and active features, and Appendix C for the evaluation of site response.

The reevaluated tsunami flood-causing mechanism is appropriately evaluated in accordance with NEI 16-05 (Ref. 5), Path 2 guidance by a Flooding FE of the site strategy for effective flood protection. NEI 16-05, Appendix B includes guidance for evaluation of passive and active features, and Appendix C for the evaluation of site response.

The reevaluated storm surge flood-causing mechanism is appropriately evaluated in accordance with Path 5 of NEI 16-05 (Ref. 5) guidance in a Flooding IA of the site strategy for using a scenario based approach of blended responses for flood mitigation.

3 REFERENCES

Please note that not all references are cited within the main document. Some are included as general background reference.

1. U.S. 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," March 12, 2012 (ADAMS Accession No. ML12053A340).
2. Millstone Licensing Assignment LA006022, "Perform an integrated assessment in response to the results of the Combined Effects flood hazards for MPS Units 2 & 3," March 10, 2015.
3. U.S. NRC JLD-ISG-2016-01, Rev. 0, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flooding Hazard Reevaluation; Focused Evaluation and Integrated Assessment," July 2016, (ML16162A301).
4. U.S. NRC COMSECY-15-0019, "Closure Plan for the Reevaluation of Flooding Hazards for Operating Nuclear Power Plants", June 30, 2015 (ML15153A105).
5. Nuclear Energy Institute 16-05, Rev. 1, "External Flooding Assessment Guidelines," June 30, 2016.
6. Letter from David L. Skeen, U.S. Nuclear Regulatory Commission, to Joseph E. Pollock, Nuclear Energy Institute, "Trigger Conditions for Performing an Integrated Assessment and Due Date for Response," December 3, 2012 (ML12326A912).
7. U.S. NRC JLD-ISG-2012-05, "Guidance for Performing the Integrated Assessment for External Flooding," November 30, 2012 (ML12311A214).

8. U.S. NRC COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," November 21, 2014 (ML14238A616).
9. U.S. NRC "Staff Requirements Memoranda to COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," March 30, 2015 (ML15089A236).
10. U.S. NRC Letter, "Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events," September 1, 2015 (ML15174A257).
11. U.S. NRC NUREG/CR-7046, "Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United States of America," December 2010.
12. Nuclear Energy Institute 12-06, Rev. 4, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," December 12, 2016 (ML16354B421).
13. Dominion Nuclear Connecticut, Inc. Letter, "Millstone Power Station Units 2 and 3 Flood Hazard Reevaluation Report in Response to March 12, 2012 Information Request Regarding Flooding Aspects of Recommendation 2.1," March 12, 2015 (Serial No. 15-106).
14. U.S. 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," March 1, 2013 (ML13044A561).
15. U.S. NRC Letter, "Millstone Power Station, Units 2 and 3 - Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10CFR50.54(f) Information Request – Flood-Causing Mechanism Reevaluation," December 21, 2016 (Serial No. 16-494).
16. Dominion Nuclear Connecticut, Inc. Letter, "Millstone Power Station Units 2 and 3 Mitigating Strategies Assessment (MSA) Report," June 28, 2017 (Serial No. 17-268).
17. U.S. NRC Letter, "Millstone Power Station Units 2 and 3 – Staff Assessment of Response to 10CFR50.54(f) Information Request – Flood-Causing Mechanism Reevaluation," October 3, 2018 (Serial No. 18-386).

18. Dominion Energy Nuclear Connecticut, Inc. Letter, "Millstone Power Station Units 2 and 3 Supplement to Dominion Flooding Hazard Reevaluation Report," January 4, 2019 (Serial No. 18-447).
19. U.S. NRC Letter to Dominion, "Millstone Power Station, Units 2 and 3 – Supplement to Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation," April 3, 2019 (Serial No. 19-169).
20. U.S. NRC Letter to Dominion, "Millstone Power Station, Units 2 and 3 – Supplement to Staff Assessment of Response to 10CFR50.54(f) Information Request – Flood – Causing Mechanism Reevaluation," October 7, 2019 (Serial 19-426).
21. Dominion Engineering Technical Evaluation, ETE-CPR-2012-0009, Rev. 7, Beyond Design Basis – FLEX Strategy Basis Document and Final Integrated Plan, Millstone Unit 2.
22. Dominion Engineering Technical Evaluation, ETE-CPR-2017-1001, Rev. 0, Millstone Unit 2 and Unit 3 Flooding Vulnerability Walk-downs.
23. Dominion Engineering Technical Evaluation, ETE-CPR-2017-1002, Rev. 0, Millstone Unit 2 Beyond Design Basis Flooding Assessment.
24. Dominion Engineering Technical Evaluation, ETE-CPR-2017-1004, Rev. 0, Impact of Reevaluated Flood Hazards on FLEX Mitigating Strategies, Millstone Units 2 & 3.
25. Dominion Engineering Technical Evaluation, ETE-CPR-2017-1005, Rev. 0, Millstone Unit 2 Beyond Design Basis Flooding Focused Evaluation and Integrated Assessment.
26. Dominion Engineering Technical Evaluation, ETE-MP-2014-1027, Rev. 1, MPS2 Conduit/Piping Penetrations & Flood Protection Features Identification.
27. Dominion Engineering Technical Evaluation, ETE-MP-2018-1006. Rev. 0, Millstone Power Station Unit 2 Local Probable Maximum Precipitation Trigger Recommendations.
28. Dominion (Zachry) Calculation 14-027, Rev. 0, Detailed Tsunami Modeling for Millstone Power Station.
29. Dominion (Zachry) Calculation, 18-075, Rev. 0, Millstone Power Station Annual Exceedance Probability 1.0E-04 for Probabilistic Storm Surge Analysis.

30. Dominion (Zachry) Calculation, 18-110, Rev. 0, Combined Effects Flood Analysis at Millstone Power Station Units 2 & 3.
31. Dominion (Zachry) Calculation, 19-005, Rev. 0, Probabilistic Stillwater Flood Elevation Analysis for an AEP of 1E-5 at Millstone Power Station.
32. Dominion (Zachry) Calculation, 19-007, Rev. 0, Combined Effects Flood Analysis for Storm Surge Annual Exceedance Probability 1E-5 for Millstone Power Station.
33. Dominion (Zachry) Calculation, NAI-1996-001, Rev. 2, MP2 Intake Structure Refined Beyond Design Basis Inundation Analysis.
34. Dominion (Bechtel) Calculation 25785-000-K0C-0000-00006, Rev. 0, Millstone Unit 2 Roof Water Depths During Site Specific Local PMP Event.
35. Dominion Calculation, MISC-11787, Rev. 0, Addendum D, Evaluation of Secondary Heat Removal Requirements Following Extended Loss of AC Power (ELAP), Millstone Cases with Preemptive Shutdown.
36. Dominion Calculation, CE-2038, Rev. 0, Addendum A, Beyond Design Basis Flooding Evaluation of the MP2 Intake Structure.
37. MPS Common Engineering Procedure C EN 104I, Rev. 13, Condition Monitoring of Structures.
38. Dominion Corporate Procedure, CO-PROC-000-HRP-NUCLEAR, Rev. 14, Hurricane Response Plan (Nuclear).
39. MPS Procedure C OP 200.6, Rev. 8, Storms and Other Hazardous Phenomena.
40. MPS Procedure SP 3670.1-008, Unit 3 Plant Equipment Rounds – Outside."
41. MPS Procedure AOP 2560, Rev. 19, Storms, High Winds and High Tides
42. MPS Vendor Technical Manual for Diesel Driven Fire Pump, MP-VTM-000-25212-903-001, Rev. 1, Inline Series 71 Service Manual Section 1-3.
43. MPS Procedure SP 2654R, Rev. 3, Intake Structure Condition Determination.
44. MPS Procedure AOP 2582, Rev. 7, Loss of Spent Fuel Pool Cooling, Millstone Unit 2.
45. MPS Procedure, AOP 2572, Rev. 16, Loss of Shutdown Cooling, Millstone Unit 2.
46. MPS Procedure MP 2701E, Rev. 0, Unit 2 Flood Gates Installation and Removal

47. MPS Procedure MP 2721C, Rev. 9, Protection and Restoration of Service Water Pump and Strainer Motor During a PMH.
48. Millstone Power Station Unit 2 Final Safety Analysis Report, Rev. 34.02
49. Millstone Unit 2 Technical Requirements Manual, Rev. 173.
50. MPS Procedure SP 2665, Rev. 10, Building Flood Gate Inspections
51. Dominion Nuclear Standard, DNES-AA-GN-1003, Rev. 20, Design Effects and Considerations.
52. Dominion Nuclear Fleet Administrative Procedure, MA-AA-113, Rev. 2, Yard Control.

4 TERMS AND DEFINITIONS

- AE – Associated Effects
- AEP – Annual Exceedance Probability
- APM – Available Physical Margin
- BDB – Beyond Design Basis
- CAENS – Connecticut Alert Emergency Notification System
- CDB – Current Design Basis
- CLB – Current Licensing Basis
- CONVEX – Connecticut Valley Exchange
- DB – Design Basis
- DNC – Dominion Nuclear Connecticut, Inc.
- ELAP – Extended Loss of AC Power
- ETE – Engineering Technical Evaluation
- FE – Focused Evaluation
- FED – Flood Event Duration
- FHRR – Flood Hazard Reevaluation Report
- FLEX – Diverse and Flexible Coping Strategies
- FSAR – Final Safety Analysis Report
- KSF – Key Safety Function
- LIP – Local Intense Precipitation
- LUHS – Loss of Ultimate Heat Sink
- MPS2 – Millstone Power Station Unit 2
- MPS3 – Millstone Power Station Unit 3
- MSA – Mitigating Strategies Assessment
- MSL – Mean Sea Level
- NACCS – North Atlantic Coast Comprehensive Study

- NOAA – National Oceanic Atmospheric Administration
- NEI – Nuclear Energy Institute
- NRC – Nuclear Regulatory Commission
- NTTF – Near-Term Task Force
- NTWC – National Tsunami Warning Center
- PMH – Probable Maximum Hurricane
- PMP – Probable Maximum Precipitation
- PSSA – Probabilistic Storm Surge Assessment
- RFI – Request for Information
- SERO – Station Emergency Response Organization
- SM – Shift Manager
- SSC – Structures, Systems, and Components
- STA – Shift Technical Advisor
- TRM – Technical Requirements Manual
- TSA – Time Sensitive Action
- US – Unit Supervisor

5 FLOOD HAZARD PARAMETERS FOR UNBOUNDED MECHANISMS

The results of the NRC review of the Millstone Power Station (MPS) FHRR (Ref. 13) and the supplemental FHRR (Ref. 18) are contained in the Staff Assessment (Ref. 17) and Supplement to the Staff Assessment (Ref. 20). These staff assessments document the NRC's conclusion that the MPS reevaluated flood hazard information is suitable input for other flooding assessments associated with the 10CFR 50.54(f) letter.

Table 1 and Table 2 of the enclosure to Ref. 19 include a summary of the Unit 2 current licensing basis and reevaluated (i.e., BDB) flood hazard parameters, respectively. In Table 1 of the enclosure to Ref. 15 and Table 3.1-2 of the enclosure to Ref. 17, the NRC lists the following eight flood-causing mechanisms for the Design Basis (DB) flood:

- Local Intense Precipitation;
- Streams and Rivers;
- Failure of Dams and Onsite Water Control/Storage Structures;
- Storm Surge;

- Seiche;
- Tsunami;
- Ice Induced Flooding; and
- Channel Migrations/Diversions.

The NRC concluded that the following three flood mechanisms are not bounded by the current licensing basis flood hazard levels for MPS2 (Refs. 15 and 17):

- LIP
- Tsunami
- Storm Surge

The Flooding FE evaluated the impact of the reevaluated LIP and tsunami flood-causing mechanism on the site strategy for effective flood protection in accordance with Path 3 and Path 2 (respectively) of NEI 16-05, Rev. 1 guidance including Appendix B and Appendix C.

The Flooding IA evaluated the impact of the reevaluated storm surge flood-causing mechanism in accordance with Path 5 of NEI 16-05, Rev. 1 guidance.

Table 5.0 provides a summary of how the unbounded mechanism was addressed in this external flooding assessment.

Table 5.0 – External Flooding Assessment Summary

	Flood Mechanism	Summary of Assessment
1	LIP	Flood Parameters were not revised as part of this assessment. Path 3 (feasible response to a LIP) was determined to be the appropriate path. The approach would be to use a planned site response utilizing procedural LIP monitoring and action triggers for installation of removable flood barriers in conjunction with permanent flood modifications. Once the flood barriers are installed in accordance with the applicable procedure(s), KSFs and key SSCs will be protected from inundation during the LIP event.
2	Tsunami	Flood Parameters were not revised as part of this assessment. Path 2 (effective flood protection) was

		determined to be the appropriate path since, while shallow flooding would occur in the intake structure pump room, all KSFs and key SSCs would be protected during the tsunami event.
3	Storm Surge	Dominion Energy concluded (Ref. 18) that 1E-4 AEP PSSA provides a more realistic analysis than the 1E-6 PSSA presented in the FHRR (Ref. 13). Flood Parameters were revised (refer to Table 7.1). Path 5 (scenario based approach) was determined to be the appropriate path to account for the probabilistic nature of the storm surge analyses and for the demonstration of adequate responses strategies for the scenarios.

6 OVERALL SITE FLOODING RESPONSE

6.1 Description of Overall Site Flooding Response

6.1.1 LIP

Surveillance Procedure SP 2654R (Ref. 43) requires monitoring of the weather forecasts and conditions, evaluation of the environmental conditions, and notifying the Shift Manager (SM) or Unit Supervisor (US) of degraded environmental conditions. This procedure is applicable at all times and performed a minimum of once per shift by the Shift Technical Advisor (STA). Station procedure AOP 2560, "Storms, High Winds and Tides" (Ref. 41) is entered upon "notification of a potential to exceed 3 inches, or more, of rain in any 6 hour period within the next 24 hour period", for any weather condition as determined by the SM or US. Notification of a LIP event may be received from the following sources: Connecticut Valley Electric Exchange (CONVEX), Connecticut Alert Emergency Notification System (CAENS) or local weather forecast. Station procedure C OP 200.6, "Storms and Other Hazardous Phenomena" (Ref. 39), which establishes command and control of the site response, will be entered with the initiation of AOP 2560, or at the discretion of the SM or US.

Site response to a LIP is initiated by the Ref. 41, Attachment 6 action trigger. Attachment 6 is entered upon notification of a potential to receive 3 inches or more of rain in any 6 hour period within the next 24 hour period, and the action trigger is: "The actions of Attachment 6 should be initiated ≥ 12 hours prior to the storm arrival on site." The site response actions initiated by the LIP action trigger include: perform additional station management notifications; request for additional site personnel to support storm preparation efforts, if necessary; initiate site inspection and cleanup of loose material and debris; close flood gates and install stop logs and flood protection devices. The flood gates, stop logs and flood protection devices implemented by Ref. 41, Attachment 6 provide 22 ft. MSL of flood protection for the main site / power block KSFs (Ref. 13). The nominal site grade at the power block for MPS2 is 14 feet. The FHRR (Ref. 13) maximum stillwater elevations for a LIP range from 14.3 feet at flood gate 20 to 17.5 feet at flood gate 13. Detailed instructions for closing / installing (and opening / removing) the flood gates, stop logs and for installing the Fire Pump House flood protection devices are provided in Maintenance Procedure MP 2701E, "Unit 2 Flood Gates Installation and Removal" (Ref. 46) and AOP 2560 (Ref. 41), respectively. The safety-related service water pumps, motors and associated electrical equipment, which provide the only KSF in the intake structure, are protected from LIP flooding by their elevation above the pump room floor. The service water pump motors have overhead electrical feeds and are mounted on pedestals at elevation 21.7 ft. MSL. If LIP flood water enters the intake structure service water pump room, it will drain through the floor grating (14 ft. MSL elevation) into the Long Island Sound and not impact the service water pump motors.

Ref. 27 includes copies of the October 29, 2012 station operations logs which documented that the closing time of the flood gates in response to the predicted arrival of Hurricane Sandy took approximately 4 hours and 34 minutes to complete. Thus, adding margin to the 10-29-2012 closure time, Ref. 27 concluded that closure of the flood gates requires approximately 5 hours. With margin assumed for closure of the flood gates and considering that the flood gates, stop logs and Fire Pump House flood protection devices can be installed in parallel and by multiple crews if available, it is reasonable that all of the LIP flood protection measures can be implemented within 5 hours following the LIP trigger. Therefore, initiation of the LIP flood protection actions starts between 24 and 12 hours prior to the LIP arriving on site provides at least 7 hours of margin for performing the all of the required procedural LIP flood protection actions prior to the LIP arrival.

With required flood gates, stop logs and flood protection devices installed in accordance with Ref. 41, LIP flood water will be prevented from impacting the safety-related structures, systems, and components (SSCs). Therefore, reevaluated

LIP flood protection is provided for the KSFs. The site response to a LIP challenge has been validated per the guidance provided in Ref. 5, Appendix C: Evaluation of Site Responses.

Ref. 24 assessed the impact of the reevaluated LIP flood hazard on the FLEX mitigating strategies and concluded that the current FLEX mitigating strategies can be deployed as designed during the reevaluated LIP flood hazard. Therefore, the FLEX mitigating strategies are available for defense-in-depth flood response to the reevaluated LIP flood hazard.

6.1.2 Tsunami

The reevaluated maximum tsunami flood level is bounded by the CLB storm surge flood level, but the warning time for the tsunami is less than that for the PMH causing the storm surge. The FHRR (Ref. 13) predicts a reevaluated maximum tsunami flood elevation of 14.7 ft. MSL at the intake structure and at the MPS2 general site area. Thus, shallow flooding (up to 0.7 ft.) above the MPS2 average site grade of 14 ft. MSL is possible. The tsunami is predicted to reach the Millstone site approximately 8.7 hours after the occurrence of the initiating event (Ref. 13).

The site response to, and command and control of, a tsunami event is similar to that for a LIP (described in Section 6.1.1) or a PMH storm surge event. The MPS2 abnormal weather procedure, AOP 2560, "Storms, High Winds and High Tides" (Ref. 41) is entered upon "notification of a potential for a tsunami to strike Millstone Station". A tsunami warning notification may be received from the following sources: CONVEX or CAENS. The National Oceanic and Atmospheric Administration (NOAA) National Tsunami Warning Center (NTWC) provides tsunami detection, forecasts and warnings for the U.S. including the Atlantic coast, operating 24 hours a day with a goal of issuing tsunami warnings within five minutes of detecting an earthquake having potential for generating a tsunami (Ref. 13). C OP 200.6, "Storms and Other Hazardous Phenomena" (Ref. 39), which establishes command and control of the site response, will be entered with the initiation of AOP 2560 (Ref. 41), or at the discretion of the SM or US.

The site response to a tsunami warning is initiated by the action trigger in Ref. 41, Attachment 7, which is: "if a tsunami warning is issued, then perform the following: ...". The site response actions initiated by the tsunami warning action trigger include: perform additional station management notifications; request additional site personnel to support tsunami preparation efforts, if necessary; initiate site inspection and cleanup of loose material and debris; close flood gates, and install stop logs and flood protection devices. The flood gates, stop logs and flood protection devices implemented by Ref. 41, Attachment 7 provide 22 ft. MSL of flood protection for the main site / power block KSFs. Detailed instructions for closing / installing (and opening / removing) the flood gates, stop logs and installing the Fire Pump House flood protection devices are provided in Maintenance Procedure MP 2701E, "Unit 2 Flood Gates Installation and Removal" (Ref. 46) and AOP 2560 (Ref. 41). The safety-related service water pumps, motors and associated electrical equipment, which are the only SSCs in the intake structure that provide a KSF, are protected from tsunami flooding by their elevation above the pump room floor. The service water pump motors have overhead electrical feeds and are mounted on pedestals at elevation 21.7 ft. MSL. The tsunami flood water will enter the intake structure service water pump room through the floor grating (14 ft. MSL elevation), but will not reach the service water pump motors. When the tsunami surge recedes, it will drain through the floor grating.

Ref. 27 includes copies of the 10-29-2012 station operations logs which documented that the closing time of the flood gates in response to the predicted arrival of Hurricane Sandy took approximately 4 hours and 34 minutes to complete. Thus, adding margin to the 10-29-2012 closure time, Ref. 27 concluded that closure of the flood gates requires approximately 5 hours. With the margin assumed for closure of the flood gates and considering that the flood gates, stop logs and Fire Pump House flood protection devices can be installed in parallel and by multiple crews if available, it is reasonable that the tsunami flood protection measures can be implemented within 5 hours after a tsunami warning. Therefore, initiation of the flood protection actions upon notification of the tsunami warning at approximately 8 hours prior to the tsunami arriving on site provides approximately 3 hours of margin for performing the required procedural flood protection actions prior to the tsunami arrival on site.

With the tsunami flood protection devices (flood gates, stop logs and Fire Pump House flood protection) installed prior to the tsunami reaching the site in accordance with Ref. 41; tsunami flood water will be prevented from entering the safety-related SSCs. Therefore, tsunami flood protection is provided for MPS2 KSFs. The site response to a tsunami challenge has been validated per the guidance provided in Ref. 5, Appendix C: Evaluation of Site Responses.

Ref. 24 assessed the impact of the reevaluated tsunami flood hazard on the FLEX mitigating strategies and concluded that the current FLEX mitigating strategies can be deployed as designed during the flood hazard. Therefore, the FLEX mitigating strategies are available for defense-in-depth flood response to the reevaluated tsunami flood hazard.

6.1.3 Reevaluated Combined Effects with Probabilistic Storm Surge

The site response to the current design basis and the reevaluated combined effects with probabilistic storm surge flood levels relies on the actions provided in Refs. 41, 39, 47, 49, 46 and 38. The reevaluated combined effects with probabilistic storm surge flood protection design basis is that of the CDB/CLB, which includes closing the flood gates, installing stop logs, installing a flood-proof can for one service water pump motor, and other procedural actions needed to protect SSCs that provide / maintain KSFs. The initiating event for the site response (CDB/CLB and reevaluated storm surge) is notification of a hurricane warning (a hurricane warning is issued when hurricane conditions are expected in a specified coastal area in 24 hours or less, and include winds of $\geq$ 74 mph and/or dangerously high tides and waves), and/or the forecast of a storm center with sustained wind speeds greater than 60 mph expected to strike the site within 12 hours (Ref. 41). Ref. 41 identifies the entry conditions that apply and the action triggers and corresponding actions required. The site response actions include:

- Institute command and control of the hurricane preparedness and response activities
- Perform appropriate notifications, emergency classifications, and requests for additional resources for assistance
- Monitor wind speed and direction and refer to Ref. 39 to evaluate status and determine course of action
- Increase monitoring of wave action, water level, operation of traveling screens at the intake structure, and operation of the circulating water pumps and condensers
- Stage flood water removal pumps and hoses in the Turbine Building condenser pit area to remove potential flood water that might bypass the flood gates
- Confirm or restore the Condensate Storage Tank (CST) level to 100%
- Perform site inspections and cleanup for loose material, debris or equipment

- Close flood gates and install stop logs (per Ref. 46)
- Install Fire Pump House flood protection devices
- Stage a BDB auxiliary feedwater (AFW) pump inside the Turbine Building Railway Access
- Install a safety line between Turbine Building and Intake Structure
- Install flood protection can on one operable service water pump motor (per Ref. 47), when water level, including wave crest height, reaches plant grade (14 ft. MSL) in accordance with TRM 3/4.7.5 (Ref. 49)
- Initiate plant shutdown if intake structure water level is forecasted to exceed 16.5 ft. MSL or site wind speed is expected to exceed 90 MPH within four hours, and maintain plant at Hot Standby conditions using the SG Atmospheric Steam Dump Valves and AFW
- Initiate Loss of Spent Fuel Pool (SFP) Cooling procedure (Ref. 44), if required
- Align fire water pump / tank to an emergency diesel generator (EDG) not electrically aligned to the "canned" service water pump, if intake water level exceeds 19.5 ft. MSL
- Start equipment powered from the EDG cooled by fire water, trip the EDG supplied by service water, stop all service water pumps and stop all reactor building component cooling water (RBCCW) pumps, if intake water level exceeds 22 ft. MSL (The EDG cooled by fire water powers one train of safety-related loads not requiring service water/RBCCW, e.g. charging (CH) pump, AFW pump, 480 VAC air compressors for operating steam generator (SG) atmospheric dump valves (ADVs) in the main control room (MCR), high pressure safety injection (HPSI) and low pressure safety injection (LPSI) pumps. Containment conditions and SFP conditions are monitored while service water/RBCCW is not available and containment cooling and SFP cooling are restored with the restoration of service water/RBCCW).
- Remove flood protection can from service water pump motor and restore service water when intake water level recedes to less than 14 ft. MSL.

6.2 Summary of Plant Modifications and Procedural Changes

6.2.1 LIP and Tsunami

Flooding vulnerabilities were identified as part of walk-downs documented in Ref. 22, and evaluated by the flooding assessment documented in Ref. 23. In addition, Ref. 23 identified vulnerable door locations at which flood barriers will be evaluated for installation to preclude flooding at these locations during periods of rainfall with less intensity than the LIP action trigger.

A list of proposed flood protection modifications is provided in Ref. 25, Attachment 1, Table 6-1. The proposed modifications provided in Table 6-1 are preliminary and may be changed during the flood protection modification design change/implementation process if other methods of flood protection are evaluated as equivalent or more effective.

Flood barriers will be constructed, installed and secured to station structures as necessary. The flood barriers will be passive structures that are either permanent or removable / temporary that can be installed quickly upon receipt of an action trigger for an approaching severe weather event. Removable/temporary barriers are pre-staged to facilitate rapid installation, and operator actions required to fully secure the barriers will be incorporated into the appropriate procedures, as necessary.

It should be noted that procedural changes have been implemented to Ref. 41, AOP 2560, Storms, High Winds and High Tides; and, Ref. 39, C OP 200.6, Storms and Other Hazardous Phenomena (Preparation and Recovery), to address LIP and tsunami monitoring and action triggers and the corresponding required implementation of flood barriers upon notification of a LIP or a tsunami advancing toward the site.

6.2.2 Storm Surge

No plant modifications, inspections or physical changes are planned to respond to the reevaluated combined effects with probabilistic storm surge flood mechanism. A procedural change is being processed which will implement the following:

> Add steps to Ref. 41 to ensure that the fire water pump diesel fuel tank is filled to maximum level prior to the storm surge arriving on site. If the

service water pump is shut down due to the intake storm surge water level > 22 ft. MSL, this will provide approximately 10 hours of diesel fuel for fire pump operation to provide fire water cooling capability for the EDG before the fire pump diesel fuel tank would require refilling during the reevaluated combined effects with $\leq$ 1E-4 AEP probabilistic storm surge flood hazard, or during the CDB/CLB storm surge flood.

7 FLOOD IMPACT ASSESSMENT

7.1 LOCAL INTENSE PRECIPITATION (LIP) – NEI 16-05, PATH 3

7.1.1 Description of Flood Impact

The reevaluated LIP flood hazard has a reevaluated maximum flood level elevation that ranges from 14.3 ft. MSL at the south side of the intake structure to 17.5 MSL at the northeast corner of the Turbine Building. The MPS2 safety-related SSCs in the main site / power block are flood protected to elevation 22 ft. MSL by concrete flood walls, procedurally closed flood gates, and procedurally installed stop logs and flood barriers. The safety-related service water pumps, motors and associated electrical equipment, which provide the only KSF in the intake structure, are protected from LIP flooding by their elevation above the pump room floor. The service water pump motors have overhead electrical feeds and are mounted on pedestals at elevation 21.7 ft. MSL. If LIP flood water enters the intake structure service water pump room, it will drain through the floor grating (14 ft. MSL elevation) into the Long Island Sound. With the procedural flood protection implemented prior to the LIP arriving on site as described in Section 6.1.1, only the plant vulnerabilities listed in Table 6-1, Ref. 25 if left unprotected, could be challenged by reevaluated LIP flood hazard flooding (which could potentially affect SSCs that protect or support KSFs).

To prevent compromising KSFs, flood protection modifications for the locations of the plant vulnerabilities identified in Ref. 25, Attachment 1, Table 6-1 will be implemented. These proposed flood protection modifications will provide flood barriers at the vulnerabilities and provide qualified seals for the identified unprotected penetrations. With the flood barriers and penetration seals installed and the procedurally required LIP flood protection implemented, the reevaluated LIP flood hazard will not adversely impact SSCs that protect or support KSFs.

Ref. 24 assessed the impact of the reevaluated LIP flood hazard on the FLEX mitigating strategies and concluded that the current FLEX mitigating strategies can be deployed as designed during the reevaluated LIP flood hazard.

7.1.2 Adequate APM Justification and Reliability of Flood Protection

The available physical margin (APM) determination is made using the guidance provided in Ref. 5 (NEI 16-05, Appendix B, Section B.1, "Determination of Adequate Available Physical Margin and Section B.2, "Reliability of Flood Protection"). Adequate APM is part of demonstrating effective flood protection. Since the MPS2 current design basis flood protection for safety-related SSCs is 22 ft. MSL, the APM for the key safety features during the reevaluated LIP flood hazard is between 7.7 ft. (22 ft. – 14.3 ft.) and 4.5 ft. (22 ft. – 17.5 ft.) depending on the location in the plant.

Walk-downs (Refs. 22 and 26) identified flooding vulnerabilities on building roofs, and locations such as door sills, siding, equipment and penetrations become points of potential flood water in-leakage due to excessive ponding during a precipitation event. These vulnerabilities were evaluated by the flooding assessment documented in Ref. 23. In addition, Ref. 27 identified vulnerable door locations at which flood barriers will be evaluated for installation to preclude flooding at these locations during periods of rainfall with less intensity than the LIP action trigger. The vulnerabilities identified by the walk-downs and by Ref. 26 are not all protected by the 22 ft. design basis flood protection. As such for the LIP, Dominion defined "Small Margin" (Ref. 26) as $\leq$ 1 inch.

Flood protection modifications have been proposed to address vulnerabilities identified by the walk-downs and by Ref. 27. The roof flooding evaluations take no credit for building roof drains but include existing scuppers. Where no scuppers exist, water levels could accumulate to the point of overflowing the roof parapets. APM will be evaluated for adequacy in locations where flood protection modifications are implemented.

Adequate APM for a LIP is afforded using flood barriers, both permanent and those installed in response to LIP action triggers, in strategic locations throughout the plant. Adequate APM is achieved provided the following requirements are satisfied:

- Credited flood gates remain closed, and credited stop logs and flood barriers remain installed during and following the LIP event, until flood waters subside (Ref. 41)
- Credited flood gates, stop logs and flood barriers are controlled and maintained in accordance with appropriate station procedures (Ref. 50)
- Permanently installed flood barriers are controlled and maintained in accordance with appropriate station procedures
- Qualified seals are in place for flood boundary penetrations
- Reinforced concrete and block walls credited for flood protection are controlled and maintained (Ref. 37)
- Roofs and roof systems credited for flood protection are controlled and maintained (Ref. 37)
- Roof penetrations are sealed / flashed to levels > 1" above the calculated roof flood elevations
- Analyzed yard flow paths are controlled, i.e., not blocked or modified without evaluation (in accordance with Ref. 52)

Flood protection barriers are designed to conform to accepted engineering practices. Conservative assumptions (e.g., active and passive drainage structures at the site are considered non-operational, and the flood contributory areas are impervious) were used to justify adequate APM. Flood feature reliability will be measured and validated through appropriate training and maintenance activities, field-testing, and analysis. To ensure flood protection reliability, detailed flood barrier installation requirements are included in the flood protection implementation procedures, (Ref. 41, Attachment 6 and Ref. 46); and credited flood gates are inspected at least once every quarter to ensure they are available to provide flood protection when needed (Ref. 50).

The station design process requires that design changes to the plant consider impact on the potential for flooding, and whether the activity affects (A) any of the station's hazards evaluations for: (1) seismic events, (2) external flooding, (3) storms such as hurricanes, high winds, and tornadoes, (4) extreme snow, ice, and cold, or (5) extreme heat; or (B) any flooding protective features such as culverts, drains and dikes (Ref. 51). Thus, the design change process provides programmatic assurance that the flooding protection design basis configuration will be maintained with adequate APM and reliability of flood protection for future design changes to the plant.

7.1.3 Adequate Overall Site Response for Flood Protection

The site response to a LIP is described in Section 6.1.1. The evaluation of adequate overall site response is performed in accordance with Ref. 5 (NEI 16-05, Appendix C, "Evaluation of Site Response," Sections C.1 – C.5). The following components are used to provide a comprehensive site response plan evaluation.

7.1.3.1 Defining Critical Path and Identifying Time Sensitive Actions (TSAs)

The critical path actions for the site response to the LIP are the procedurally required actions for closing of flood gates, and installation of stop logs and flood barriers, which are initiated by the LIP action trigger and are also the TSAs. The required minimum time and detailed installation requirements for the critical path actions (TSAs) are provided in Ref. 41, Attachment 6 and Ref. 46, respectively. The TSA actions are to be initiated ≥ 12 hours prior to a forecasted LIP of 3 inches or more of rain in any 6 hour period within the next 24 hour period reaching the site (the LIP action trigger in Ref. 41, Attachment 6) based on monitoring of local forecasts, or receiving notifications from CONVEX or CAENS. Forecast monitoring and timely actions allow for TSAs to be completed prior to a consequential LIP storm arriving on site. The other actions required in Ref. 41, Attachment 6 prior to installing the flood gates, (i.e., performing station management notifications of storm conditions; requesting additional site personnel, if necessary, to support preparation efforts; initiating site inspection and cleanup of loose material and debris), are non-TSAs. Performing notification and requesting additional site personnel, if necessary, are accomplished quickly, and site inspection and cleanup of loose material and debris can be accomplished prior to or during the installation of the flood gates without impacting the TSAs.

7.1.3.2 Demonstrating TSAs are Feasible

Once a LIP action trigger has been initiated, implementation of the flood protection TSAs (i.e., flood gate closure and stop logs and flood barrier installations), must be completed prior to the storm arriving on site. Ref. 41, Attachment 6 requires initiation of the LIP action trigger actions ≥ 12 hours prior to the LIP storm arrival on site. Detailed instruction for installing the LIP flood protection is provided in Ref. 46. To reduce installation time, the stop logs and flood barriers are pre-staged near locations requiring flood protection. Required equipment and personnel needs for flood gate closure / stop log installations, and flood barrier installations are described in Ref. 46 and Ref. 41, Attachment 6.

The guidance provided in Ref. 12 (NEI 12-06, Appendix E, Section E.6.3.2, Validation for Level B TSAs) was applied to validate the LIP flood protection TSAs. The station response to the imminent arrival of Hurricane Sandy on 10-29-2012 serves as a functional validation of the feasibility of the LIP flood protection TSAs. The 10-29-2012 station operations logs documented that the closing time of the flood gates in response to the predicted arrival of Hurricane Sandy took approximately 4 hours and 34 minutes to complete. Adding margin to the 10-29-2012 documented closure time, Ref. 27 concluded that closure of the flood gates requires approximately 5 hours. The closure time documented in the 10-29-2012 operations logs is considered to be a Level B Record for timed validation of Level B TSAs under the guidance of NEI 12-06, Appendix E, Section E.6.3.2.

The 10-29-2012 closure of the flood gates was performed with a fully staffed operations / maintenance crew and during the site environmental conditions of an approaching hurricane. The site environmental conditions of an approaching consequential LIP storm are considered sufficiently similar to those of an approaching hurricane. Therefore, it is reasonable to conclude that the approximate 5 hour actual flood gates closure time during the response to Hurricane Sandy approaching the site is applicable to the closure time during the response to a consequential LIP storm approaching the site.

Considering a worst case operations / maintenance staffing scenario, Ref. 41, Attachment 6 could be entered (24 hours prior to notification of the consequential LIP storm predicted to arrive at the site) during a time at which the unit has minimum staff. In this scenario, the SM or US in charge would immediately perform the Attachment 6 notifications and requests for additional personnel to support the preparation efforts. Approximately 12 hours would be available for the additional personnel to arrive on site within ≥ 12 hours prior to the LIP arriving on site to makeup an operations / maintenance crew capable of performing the flood gate closure in 5 hours. Since MPS3 does not require extensive site preparations for an approaching LIP storm, MPS3 operations / maintenance personnel could further supplement the MPS2 operations / maintenance staff for site LIP response, if needed.

Thus, with the margin added to the 10-29-2012 actual closure time of the flood gates and reasonable assurance that an adequate operational / maintenance staff is available to implement the LIP flood protection TSAs for any unit staffing condition that exists when the site LIP response procedure is entered, the TSAs can be feasibly implemented during the site LIP response. Furthermore, initiation of the LIP TSA actions at 24 to 12 hours prior to the LIP arriving on site as required by Ref. 41, Attachment 6, provides a minimum of approximately 7 hours of margin for implementing the LIP flood protection TSAs.

7.1.3.3 Establishing Unambiguous Procedural Triggers

Ref. 27 developed the LIP rainfall intensity value that clearly defined the procedural action trigger for the site response to LIP. The LIP action trigger has been incorporated in Ref. 41, Attachment 6 for initiation of site response to a LIP. Ref. 41, Attachment 6 is entered upon notification of a potential to receive 3 inches, or more, of rain in any 6-hour period within the next 24 hour period, and includes the LIP action trigger of initiating LIP response action $\geq$ 12 hours prior to the storm arrival on site. The following actions are initiated by the Ref. 41, Attachment 6 LIP action trigger:

- Perform station management notifications of storm conditions;
- Request additional site personnel, if necessary, to support preparation efforts;
- Initiate site inspection and cleanup of loose material and debris; and,
- Close flood gates and install stop logs and Fire Pump House flood protection devices.

Therefore, the procedural LIP action triggers have clearly defined bases (Ref. 27) and the direction for initiating the action triggers is unambiguous in the site LIP response procedure (Ref. 41, Attachment 6).

7.1.3.4 Proceduralized and Clear Organizational Response to a Flood

Surveillance Procedure SP 2654R (Ref. 43) requires monitoring of the weather forecasts and conditions, evaluation of the environmental conditions, and notifying the SM or US of degraded environmental conditions. SP 2654R is applicable at all times and performed a minimum of once per shift by the STA. AOP 2560, "Storms, High Winds and Tides" (Ref. 41) is entered upon "notification of a potential to exceed 3 inches, or more, of rain in any 6 hour period within the next 24 hour period," for any weather condition as determined by the SM/US. Notification of a LIP event may be received from the following sources: CONVEX, CAENS or local weather forecast. C OP 200.6, "Storms and Other Hazardous Phenomena" (Ref. 39), which establishes command and control of the site response, will be entered with the initiation of AOP 2560, or at discretion of the SM or US.

Site response to a LIP is initiated by the Ref. 41, Attachment 6 action trigger: 24 to 12 hours prior to the storm arrival on site. The actions initiated by the Ref. 41, Attachment 6 action trigger include: perform additional station management notifications; request for additional site personnel to support storm preparation efforts, if necessary; initiate site inspection and cleanup of loose material and debris; close flood gates, and install stop logs and flood protection devices. Detailed instructions for closing / installing (and opening / removing) the flood gates, stop logs and Fire Pump House flood protection devices are provided in Maintenance Procedure MP 2701E, "Unit 2 Flood Gates Installation and Removal" (Ref. 46).

The above described procedural direction establishes clear organizational response to a LIP flooding event with procedurally defined responsibility for command and control of station personnel for severe weather preparations and the site response to a LIP storm. Procedures AOP 2560 and MP 2701E provide detailed instructions for initiation and installation of required LIP flood protection barriers on a timeline that ensures installation is completed prior to the LIP storm arriving on site.

Therefore, the station procedures clearly define the roles and responsibilities for each function of the MPS2 organization with respect to implementing the critical response action plan before, during, and after the LIP event.

7.1.3.5 Detailed Flood Response Timeline

The strategy for the successful timeline response considered the following:

- Monitoring and action triggers
- Lead time to event and margin for preparation
- Inspection activities
- Flood protection installation activities
- Event duration
- Flood protection removal activities

The detailed site LIP flood response timeline is included in Ref. 41, Attachment 6. The LIP action trigger, initiated by Ref. 41, Attachment 6, directs the initiation of the site LIP flood protection actions within a predicted window of 24 to 12 hours prior to the arrival of the consequential LIP storm on site. Since installation and verification of the procedurally required flood protection features can be completed within approximately 5 hours, a flood protection implementation time margin of at least 7 hours prior to the consequential LIP storm arriving on site is provided.

As described in detail in Section 7.1.3.2, functional validation of the LIP flood response timeline margin has been performed to demonstrate the feasibility of the detailed flood response timeline.

7.1.3.6 Accounting for the Expected Environmental Conditions

The environmental conditions are expected to have minimal impact on the deployment of the flood protection features in response to the LIP action trigger. Advance warning of the storm approaching the site will provide sufficient time for personnel to close the flood gates / stop logs to protect the station against flooding effects prior to the onset of severe weather. As described in Section 7.1.3.2, the TSA actions of closing the flood gates / stop logs have been functionally validated during the actual environmental conditions of an approaching hurricane, which are considered sufficiently similar to those of an approaching consequential LIP storm. Therefore, no additional protective measures associated with any expected adverse environmental conditions are required.

7.1.3.7 Demonstration of Adequate Site Response

The MPS2 site response to a LIP has been demonstrated as adequate by meeting the guidelines in NEI 16-05, Appendix C. TSAs have been identified and determined to be feasible in accordance with NEI 12-06, Appendix E validation guidance. The clearly defined and unambiguous LIP action trigger initiating the LIP site response (24 to 12 hours prior to a consequential LIP arriving on site) allows ample time to perform management notifications of storm conditions; augment plant staff for response support, if required; inspect and prepare the site; and to close / install flood barriers (implement the LIP flood protection TSAs). The detailed procedural approaches in Refs. 41 and 39 clearly establish the organizational command and control structure for site response, and detailed procedural instructions will allow each organization to effectively complete the required actions. Finally, adverse environmental conditions are expected to have minimal impact on LIP flood protection preparation efforts.

Accordingly, this flood impact assessment demonstrates that the overall site response to the reevaluated LIP flood hazard is adequate in accordance with the guidance of NEI 16-05 (Ref. 5).

7.2 TSUNAMI – NEI 16-05 PATH 2

7.2.1 Description of Flood Impact

Tsunami flooding was not included in the current design basis for MPS2. The FHRR (Ref. 13) predicted reevaluated maximum tsunami flood elevations of 14.7 ft. MSL at the intake structures for both units and at the MPS2 general site area. Shallow flooding (up to 0.7 ft.) above the MPS2 nominal site grade of 14 ft. MSL is possible. The tsunami is predicted to reach the Millstone site approximately 8.7 hours after the initiation of the event (Ref. 13). The site response to a tsunami event is similar to that for a PMH event (i.e., combined effects with probabilistic storm surge flooding mechanism). The maximum tsunami flood level is bounded by the maximum storm surge flood level, but the warning time for the tsunami is less than that for the PMH.

The MPS2 main site / power block SSCs that protect or support the KSFs are flood protected to elevation 22 ft. MSL by concrete flood walls, procedurally (Ref. 41, Attachment 6) closed flood gates, and procedurally installed stop logs and flood barriers. The safety-related service water pumps, motors and associated electrical equipment, which are the only SSCs in the intake structure that provide a KSF, are protected from tsunami flooding by their elevation above the pump room floor. The service water pump motors have overhead electrical feeds and are mounted on pedestals at elevation 21.7 ft. MSL. The tsunami flood water will enter the Intake Structure Pump Room through the floor grating (14 ft. MSL elevation), but will not reach the service water pump motors. When the tsunami surge recedes, it will drain through the floor grating. With the procedural flood protection implemented prior to the tsunami arriving on site as described in Section 6.1.2, the SSCs that protect or support KSFs will not be adversely impacted by the reevaluated tsunami flood hazard.

Ref. 24 assessed the impact of the reevaluated tsunami flood hazard on the FLEX mitigating strategies and concluded that the current FLEX mitigating strategies can be deployed as designed during the reevaluated tsunami flood hazard.

7.2.2 Adequate APM Justification, Reliability of Flood Protection and Adequate Overall Response for Flood Protection

The tsunami flood protection actions required by Ref. 41, Attachment 7 are essentially the same as those for LIP flood protection. The same flood protection barriers are implemented, i.e., closing flood gates, and installing stop logs and Fire Pump House flood protection devices, for both tsunami and LIP flooding events.

The procedural implementation of tsunami flood protection barriers provides 22 ft. MSL of design basis flood protection with an APM = 22 ft. - 14.7 ft. = 7.3 ft. for the main site / power block and for the service water pump motors and electrical equipment, which are the only safety-related components in the intake structure (Ref. 13).

It should be noted that the primary difference between a LIP and Tsunami response is the timeline required for implementation of the flood protection actions prior to the tsunami arriving on site. Tsunami flood protection implementation is required to be initiated upon receipt of a tsunami warning, i.e., within approximately 8 hours prior to the tsunami arriving on site, while LIP flood protection implementation is required within 24 to 12 hours of the consequential LIP arriving on site.

Ref. 27 documented flood gate closure time for the arrival of Hurricane Sandy on October 29, 2012. As detailed in Ref. 27, the closing of the flood gates took 4 hours and 34 minutes. Note that the site environmental conditions of an approaching consequential tsunami are considered to be no worse and very likely better than those of an approaching hurricane. Therefore, with margin, it is reasonable to conclude that closure of the flood gates will take 5 hours. The closure time documented in Ref. 27 is considered to be a Level B Record for timed validation of Level B TSAs under the guidance of NEI 12-06, Appendix E, Section E.6.3.2. Furthermore, initiation of the tsunami TSAs at approximately 8 hours prior to the tsunami arriving on site as required by Ref. 41, Attachment 7, provides a minimum of approximately 3 hours of margin for implementing the tsunami flood protection TSAs.

Therefore, since it has been validated that the required tsunami flood protection barriers can be implemented by the abnormal weather procedure (Ref. 41, Attachment 7) prior to the tsunami reaching the site, the potential 0.7 ft. reevaluated tsunami flood depth at the intake structure and in the MPS2 general site area would not adversely impact structures, systems or components that protect or support KSFs.

Based on the similarities between the site tsunami and LIP flood responses as described in Section 7.1, adequate overall site response for the reevaluated tsunami flood hazard are demonstrated in accordance with the guidance in NEI 16-05 (Ref. 5).

The station design process requires that design changes to the plant consider impacts on the potential for flooding, and whether the activity affects: (A) any of the station's hazards evaluations for (1) seismic events, (2) external flooding, (3) storms such as hurricanes, high winds, and tornadoes, (4) extreme snow, ice, and cold, or (5) extreme heat; or (B) any flooding protective features such as culverts, drains, and dikes (Ref. 51). Thus, the design change process provides programmatic assurance that the flooding protection design basis configuration will be maintained with adequate APM and reliability of flood protection after future design changes to the plant.

7.3 REEVALUATED COMBINED EFFECTS WITH PROBABILISTIC STORM SURGE – NEI 16-05 PATH 5

As discussed in NEI 16-05, Rev 1, Path 5 permits consideration of the likelihood of flood scenarios when applying standards ("feasible" versus "effective" flood strategy) for assessing flooding impacts, using the 1E-3 (with margin) to 1E-4 annual exceedance probability (AEP) range as the "high" and "low" likelihood thresholds. Therefore, the approach in developing a probabilistic characterization of the flood hazard is principally concerned with defining flood-frequencies to an AEP greater than 1E-4. Flood scenarios with lesser AEPs are simply designated having a "low" likelihood.

Path 5 evaluations use a blend of strategies when an effective mitigation strategy cannot be demonstrated for the most bounding flood parameters. The scenarios developed for the MPS2 reevaluated storm surge are summarized below.

7.3.1 Flood-Frequency Development

7.3.1.1 Approach

The Supplement to the FHRR (Ref. 18) and the accompanying Staff Assessment (Ref. 20) provide details of the methodology and analyses used to develop the reevaluated combined effects with a 1E-4 AEP probabilistic storm surge flood hazard. This methodology was also used for the 1E-5 AEP analyses. The analyses (Refs. 29, 30, 31, 32) include descriptions of:

- Joint Probability Method
- Hydrodynamic Modeling Storm Surge Interpolation
- Antecedent Water Levels
- Source of Storm Data
- Storm Recurrence Rate
- Statistical Analysis of Storm Data
- Tropical Storm Surge Frequency Curve Using Joint Probability Analysis
- Error and Uncertainty Estimates
- Extratropical Storm Surge Frequency Curve
- Mesh Refinements
- Combined Effects Numerical Simulation of Synthetic Hurricanes
- Total Water Levels Approach
- Wave Overtopping Calculation at Unit 2 Turbine Building
- Flood Loads, Debris Impact Loads, and Standing (Non-Breaking) Wave Loads
- Results and Conclusions

The following sections summarize the storm surge analyses and results.

7.3.1.2 Summary of Analyses

As stated in Refs. 29 and 31, the probabilistic storm surge analyses (PSSA) used a logic tree approach to obtain multiple flood frequency curves to support the calculation of a stillwater elevation associated with the specified AEP (1E-4 or 1E-5, respectively). Each logic tree branch carried a certain weight (i.e., probability), with the sum of the branch weights equal to one. The Joint Probability Method was used for developing flood frequency curves. Each logic tree path from the start to the end node produces a distinct flood frequency curve, which includes error and uncertainty. For each calculation, the error and uncertainty estimates include numerical modeling error, antecedent water level, and hurricane parameter variability. The mean tropical cyclone-induced storm surge flood frequency curve was calculated as the weighted average of 96 developed branches. The extratropical surge flood frequency curve was calculated based on North Atlantic Coast Comprehensive Study (NACCS) simulated results using historical extratropical storm data. Uncertainty bounds of the flood frequency curve were estimated by the bootstrapping method. The final storm surge flood frequency curve combines the probabilities and responses from both tropical and extratropical cyclones.

The combined effects analyses (Refs. 30 & 32) developed the combined effects flooding elevation, associated hydrodynamic and wave loading, and wave overtopping rate and volume at MPS associated with the chosen AEP (1E-4 or 1E-5), including a projected 50-year sea level rise. The mean 1E-4 stillwater elevation was developed in the PSSA (Refs. 29 & 31). The MPS structures analyzed include the Unit 2 Intake Structure and Unit 2 Turbine Building. Total water levels (stillwater and wave runup) were calculated for the intake structure and Unit 2 Turbine Building. Hydrostatic, hydrodynamic, and debris impact loads were calculated for the intake structure and Unit 2 Turbine Building. Overtopping due to waves at the West Wall of Unit 2 Turbine Building was estimated.

7.3.1.3 Key Assumptions

A list of key assumptions in the storm surge analyses (Ref. 29 & 31) and combined effects analyses (Ref. 30 & 32) is provided below:

- The analysis results, which include mean and upper confidence water levels at the chosen AEP (1E-4 or 1E-5), are expected to vary slightly if new additional branches were added.
- The historical hurricane data trimmed by spatial and temporal filters applied in this analysis is adequate to characterize hurricane parameters in the vicinity of Millstone.

- The storm surge elevation associated with the chosen AEP (1E-4 or 1E-5) can be reliably determined by using, in part, approximately 80 years of observed hurricane data (1938 through 2016).
- Normal distribution was assumed for estimating prediction intervals for heading-dependent maximum wind speed (Vm) and central pressure deficit (CPD) functions.
- Lower weighting factors were used for logic tree branches that assume parameter independence.
- The probabilistic storm was assumed to be steady-state and symmetrical (i.e., storm parameters and track bearings were not varied with time) prior to landfall.
- No tidal time series were used for ADCIRC modeling. A constant water level at Elevation 1.16 feet North American Vertical Datum of 1988 (NAVD88) was used for all the numerical simulations. Tidal influences were included in the calculated mean stillwater elevation at the chosen AEP 1E-4 or 1E-5). This method is consistent with the modeling approach used by the NACCS.
- A remaining active plant life of fifty (50) years was assumed for the purpose of calculating the Sea Level Rise component of the Antecedent Water Level.
- Equation 5-44 Configuration (d) from the EurOtop Manual was used to estimate the overtopping rates due to wave breaking before the MPS Unit 2 Turbine Building foreshore is flooded under the selected storm event. Configuration (d) includes a dike slope, a flat promenade, and a storm wall which approximately resembles the cross section from the Long Island Sound to the Unit 2 Turbine Building flood wall (applicable to Stage 1 and 3). Wave obliquity is conservatively not considered in the overtopping calculation under this condition (Stage 1 and 3).

7.3.1.4 Treatment of Uncertainties

NEI 16-05, Rev 1, Appendix D, states that the "licensee should identify and address important sources of aleatory variability and epistemic uncertainty (e.g., alternate data sources, options for filtering data, or alternate functional forms for probability distributions) for each flood mechanism. The licensee may utilize simplifying and bounding assumptions to address uncertainty but should also clarify how they affect key insights and conclusions. Sensitivity studies examining the effect of key components and assumptions on flood hazard estimates may be used to address epistemic uncertainty."

The NRC confirms the proper incorporation of aleatory and epistemic uncertainty in its summary comments (Ref 20, Section 2.1):

"Aleatory variability and epistemic uncertainty are incorporated into the storm surge evaluation to account for natural variability that is not captured in the deterministic models and uncertainties associated with a range of acceptable modeling decisions. Probability density functions of storm parameters (PDFs) are used to represent the aleatory/natural variability of the parameters based on historical data and are used to estimate the probability of exceeding specified surge elevations. Storm surge estimates obtained from numerical models are assumed to be median values and have a normal distribution. The standard deviation for this normal distribution accounts for the aleatory variability in storm surge given a set of known storm parameters. A logic tree is used to incorporate epistemic uncertainty in the storm hazard analysis."

7.3.1.5 Results

The combined effects flooding results are provided in Sections 6.0 of Refs. 30 and 32. Table 7.1 summarizes the pertinent results.

7.3.2 Comparison of Flood Scenarios

7.3.2.1 Define flood scenarios

During the NRC's review of the reevaluated storm surge flood hazard information submitted in the FHRR (Ref. 13), Dominion and the NRC concluded that in order to reduce the uncertainty around the FHRR's reevaluated 1E-6 Annual Exceedance Probability (AEP) probabilistic storm surge analysis, a more frequent AEP (1E-4) probabilistic storm surge analysis would be performed. Thus, the NRC did not submit a Staff Assessment for the reevaluated storm surge flood hazard information submitted in the FHRR. Dominion submitted the results of the 1E-4 AEP probabilistic storm surge analysis in a Supplement to the FHRR (Ref. 18).

Since the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard was assessed to have no impact on the MPS KSFs, a flood impact assessment was performed for a less probable combined effects with probabilistic storm surge flooding scenario. A 1E-5 AEP analysis was chosen for assessment of storm surges of less frequent occurrence than 1E-4 because, as stated in Ref. 31:

"Guidance from U.S Army Corps of Engineers or other federal agencies for PSSA at lower frequencies (i.e., AEP less than 1E-5) are not well-established and such analyses would require additional evaluation of the methodology and input data used herein. Previous calculations indicate that there is inherently large uncertainty associated with the results at the AEP of 1E-6, when the storm surge stillwater frequency curves become very sensitive to perturbations of various input parameters. Therefore, the AEP of 1E-5 (flood scenario 2) is a more severe event alternative to the previous 1E-4 (flood scenario 1) analysis. Both 1E-4 and 1E-5 analyses are judged to have reasonable confidence levels in defining a mean stillwater elevation at the selected AEP levels."

Table 7.0 - Flood Scenario Definitions

Flood Scenario	Storm Surge AEP	Likelihood	Description
1	1E-4	High	Effective Protection
2	1E-5	Low	Feasible Response/Mitigation

Note detailed characteristics of the flood scenarios referenced in Table 7.0, above, are provided in Table 7.1.

7.3.2.2 Characterization of flood parameters for each scenario

Table 7.1 - Flood Parameters for each Scenario

Flood Mechanism Parameter		Scenario 1 (1E-4 AEP)	Scenario 2 (1E-5 AEP)
1	Maximum Stillwater Elevations (Intake Structure/Power Block)	16.9 ft. / 17.5 ft. MSL	19.8 ft. / 20.9 ft. MSL
2	Maximum Wave Run-up Elevations	37.2 ft. MSL intake structure 27.6 ft. MSL maximum peak water level inside the intake structure 17.5 ft. MSL at the east side of MPS2 19.8 ft. MSL at west side of MPS2	43 ft. MSL intake structure 31.7 ft. MSL maximum peak water level inside the intake structure 20.9 ft. MSL at the east side of MPS2 23.6 ft. MSL at west side of MPS2
3	Maximum Hydrodynamic / Debris Loading	Evaluated as Satisfactory	Evaluated as Satisfactory
4	Effects of Sediment Deposition / Erosion	Minimal	Minimal

Table 7.1 - Flood Parameters for each Scenario

Flood Mechanism Parameter		Scenario 1 (1E-4 AEP)	Scenario 2 (1E-5 AEP)
5	Other Associated Effects	Minimal	Minimal
6	Concurrent Site Conditions	N/A	N/A
7	Effects on Ground Water	Minimal	Minimal
8	Warning Time	12 - 24 hours	12 - 24 hours
9	Period of Site Preparation	12 - 24 hours	12 - 24 hours
10	Period of Inundation	10 hours	9 hours
11	Period of Recession	10 hours	8 hours
12	Plant Mode of Operation	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 6
13	Other Factors	Minimal	Minimal

7.3.3 Flood Scenario 1— Effective Flood Protection

7.3.3.1 Flood Scenario 1 Summary

The reevaluated combined effects with 1E-4 AEP storm surge flood hazard total water levels are bounded by the respective CDB/CLB water levels for the east side of the power block (17.5 ft. vs. 21.3 ft. MSL), at the west wall of the Turbine Building (19.8 ft. vs. 25.1 ft. MSL), and at the intake structure exterior (37.2 ft. vs. 42.5 ft. MSL), but not for the storm surge standing wave inside the intake structure (27.6 ft. vs. 26.5 ft. MSL).

The MPS2 nominal site grade elevation is 14 ft. MSL in the power block. The safety-related SSCs on the east side of the power block are flood protected to 22 ft. MSL by closing the flood gates and installing stop logs as required by Ref. 41. In addition, above elevation 22 ft. MSL, the external concrete (flood) walls of the Turbine Building transition to metal siding. In the CDB/CLB, the metal siding is credited as a flood protection feature that prevents the 25.1 ft. MSL CDB/CLB wave run-up from overtopping the west flood wall of the Turbine Building (Ref. 48, Section 2.5.4.2.2). However, a more conservative approach was taken for Turbine Building flood protection by the reevaluated combined effects with probabilistic storm surge analyses based on considerations regarding potential hurricane wind speeds and storm-driven debris. The reevaluation (Ref. 30) assumed that the Turbine Building siding is not present to prevent flood water wave runup from overtopping the west flood wall during the reevaluated flood hazard and conservatively estimated the total wave overtopping volume entering the Unit 2 Turbine Building to be 8,842 gallons. The evaluation concluded that this overtopping water volume could be contained within the condenser pit (approximately 280,000 gallon volume capacity), and that the water overtopping the 22 ft. MSL elevation flood wall would be adequately distributed for draining to the Turbine Building condenser pit without challenging the safety-related targets in the area (the AFW system and the DC switchgear equipment rooms).

Therefore, the safety-related SSCs east of the Turbine Building west flood wall are protected from the reevaluated combined effects flooding with 1E-4 AEP probabilistic storm surge flood hazard by the flood walls, flood gates, and stop logs (i.e., APM $\geq$ (22 ft. – 17.5 ft.) $\geq$ 4.5 ft.). Since the Turbine Building siding is assumed to have been lost during the reevaluated flood hazard, the key SSCs inside the Turbine Building are flood protected from the wave runup water volume that overtops the 22 ft. MSL elevation Turbine Building west flood wall by the ability of the Turbine Building condenser pit to collect the overtopping volume.

The safety-related service water pumps, motors, and associated equipment are the only SSCs located in the MPS2 intake structure. These SSCs provide the service water KSF, (i.e., the ultimate heat sink). One service water pump motor is flood protected to 28 ft. MSL (Ref. 49, Item 3/4.7.5) by installing the flood protection can as directed by Ref. 41 and Ref. 47 for a rising storm surge level. All service water pumps are stopped if the intake structure water level exceeds 22 ft. MSL and the protected service water pump is restarted when the water level at the intake structure recedes to less than 14 ft. MSL. Therefore, one service water pump is flood protected during the maximum 27.6 ft. MSL flood level inside the intake structure (Ref. 33) during the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard (i.e., APM = (28 ft. – 27.6 ft.) = 0.4 ft.).

Intake structure hydrostatic, hydrodynamic and debris loading analyses were performed for the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard. Loads due to non-breaking waves were calculated as hydrostatic and hydrodynamic loads. Debris impact loads are assumed to act at the water surface elevation (Ref. 30). The Ref. 36 evaluations conclude that the intake structure can accommodate the loads.

Therefore, the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard will not adversely impact any key SSCs that protect or support KSFs.

7.3.3.2 Adequate APM Justification and Reliability of Flood Protection

The APM determination is made using the guidance provided in Appendix B of NEI 16-05, "External Flooding Assessment Guidelines" (Ref. 5). Adequate APM against the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard is provided by plant site grade elevation as well as the current design basis flood protection for safety-related SSCs in the power block (22 ft. MSL), and by the flood protection can for one service water pump motor in the intake structure (28 ft. MSL).

The safety-related SSCs in the power block on the eastern side of the Turbine Building west flood wall (22 ft. MSL elevation) are flood protected from the reevaluated combined effects flooding with 1E-4 AEP probabilistic storm surge flood hazard by permanent flood walls and closure of flood gates and stop logs that provide an APM = (22 ft. – 17.5 ft.) = 4.5 ft. As discussed in Section 7.3.3.1, the Turbine Building siding is assumed to have been lost during the reevaluated flood hazard. However, the key SSCs inside the Turbine Building are flood protected from the conservatively estimated wave runup water volume that could overtop the Turbine Building west flood wall by the Turbine Building condenser pit. The condenser pit has more than adequate capacity to collect the overtopping volume without impact to the SSCs located in the Turbine Building that provide KSFs.

The safety-related service water pumps, motors, and associated equipment are the only SSCs located in the intake structure that provide a KSF (service water, i.e., ultimate heat sink). One service water pump motor is flood protected to 28 ft. MSL (Ref. 49, Item 3/4.7.5) by installing the flood protection can as directed by Ref. 41 and Ref. 46 for a rising storm surge level. Therefore, one service water pump is flood protected against the maximum 27.6 ft. MSL flood level inside the intake structure (Ref. 33) with an APM = (28 ft. – 27.6 ft.) = 0.4 ft. during the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard.

Adequate APM for a consequential storm surge is afforded using flood barriers, both permanent and installed, in response to the hurricane warning or high wind action trigger, in strategic locations throughout the plant. Adequate APM is achieved provided the following requirements are satisfied:

- Credited flood gates remain closed, and credited stop logs and flood barriers remain installed during and following the storm surge event, until flood waters subside (Ref. 41)
- Credited flood gates, stop logs, and flood barriers are controlled and maintained in accordance with appropriate station procedures (Ref. 50)
- Permanently installed flood barriers are controlled and maintained
- Qualified seals are in place for flood boundary penetrations
- Reinforced concrete and block walls credited for flood protection are controlled and maintained (covered by existing procedure Ref. 37)

- Analyzed yard flow paths are controlled, (i.e., not blocked or modified without evaluation in accordance with Ref. 52)

Flood protection barriers are designed to conform to accepted engineering practices. Conservative assumptions (e.g., active and passive drainage structures at the site are considered non-operational, and the flood contributory areas are impervious) were used to justify adequate APM. Flood feature reliability will be measured and validated through appropriate training and maintenance activities, field-testing, and analysis. To ensure flood protection reliability, detailed flood barrier installation requirements are included in the flood protection implementation procedures (i.e., Ref. 41 and Ref. 46); and credited flood gates are inspected at least once every quarter to ensure they are available to provide flood protection when needed (Ref. 50).

The station design process (Ref. 51) requires that design changes to the plant consider impacts on the potential for flooding, and whether the activity affects: (A) any of the station's hazards evaluations for (1) seismic events, (2) external flooding, (3) storms such as hurricanes, high winds, and tornadoes, (4) extreme snow, ice, and cold, or (5) extreme heat; or (B) any flooding protective features such as culverts, drains, and dikes. Thus, the design change process provides programmatic assurance that flooding protection design basis configuration will be maintained with adequate APM and reliability of flood protection after future design changes to the plant.

Therefore, adequate APM and reliable flood protection is available for key SSCs that protect or support KSFs during the reevaluated combined effects with 1E-4 AEP storm surge flood hazard event.

7.3.3.3 Adequate Overall Site Response

The evaluation of adequate overall site response is performed in accordance with Ref. 5 (NEI 16-05, Appendix C, "Evaluation of Site Response", Sections C.1 – C.5). The following sections provide a comprehensive site response plan evaluation.

7.3.3.3.1 Defining Critical Path and Identifying Time Sensitive Actions (TSAs)

The critical path for the site storm surge response are the existing CDB/CLB actions to implement the procedurally required storm surge flood protection barriers, (i.e., closure of flood gates, and installation of stop logs and flood barriers, and installation of the service water pump motor can), and the operations staff actions to ensure the reactor plant is maintained in a safe condition at various flood levels at the intake. These are the critical path actions and also the TSAs, are all initiated by action triggers. The action triggers and detailed implementation requirements for the TSAs are provided in Refs. 41, 47, 49 and 46.

The other actions required in Ref. 41 prior to installing the flood protection barriers (e.g., perform station management notifications of storm conditions; request additional site personnel, if necessary, to support preparation efforts; initiate site inspection and cleanup of loose material and debris, etc.) are non-TSAs.

The operations staff actions to ensure the reactor plant is maintained in a safe condition at various intake structure flood levels are existing CDB/CLB actions prescribed by the TRM (Ref. 49) and by Ref. 41. These critical path actions (TSAs) are described in detail in Section 7.3.3.3.7.

7.3.3.3.2 Demonstrating TSAs are Feasible

The guidance provided in Ref. 12 (NEI 12-06, Appendix E, Section E.6.3.2, Validation for Level B TSAs) was applied to validate the site storm surge response TSAs.

The station response to the imminent arrival of hurricane Sandy on 10-29-2012 serves as a functional validation of the feasibility of the site storm surge flood protection implementation TSA. Station operations logs documented that the closing time of the flood gates in response to the predicted arrival of Hurricane Sandy took approximately 4 hours and 34 minutes to complete. Adding margin to the 10-29-2012 documented closure time, Ref. 27 concluded that closure of the flood gates requires approximately 5 hours. The closure time documented in the 10-29-2012 operations logs is considered to be a Level B Record for timed validation of Level B TSAs under the guidance of NEI 12-06, Appendix E, Section E.6.3.2.

The 10-29-2012 closure of the flood gates was performed with a fully staffed operations / maintenance crew and during the site environmental conditions of an approaching hurricane. The site environmental conditions of an approaching consequential storm surge are considered essentially the same as those during the approach of Hurricane Sandy.

Therefore, it is reasonable to conclude that the approximate 5 hour actual flood gates closure time during the response to Hurricane Sandy approaching the site is applicable to the closure time during the response to a consequential storm surge approaching the site.

Considering a worst-case operations / maintenance staffing scenario, Ref. 41 could be entered (12 - 24 hours prior to notification of a potential consequential storm surge predicted to arrive at the site) during a time when the unit has minimum staff. In this scenario, the SM or US in charge would immediately perform the Ref. 41 notifications and requests for additional personnel to support the preparation efforts. The minimum staff would initiate closure of the flood gates, and approximately 7 hours would be available for the additional personnel to arrive on site within ≥ 5 hours prior to the consequential storm surge arriving on site to ensure the flood gate closure could be completed prior to arrival of a consequential storm surge. Additionally, since MPS3 does not require extensive site preparations for an approaching storm surge, MPS3 operations / maintenance personnel could also supplement the MPS2 operations / maintenance staff for site storm surge response, if needed.

Thus, with the 10-29-2012 actual flood gates closure time of 5 hours serving as a timed validation, and reasonable assurance that an adequate operational / maintenance staff will be available to implement the site storm surge flood protection TSA for any unit staffing condition that exists when the site storm surge response procedure is entered, the site flood protection TSAs can be feasibly implemented prior to a consequential storm surge arriving on site with > 12 hours available to perform this TSA.

The TSAs of installing the service water pump motor can and the operations staff actions to ensure the reactor plant is in a safe condition at various flood levels at the intake are CDB/CLB site flood response actions, (i.e., TSAs that are initiated and performed as directed by the TRM (Ref. 49) and the AOP (Ref. 41)). While the service water pump motor can installation TSA has not been functionally verified in an actual event because the site has never experienced a storm surge level of 14 ft.

MSL at the intake structure, this assessment concludes that this TSA is validated as a Level B Reasonable Judgement validation using the guidance of NEI 12-06, Appendix E, Section E.6.3.2. The installation of the service water pump motor can is judged to be feasible and to be able to be completed in a timely manner to ensure a safe condition of the reactor plant. The operations staff actions to ensure the reactor plant is in a safe condition at various flood levels at the intake are AOP actions which are periodically validated on the simulator during operator training and are considered to be a Level B Simulated Scenario (from Level A) validation of a Level B TSA under the guidance of NEI 12-06, Appendix E, Section E.6.3.2.

Therefore, this evaluation demonstrates that the TSAs can be feasibly implemented during the site storm surge response.

7.3.3.3.3 Establishing Unambiguous Procedural Triggers

The procedural action triggers for a consequential storm surge are provided in Refs. 41 and 49. The procedural action trigger that initiates the site storm surge response is notification of a hurricane warning (a hurricane warning is issued when hurricane conditions are expected in a specified coastal area in 24 hours or less, and include winds of $\geq$ 74 mph and/or dangerously high tides and waves), and/or the forecast of a storm center with sustained wind speeds greater than 60 mph expected to strike the site within 12 hours (Ref. 41). Thus, the initiating action trigger requires the site storm surge response to be initiated between 24 and 12 hours prior to a consequential storm surge reaching the site.

The primary actions required by the Ref. 41 initiating action trigger are to install the flood protection barriers prior to the storm surge arriving on site. Additionally the Ref. 41 action trigger requires the site to: perform station management notifications of storm conditions; request additional site personnel, if necessary, to support preparation efforts; and initiate site inspection and cleanup of loose material and debris, etc. Performing notification and requesting additional site personnel, if necessary, are accomplished promptly after the action trigger is activated, and site inspection and cleanup of loose material and debris can be accomplished prior to or during the installation of the flood protection barriers without impacting the installation.

Refs. 41 and 49 also include clearly stated action triggers for operations staff to ensure the reactor plant is in a safe condition at various intake structure storm surge flood levels. The action triggers are in the existing CDB/CLB actions prescribed by the TRM (Ref. 49) and Ref. 41. These action triggers and the associated required actions are described in detail in Section 7.3.3.7.

Therefore, the procedural action triggers provided in the site storm surge response procedures (Refs. 41 and 49) are clearly defined and unambiguous.

7.3.3.3.4 Proceduralized and Clear Organizational Response to a Flood

Surveillance Procedure SP 2654R (Ref. 43) requires monitoring of weather forecasts and conditions, evaluation of environmental conditions, and notifying the SM or US of degraded environmental conditions. SP 2654R is applicable at all times and performed a minimum of once per shift by the STA; and notes several examples of the various weather sources that may be used for severe weather forecasts. AOP 2560, "Storms, High Winds and Tides" (Ref. 41) is entered upon: observed high wave action at the intake structure; notification of a hurricane warning (a hurricane warning is issued when hurricane conditions are expected in a specified coastal area in 24 hours or less, and include winds of $\geq$ 74 mph and/or dangerously high tides and waves); the forecast of a storm center with sustained wind speeds greater than 60 mph expected to strike the site within 12 hours; or for any weather condition as determined by the SM/US (Ref. 41). C OP 200.6, "Storms and Other Hazardous Phenomena" (Ref. 39), which establishes command and control of the site response, will be entered with the initiation of AOP 2560, or at the discretion of the SM or US.

Dominion fleet procedure, HRP – N, "Hurricane Response Plan – Nuclear" (Ref. 38) provides for a corporate level assessment of station operational status and for the delineation of corporate responsibilities and support staff requirements for a hurricane related storm surge event. Provisions for assisting the station in evaluation and restoration efforts are also considered. HRP-N also establishes guidelines for instituting command and control of hurricane preparedness and response activities at the station level, to including, maintaining and restoring communications system functionality.

Site storm surge response is controlled by the clear procedural direction delineated in Ref. 41 and the various supporting procedures invoked by Ref. 41. The overall site storm surge response is described in Sections 6.1.3 and 7.3.3.3.7 including a detailed description of the site response to the various action triggers associated with the forecasted arrival of the storm surge and the actual storm surge levels.

The above described procedural direction establishes clear organizational response to a storm surge flooding event with procedurally defined responsibility for command and control of station personnel for severe weather preparations and the site response to a consequential storm surge.

Therefore, the station procedures clearly define the roles and responsibilities for each function of the MPS2 organization with respect to implementing the site storm surge response action plan before, during, and after a consequential storm surge event.

7.3.3.3.5 Detailed Flood Response Timeline

The strategy for the successful timeline response considered the following:

- Monitoring and action triggers
- Lead time to event and margin for preparation
- Inspection activities
- Flood protection installation activities
- Event duration
- Flood protection removal activities

The above listed considerations for a successful site storm surge flood response timeline are included in Ref. 41 and described in Section 7.3.3.3.7. Refs. 41 and 43 monitor storm conditions and Ref. 41 includes a storm surge action trigger that assumes initiation the site storm surge flood protection actions between 24 and 12 hours prior to the arrival of the consequential storm surge on site. As described in site response description detailed in Section 7.3.3.3.2, it has been validated that installation of the procedurally required power block flood protection features can be completed within approximately 5 hours. Thus, a flood protection implementation time margin of at least 7 hours (including site preparation and notification actions) prior to a consequential storm surge arriving on site is provided. Also as described in Section 7.3.3.3.2, validation of the storm surge flood operations staff response to other action trigger required actions has been performed to demonstrate the feasibility of the required actions to be completed in a timely manner. Section 7.3.3.3.7 evaluated the predicted event duration of the reevaluated combined effects with 1E-4 AEP probabilistic storm surge as acceptable with respect to the timeline for Ref. 41 required operator response. Ref. 41 includes flood protection removal actions, which are restoration actions and thus not critical timeline response activities.

7.3.3.3.6 Accounting for the Expected Environmental Conditions

The environmental conditions are expected to have minimal impact on the deployment of the flood protection features in response to the storm surge action triggers. Advance warning of the storm approaching the site will provide sufficient time for personnel to close the flood gates / stop logs to protect the station against flooding effects prior to the onset of severe weather. As described in Section 7.3.3.3.2, the TSA actions of closing the flood gates / stop logs have been functionally validated during the action environmental conditions of an approaching hurricane, which are considered sufficiently similar to those of an approaching reevaluated storm surge. Therefore, no additional protective measures associated with any expected adverse environmental conditions are required.

7.3.3.3.7 Demonstration of Adequate Site Response

The evaluation of adequate overall site response is performed in accordance with Appendix C of NEI 16-05 (Ref. 5).

Existing site procedures (Ref. 41) provide 12 - 24 hours of warning / site preparation time, which is based on hurricane and/or high wind and/or flood watches and warnings of a possible consequential storm surge arriving on site. The primary flood protection against a consequential storm surge are the existing permanent flood walls, procedurally closed flood gates and stop logs, and the existing procedurally installed flood protection can for one service water pump motor in the intake structure. This CDB/CLB flood protection bounds the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard flood levels in the power block and in the intake structure. Thus key SSCs that protect or support KSFs have adequate flood protection for a consequential storm surge.

While the reevaluated combined effects with 1E-4 AEP probabilistic storm surge maximum flood level inside the intake structure (27.6 ft. MSL) is bounded by the flood protection level (28 ft. MSL) for the one service water pump motor protected by the procedurally installed flood protection can, it exceeds the CLB storm surge maximum flood level inside the intake structure (26.5 ft. MSL). The 27.6 ft. MSL water level also exceeds the Ref. 41 and Ref. 49 TRM trigger for total water level exceeding site grade (14 ft. MSL), and the Ref. 41 procedural triggers for water levels exceeding 16.5 ft., 19.5 ft. and 22 ft. MSL in the intake structure. These procedural triggers require operator actions that impact/protect the reactor plant. They are listed below with their corresponding required operator actions:

- When water level including wave crest height reaches plant grade (14 ft.), install flood protection can on one operable service water pump motor (Ref. 47), (Ref. 41, step 4.3), (Ref. 49);
- If intake structure water level is forecasted to exceed 16.5 ft. within 4 hours, initiate plant shutdown to Hot Standby conditions (Ref. 41, step 4.8), establish AFW to SGs and maintain at Hot Standby using the SG ADVs (Ref. 41, step 4.15);
- If intake structure water level exceeds 19.5 ft., align fire water tank / pump to cool EDG not electrically aligned to the "canned" service water pump (Ref. 41, step 4.16);
- If intake water level exceeds 22 ft., start equipment powered from the EDG cooled by fire water, trip the EDG supplied by service water, stop all service water pumps and stop all RBCCW pumps (Ref. 41, step 4.17). (The EDG cooled by fire water powers one train of safety-related loads not requiring service water/RBCCW, e.g. CH pump, AFW pump, 480 VAC air compressors for operating SG ADVs in MCR, HPSI and LPSI pumps. Containment conditions and SFP conditions are monitored while service water/RBCCW is not available and containment cooling and SFP cooling are restored with the restoration of service water/RBCCW.);
- When intake water level recedes to less than 14 ft., remove the flood protection can from service water pump motor, re-connect the motor electrically, and restore service water to the applicable EDG (Ref. 41, step 5.1).

Ref. 21 documents the requirements and strategies for maintaining the key safety functions required for cooling the fuel in the reactor and the SFP, and to maintain the containment cooling function during an extended loss of all AC power (ELAP). The key safety functions required to be maintained during an ELAP (Ref. 21) are also required during the potential temporary short term loss of all AC power during the reevaluated combined effects with 1E-4 probabilistic storm surge flood hazard after depletion of the diesel-driven fire water pump fuel tank until service water is restored to the EDG. These key safety functions (KSFs) and how they will be maintained with a temporary loss of emergency AC power (temporary loss of EDG availability) during the reevaluated 1E-4 AEP probabilistic storm surge (and similarly during the CDB/CLB storm surge) are described in the following:

- Provide reactor core cooling and heat removal - When intake structure water level is forecasted to exceed 16.5 ft. within 4 hours, plant shutdown to Hot Standby conditions is initiated (Ref. 41, step 4.8), AFW to the SGs is initiated and the plant is maintained at Hot Standby using the SG ADVs (Ref. 41, step 4.15). Ref. 30, Attachment C, Figure 14 shows that intake structure total water level is at 16 ft. MSL and increasing at hour 48. The Ref. 35 analysis shows that if pre-emptive shutdown from full power is performed 4 hours prior to initiation of decay heat removal using the SG ADVs and AFW, the CST has 17.4 hours of AFW supply prior to depletion and SG dryout would occur after 23.9 hours without replenishing the CST. SG ADVs have manual operation capability if AC power is not available (Ref. 21). Therefore, if emergency power is lost due to a temporary loss of EDG availability, CST volume and SG inventory are sufficient for reactor heat removal using the TD AFW pump and SG ADVs for about 23.9 hours, (i.e., until about hour 71.9), which is more than an adequate amount of time for restoring cooling water (either fire water or service water) to the EDG for restoring emergency power and replenishing the CST.
- Provide RCS inventory and reactivity control – Loss of CH pump / system occurs with a temporary loss of emergency power (i.e., loss of EDG cooling) at hour 55, if service water is not restored. RCS inventory makeup to prevent loss of natural circulation and inventory control is not required for about 25 hours (Ref. 21, Attachment 1, Table 9.1-1). Therefore, emergency power for operation of the CH pumps / system, (i.e., RCS injection), would not be required for about 25 hours (i.e., until about hour 80).
- Provide SFP cooling – Ref. 41, step 4.12 directs operators to AOP 2582 (Ref. 44) for alternate SFP cooling, if required. More than sufficient time is available to initiate alternate SFP cooling, because after loss of SFP cooling (resulting from a temporary loss of emergency power due to loss of EDG cooling at hour 55) with the maximum expected SFP heat load, the SFP will begin to boil in approximately 6 hours and boil off to a level 10 ft. above top of fuel in 30 hours (Ref. 21, Attachment 1, Table 9.1-1). Therefore, SFP

cooling would not be required during a temporary loss of emergency power due to EDG unavailability for between 6 and 30 hours (i.e., between hour 61 and hour 85).

- Provide indication of key parameters – DC batteries provide power for key parameter indication for 29 hours after a loss of all AC power, if loss of all AC load stripping is performed within 75 minutes (Ref. 21, Attachment 1, Table 9.1-1). Therefore, since the DC switchgear room would not flood, DC battery power would be available, and emergency AC power for key parameter indication would not be required during a short-term temporary loss of emergency AC power supplied by the EDG (i.e., would not be required for 29 hours until about hour 84) if loss of all AC load stripping of the DC batteries is performed. If AC load stripping is not performed, DC battery capacity is 8 hours following the loss of emergency AC power (i.e. loss of the EDG). It can be concluded that key parameter indication would not be lost during the event even if AC load stripping was not performed. Although service water is procedurally secured at a storm surge elevation of about 22 ft. MSL, it could reasonably be restored for EDG cooling following recession of the storm surge within the available 10 hours of EDG operation using fire water for cooling (based on a full fire pump diesel fuel tank). Additionally, 8 hours of margin is available for powering indication of key parameters via the DC batteries. Furthermore, the fire pump diesel fuel tank could be refilled for longer term EDG cooling / operation, if the service water system became inoperable.
- Provide Containment cooling – Reduction of containment temperature and pressure (containment cooling) is not required until 4 – 5 days after an ELAP (Ref. 21, Attachment 1, Table 9.1-1). Therefore, containment cooling is not required until 4 – 5 days after the storm surge has passed through the site and would not be impacted by a temporary loss of emergency power due to temporary loss of EDG cooling during the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard (or during CDB/CLB storm surge flooding).
- Provide reactor core cooling in Shutdown Modes – If emergency power is lost temporarily due to temporary loss of EDG cooling, FLEX strategies (Ref. 21, Attachment 1, Chapter 8) are provided for reactor core cooling in Shutdown Modes during a loss of all AC power. Reactor core cooling is accomplished in Mode 5 using the SG ADVs initially steaming off SG inventory

and, if needed, with AFW delivered to the SGs using the BDB AFW pump pre-staged inside the Turbine Building railway access (Ref. 41, step 3.19 - for storm surge flood protection). In Mode 6, reactor core cooling during a loss of all AC power is accomplished by gravity feed from the Refueling Water Storage Tank (RWST) and by the BDB AFW pump if RWST driving head is not available. Therefore, reactor core cooling in Shutdown Modes would be insignificantly impacted by a temporary loss of emergency power due to temporary loss of EDG cooling during the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard (or during CDB/CLB storm surge flooding).

The reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard will have insignificant impact on the Ref. 41 required operator actions in response to the storm surge flood levels, even if a temporary loss of all AC power occurs as a result of the EDG becoming unavailable due to depletion of the diesel-driven fire water pump fuel tank prior to service water being restored to the EDG. The plant's KSFs can be maintained during a temporary loss of emergency power for more than a sufficient time than would be required to restore either fire water or service water cooling to the EDG, and thus restore emergency power.

Additionally, the Ref. 30, Attachment D, Figure D-14 wind speed transient plot shows that the wind speed at the intake structure is approximately 80 MPH at hour 55 of the storm surge event. Thus, operations / maintenance personnel travelling to the intake structure at hour 55 to remove the service water pump motor flood protection can and restore service water would necessarily have to use the safety line previously installed at the intake structure when they are traveling from the power block to the intake. Delaying this activity for 5 hours until the wind speed subsided to a safer speed would be desirable (wind speed drops to below 50 MPH at hour 60 and to approximately 15 MPH at hour 70).

Therefore, this evaluation recommends that Ref. 41 be enhanced by adding steps to ensure that the fire water pump diesel fuel tank level is at maximum level when a hurricane warning is issued. If the service water pump is shut down due to an intake structure storm surge water level $\geq$ 22 ft. MSL, this enhancement will provide approximately 10 hours of diesel fuel for fire pump operation to provide fire water cooling capability for the EDG, before the diesel fuel tank would require refilling during the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard (as well as during CDB/CLB storm surge flooding). This enhancement will provide the maximum time to restore service water to the EDGs (removing the service water pump motor can, reconnecting the pump motor electrically, and restoring service water to the EDG) once the storm surge level recedes to 14 ft. MSL without having to refill the diesel fuel tank. This would prevent or minimize the potential for a temporary loss of emergency power due to unavailability of the EDG from loss of fire water cooling due to depleting the fire pump diesel fuel tank during the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard or during CDB/CLB storm surge flooding.

The site response to the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard has been demonstrated as adequate by meeting the guidelines in NEI 16-05, Appendix C. The TSAs have been identified and determined to be feasible in accordance with NEI 12-06, Appendix E validation guidance. The clearly defined and unambiguous action trigger initiating the site response (24 to 12 hours prior to a consequential storm surge arriving on site) allows ample time to perform management notifications of storm conditions, augment plant staff for response support, if required, inspect and prepare the site, and to close / install flood barriers (implement the storm surge flood protection TSAs). The detailed procedural approaches in Refs. 41, 39 and 38 clearly establish the organizational command and control structure for site response, and detailed procedural instructions will allow each organization to effectively complete the required actions. Finally, adverse environmental conditions are expected to have minimal impact on storm surge flood protection preparation efforts.

Accordingly, this flood impact assessment demonstrates that the overall site response to the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard is adequate in accordance with the guidance of NEI 16-05 (Ref. 5).

7.3.4 Flood Scenario 2 — Feasible Response/Mitigation Approach

7.3.4.1 Flood Scenario 2 Summary

The reevaluated combined effects with 1E-5 AEP storm surge flood hazard total water levels are bounded by the respective CDB/CLB water levels for the east side of the power block (20.9 ft. vs. 21.3 ft. MSL) and at the west wall of the Turbine

Building (23.6 ft. vs. 25.1 ft. MSL); but not by the CDB/CLB storm surge standing wave level inside the intake structure (31.7 ft. vs. 26.5 ft. MSL). The west side of the intake structure is flood protected by its parapet elevation (43 ft. MSL), which bounds the reevaluated combined effects with 1E-5 AEP storm surge flood hazard total water elevation of 42.5 ft. MSL. However, the south side of the intake structure (39.0 ft. MSL roof elevation) is overtopped by the storm surge total water elevation at the south side of the intake of 43.0 ft. MSL. Ref. 32, Attachment B, Table 11 and Ref. 33 includes additional details.

The MPS2 nominal site grade elevation is 14 ft. MSL in the power block. The safety-related SSCs on the east side of the power block are flood protected to 22 ft. MSL by closing the flood gates and installing stop logs as required by Ref. 41. In addition, above elevation 22 ft. MSL, the external concrete (flood) walls of the Turbine Building transition to metal siding. In the CDB/CLB, the metal siding is credited as a flood protection feature that prevents the 25.1 ft. MSL CDB/CLB wave run-up from overtopping the west flood wall of the Turbine Building (Ref. 48, Section 2.5.4.2.2). However, a more conservative approach was taken for Turbine Building flood protection by the reevaluated combined effects with probabilistic storm surge analyses based on considerations regarding potential hurricane wind speeds and storm-driven debris.

The reevaluation (Ref. 32) assumed that the Turbine Building siding is not present to prevent flood water wave runup from overtopping the 22 ft. MSL west flood wall during the reevaluated flood hazard. The reevaluation conservatively estimated the total wave overtopping volume entering the MPS2 Turbine Building to be 872,000 gallons based on a conservative runup, and that the event would flood the Turbine Building floor at 14.5 ft. MSL to a depth of approximately 1.9 ft. (Ref. 25, Attachment 3).

The overtopping flood volume would fill the AFW pump room to a floor elevation of 1.5 ft. MSL (located in the Turbine Building below the 14.5 ft. floor elevation) and inundate the two motor-driven auxiliary feedwater (MDAFW) and turbine-driven auxiliary (TDAFW) pumps, resulting in a loss of the AFW KSF. The about 1.9 ft. flood depth on the Turbine Building 14.5 ft. floor elevation would not inundate the BDB AFW pump (pre-staged in the Turbine Building railway access per Ref. 41, step 3.19) with a top of trailer frame height of about 2.3 ft. (Ref. 24, Attachment 4), but would partially submerge the BDB FLEX AFW and CST connections for the BDB AFW pump discharge and suction hoses. Therefore, margin is available for more overtopping volume than is predicted by the reevaluated combined effects with 1E-5 AEP storm surge flood hazard analysis.

Key safety-related SSCs east of the Turbine Building west flood wall are protected from the reevaluated combined effects flooding with 1E-5 AEP probabilistic storm surge flood hazard by the flood wall and the Ref. 41 installed flood gates and stop logs (i.e., APM = (22 – 20.9) = 1.1 ft.).

The service water system SSCs located in the intake structure are assumed to be inundated during the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard, since the 43.0 ft. MSL wave runup at the south side of the intake structure overtops the roof at 39.0 ft. MSL and wave runup overtopping flood water would enter the intake structure via openings in the roof. The service water pump motor flood protection can and the sealed power cables would prevent some inundation by the wave runup overtopping flood water entering from the roof louvers. When the storm surge level recedes to below 14 ft. MSL, the service water pump motor flood protection can and power cable wrapping would be removed. Then motor and cable availability / unavailability could be verified via meggering and potential dry out, and service water system operability or inoperability could be determined. However, this assessment conservatively assumes that the service water function is lost during the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard. Note that there are other enhancements identified during the IA process and those enhancements will be discussed at the end of the Flood Scenario 2 section.

Intake structure hydrostatic, hydrodynamic and debris loading analyses were performed for the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard. Loads due to non-breaking waves were calculated as hydrostatic and hydrodynamic loads. Debris impact loads are assumed to act at the water surface elevation (Ref. 31). The Ref. 36 evaluations conclude that the intake structure can accommodate the loads.

Therefore, the AFW system pumps and associated equipment located in the AFW pump room are the only safety related SSCs located in the power block that are inundated by the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard. Thus, once the initial SG inventory is depleted, the loss of AFW results in the loss of the reactor heat removal KSF. Additionally, this assessment assumes that the combined effects with 1E-5 AEP probabilistic storm surge flood hazard will inundate the electrical power cabling for the service water pump motors and will result in the loss of the service water KSF, i.e., LUHS.

7.3.4.2 Adequate APM Justification and Reliability of Flood Protection

The APM determination is made using the guidance provided in Appendix B of NEI 16-05, "External Flooding Assessment Guidelines" (Ref. 5).

The MPS2 nominal site grade elevation is 14 ft. MSL in the power block. Except for the AFW pump room with a floor elevation of 1.5 ft. MSL (located in the Turbine Building below the 14.5 ft. floor elevation), the safety-related SSCs in the power block are flood protected to 22 ft. MSL during the reevaluated combined effects flooding with 1E-5 AEP probabilistic storm surge flood hazard by closing the flood gates and installing stop logs as required by Ref. 41. The Turbine Building west flood wall overtopping flood volume would fill the AFW pump room and inundate the two MDAFW and the TDAFW pumps, resulting in a loss of the AFW KSF. The west side of the MPS1 and MPS2 power block buildings combine to essentially form a continuous barrier, which effectively prevents wave runup along the west side wall of the "barrier" from continuing on into the main site / power block area east of Turbine Building. Consequently, wave effects are judged to be negligible in the MPS2 main site / power block area and the total water level in the power block east of the Turbine Building is 20.9 ft. MSL (Ref. 32, Attachment B, Table 11).

Therefore, other than the AFW SSCs in the Turbine Building, key safety-related SSCs in the power block are reliably flood protected from the reevaluated combined effects flooding with 1E-5 AEP probabilistic storm surge flood hazard with an APM = (22 ft. – 20.9 ft.) = 1.1 ft. Thus, 1.1 ft. of margin is available in the stillwater flood level in the power block during the 1E-5 AEP storm surge scenario.

The service water system is assumed to be lost during the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard, since the 43.0 ft. MSL wave runup at the south side of the intake structure overtops the roof at 39.0 ft. MSL, allowing wave runup overtopping flood water to enter the intake structure via openings in the roof. The service water pump motor flood protection can and the sealed power cables would prevent some inundation by the wave runup overtopping flood water entering from the roof. When the storm surge level recedes to below 14 ft. MSL, the service water pump motor flood protection can and power cable wrapping would be removed. Then motor and cable availability /

unavailability could be verified via meggering and potential dry out, and service water system operability or inoperability could be determined.

Therefore, reliable flood protection is not available for the AFW and service water system SSCs during the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard. Reliable flood protection with adequate APM is provided for other SSCs that provide / maintain KSFs.

7.3.4.3 Response Strategy for Combined Effects with 1E-5 AEP Probabilistic Storm Surge Flood Scenario (Effective Mitigation/Feasible Response)

Adequate APM and reliable flood protection is available for the SSCs located in the power block, except for the AFW pumps and associated equipment housed in the AFW pump room with a floor elevation of 1.5 ft. MSL (located in the Turbine Building below the 14.5 ft. MSL floor elevation). Reliable flood protection is not available for the service water pumps, motors and associated equipment, which are the only safety-related SSCs located in the intake structure. Thus, the service water SSCs located in the intake structure are inundated during the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard event. Therefore, the AFW reactor heat removal KSF and the service water KSF are lost (i.e., LUHS occurs) in this scenario.

7.3.4.3.1 Loss of AFW Response Strategy

Loss of AFW function during the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard event can be mitigated using a FLEX strategy where the BDB AFW pump is used to supply AFW to the SGs for reactor heat removal (Ref. 21, Attachment 1, Section 2.2.2). As described in Ref. 21, Attachment 1, Section 2.2.2, the BDB AFW is pre- staged in the Turbine Building railway access, if the potential for flooding exists (as directed by Ref. 41, step 3.19). Section 7.2.1 recommended enhancements to Ref. 41, step 4.8, which would procedurally direct connection of the pre-staged BDB AFW pump discharge and suction hoses to the FLEX AFW and CST connections, respectively; and to step 4.17 to open the FLEX connections' isolation valves when excessive flood water level begins accumulating in the condenser pit. This will ensure that the BDB AFW pump, with a 28 inch top of trailer frame height, will be available for operation with approximately 1.9 ft. maximum flood depth present on the 14.5 ft. MSL elevation Turbine Building floor during the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard (Ref. 25, Attachment 3).

Ref. 32 concludes that significant wave overtopping of the Turbine Building flood wall would be approximately 872,000 gallons and last approximately 7 to 8 hours in total. Ref. 32, Attachment C, Figure 18 shows that the maximum significant wave height occurs at hour 51 of the 1E-5 AEP probabilistic storm surge event. As described in Section 7.3.4.1, approximately 395,400 gallons of the 872,000 gallons of overtopping volume would flood the Turbine Building floor at 14.5 ft. MSL and then flood into the AFW pump room at the 1.5 ft. elevation. Since roughly half of the overtopping flood volume would be contained in the condenser pit, etc. and the significant wave height transient plot is symmetrical about its maximum height, it is reasonable that the 14.5 ft. floor elevation would start accumulating water at about the time of the maximum height, which is at about hour 51 of the event (Ref. 32, Attachment C, Figure 18).

Review of Ref. 32, Attachment C, Figure 14 shows that total water level of about 16.5 ft. MSL occurs at the intake structure at about hour 48 of the event. Ref. 32, Attachment C, Figure 14 shows that total water level of about 16.5 ft. MSL occurs at the intake structure at about hour 48 of the event. Ref. 41, step 4.8 initiates a preemptive plant cooldown to Hot Standby conditions when intake structure water level is forecasted to exceed 16.5 ft. within 4 hours, which would be at less than hour 44 of the event. Thus, the TDAFW pump would have been delivering AFW to the SGs for reactor heat removal for about 7 hours prior to loss of AFW function at about hour 51 of the event when the AFW pump room is inundated. This assessment recommends pre-connecting the BDB AFW pump hoses to the FLEX AFW discharge and CST supply connections and also recommends maintaining the SG levels at the maximum value of the range while in Hot Standby conditions. With approximately 6.5 hours of SG inventory available (with the SGs at normal level) for reactor decay heat removal after 17.4 hours following a preemptive reactor shutdown (Ref. 35), there is reasonable assurance that the pre-staged / pre-connected BDB AFW pump would be started and delivering AFW to the SGs well before SG inventory is depleted in this scenario.

Therefore, the FLEX strategy of using the BDB AFW pump to supply AFW to the SGs for reactor heat removal, in conjunction with the enhancements to Ref. 41, steps 4.8 and 4.15.e (which would procedurally direct connection of the pre-staged BDB AFW pump discharge and suction hoses to the BDB FLEX AFW and CST connections, respectively, when the unit is shutdown to Hot Standby and opening the FLEX connections' isolation valves if excessive flood water is filling the condenser pit; and maintaining the SGs levels at the maximum value in their level range when the plant is in Hot Standby) is an effective mitigation strategy for the loss of AF function during the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard scenario.

7.3.4.3.2 Loss of Service Water Response Strategy

As described in Section 7.3.4.1, the service water SSCs in the intake structure are assumed to be inundated during the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard, since the 43.0 ft. MSL wave runup at the south side of the intake structure overtops the roof at 39.0 ft. MSL and wave runup overtopping flood water would enter the intake structure via openings in the roof.

The site response to the reevaluated combined effects with 1E-5 AEP probabilistic storm surge follows the CDB / CLB storm surge site response prescribed in Ref. 41 specifically if the flood protected service water pump, motor and associated equipment can be recovered after being inundated as described above, the response is also the same as the site response described in Section 7.3.3.3.7 for the reevaluated combined effects with 1E-4 AEP probabilistic storm surge. The Ref. 41 site response is based on procedural implementation of flood protection for key SSCs and operations staff actions to ensure the reactor plant is in a safe condition at various storm surge flood levels and contains procedural triggers at various flood levels that require operator actions which impact / protect the reactor plant.

These procedural triggers are listed below with the corresponding required operator actions:

- When water level including wave crest height, reaches plant grade (14 ft.), install flood protection can on one operable service water pump motor (Ref. 47), (Ref. 41, step 4.3), (Ref. 49);
- If intake structure water level is forecasted to exceed 16.5 ft. within 4 hours, initiate plant shutdown to Hot Standby conditions (Ref. 41, step 4.8), establish AFW to the SGs and maintain at Hot Standby using the SG ADVs (Ref. 41, step 4.15);
- If intake structure water level exceeds 19.5 ft., align fire water tank / pump to cool EDG not electrically aligned to the “canned” service water pump motor (Ref. 41, step 4.16);
- If intake water level exceeds 22 ft., start equipment powered from the EDG cooled by fire water, trip the EDG supplied by service water, stop all service water pumps and stop all RBCCW pumps (Ref. 41, step 4.17). (The EDG cooled by fire water powers one train of safety-related loads not requiring service water / RBCCW, e.g. CH pump, AFW pump, 480 VAC air compressors for operating SG ADVs in MCR, HPSI and LPSI pumps. Containment conditions and SFP conditions are monitored while service water / RBCCW is not available, and containment cooling and SFP cooling are restored with the restoration of service water / RBCCW.);
- When intake water level recedes to less than 14 ft., remove the flood protection can from service water pump motor, re-connect the motor electrically, and restore service water to the applicable EDG (Ref. 41, step 5.1).

The fire water pump’s 275 gallon diesel fuel tank is verified to be filled to between L (50%) and F (100%) level during operator daily rounds (Ref. 40). If the 275 gallon fuel tank is assumed to be half full, sufficient fuel would be available to operate the diesel driven fire pump (with a fuel consumption rate of 26 gallons / hour (Ref. 42)) for approximately 5 hours. Thus, the fire water pump diesel fuel tank would need to be verified to be at full level for 10 hours of fire pump operation and refilled during the event. However, the outdoor activity of refilling the fire water pump diesel fuel tank cannot be performed until the storm surge recedes to the power block site grade elevation of about 14 ft. (about 8 hours after initiating fire water pump operation) and the wind speed subsides to a reasonable level. Therefore, the EDG may not have cooling water for a short time, which could result in emergency power not being available (i.e., a temporary loss of all AC power) after the diesel-driven fire water pump fuel tank is depleted (at about 10 hours after initiating fire water pump operation).

Ref. 21 documents the requirements and strategies for maintaining the key safety functions (KSFs) required for cooling the fuel in the reactor and the spent fuel pool (SFP), and to maintain the containment cooling function during an extended loss of all AC power (ELAP). These KSFs are also required during the potential temporary short term loss of all AC power and the loss of the service water and AFW KSFs due to flood inundation during the reevaluated combined effects with 1E-5 probabilistic storm surge flood hazard.

These key safety functions (KSFs) and how they will be maintained during the reevaluated 1E-5 AEP probabilistic storm surge (and similarly during the CDB / CLB storm surge) are described below:

- Provide reactor core cooling and heat removal - When intake structure water level is forecasted to exceed 16.5 ft. within 4 hours, plant shutdown to Hot Standby conditions is initiated (Ref. 41, step 4.8), AFW to the SGs is initiated and the plant is maintained at Hot Standby using the SG ADVs (Ref. 41, step 4.15). Analysis (Ref. 35) indicates the TDAFW pump would have been delivering AFW to the SGs for reactor heat removal for approximately 7 hours prior to loss of AFW function event when the AFW pump room is inundated. This assessment recommends pre-connecting the BDB AFW pump hoses to the FLEX BDB AFW discharge and CST supply connection and maintaining SG levels at the maximum value of the range while in Hot Standby conditions. There is reasonable assurance that the pre-staged / pre-connected BDB AFW pump would be started and deliver AFW to the SGs well before SG inventory depleted in this scenario. Therefore, the reactor core cooling and heat removal KSF can be maintained during the 1E-5 AEP probabilistic storm surge scenario using SG ADVs; initially steaming SG inventory, followed by the FLEX strategy for alternate AFW using the BDB AFW pump (Ref. 21, Attachment 1, Section 2.2.2).

- Provide RCS inventory and reactivity control – Loss of CH pump / system occurs with a temporary loss of emergency power if the diesel-driven fire pump diesel fuel tank only has an inventory for 5 hours of fire pump operation. RCS inventory makeup to prevent loss of natural circulation and inventory control is not required for about 25 hours (Ref. 21, Attachment 1, Table 9.1-1). Consequently, emergency power for operation of the CH pumps / system (i.e., RCS injection), would not be required for about 25 hours. Therefore, more than adequate time is available after the storm surge passes through the site to regularly refill the fire pump diesel tank for EDG operability, or to initiate the FLEX strategy for RCS injection using the BDB RCS Injection pump (Ref. 21 Attachment 1, Chapter 3). Either method will ensure that the RCS inventory and reactivity control KSF can be maintained during the 1E-5 AEP probabilistic storm surge scenario.
- Provide SFP cooling – Ref. 41, step 4.12 directs operator to implement AOP 2582 (Ref. 44) for alternate SFP cooling, if required. After loss of SFP cooling (resulting from a potential temporary loss of emergency power due to loss of EDG cooling with the maximum expected SFP heat load), the SFP will boil off to a level 10 ft. above top of fuel in 30 hours (Ref. 21, Attachment 1, Table 9.1- 1). Thus, SFP cooling would not be required during a temporary loss of emergency power due to EDG unavailability until between 6 and 30 hours. Therefore, more than adequate time is available after the storm surge passes through the site to initiate alternate SFP cooling via AOP 2582, or to initiate the FLEX strategy for SFP cooling (Ref. 21 Attachment 1, Chapter 6), which ensures that the SFP cooling KSF can be maintained during the 1E-5 AEP probabilistic storm surge scenario.
- Provide indication of key parameters – DC batteries provide power for key parameter indication during a loss of all AC power (Ref. 21, Attachment 1, Table 9.1-1). Since DC battery power is available, emergency AC power for key parameter indication would not be required during a potential temporary loss of emergency power supplied by the EDG. It is reasonable to conclude that the DC batteries would be available for the short time that EDG cooling / emergency power could be lost until diesel-driven fire pump diesel fuel tank was refilled and EDG cooling using the fire pump was re-initiated (described in detail above). Additionally, FLEX strategies are available for obtaining key parameter instrument readings locally if DC power and emergency AC power are not available (Ref. 21, Attachment 1, Section 7.2.4).

Therefore, response strategies are available for maintaining the indication of key parameters KSF during the 1E-5 AEP probabilistic storm surge scenario.

- Provide Containment cooling – Reduction of containment temperature and pressure (containment cooling) is not required until 4 – 5 days after an ELAP (Ref. 21, Attachment 1, Table 9.1-1). Consequently, containment cooling is not required until well after the storm surge passes through the site and thus would not be impacted by a potential temporary loss of emergency power due to temporary loss of EDG cooling during the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard (or during CDB / CLB storm surge flooding. Therefore, response strategies are available for maintaining the containment cooling KSF during the 1E-5 AEP probabilistic storm surge scenario.
- Provide reactor core cooling in Shutdown Modes – If emergency power is lost temporarily due to temporary loss of EDG cooling, FLEX strategies (Ref. 21, Attachment 1, Chapter 8) are provided for reactor core cooling in Shutdown Modes during a loss of all AC power. This assessment assumes that with a consequential storm surge approaching, station operations staff will move the shutdown reactor to the safest condition possible prior to the storm reaching the site. Reactor core cooling is accomplished in Mode 5 using the SG ADVs initially steaming off SG inventory and, if needed, with AFW delivered to the SGs using the BDB AFW pump pre-staged inside the Turbine Building railway access (Ref. 41 step 3.19 - for storm surge flood protection). In Mode 6, reactor core cooling during a loss of all AC power is accomplished initially by gravity feed from the RWST and by the pre-staged BDB AFW pump when RWST driving head is not available. Therefore, response strategies are available for maintaining the reactor core cooling in Shutdown Modes KSF during the 1E-5 AEP probabilistic storm surge scenario.

8 CONCLUSIONS

The results of the MPS FHRR (Ref. 13), the supplement to the FHRR (Ref. 18), the NRC's Staff Assessment (Ref. 17) and the NRC's Supplement to the Staff Assessment (Ref. 20) concluded that three (3) reevaluated flood-causing mechanisms (LIP, tsunami and storm surge) that were not bounded by the MPS2 current licensing basis required further evaluation. The reevaluated LIP and tsunami flood hazards are evaluated in this Focused Evaluation in accordance with Path 3 and Path 2, respectively, of NEI 16-05, Rev. 1 (Ref. 5) guidance for evaluating the site strategy for effective flood protection. The reevaluated storm surge flood hazard is evaluated in accordance with Path 5 of NEI 16-05, Rev. 1 (Ref. 5).

Reevaluated LIP and Tsunami Flood Hazard – Focused Evaluation

The reevaluated LIP flood-causing mechanism generates flood water levels ranging from 14.3 ft. MSL to 17.5 ft. MSL at the intake structure and main site / power block, respectively. Flood levels above 14.5 ft. MSL will typically challenge door thresholds and yard penetrations, but remain below the flood walls, flood gate / stop log and flood barrier protection level of 22 ft. MSL at the main site / power block. Station procedures detail required LIP flood protection actions (i.e., flood gate closure, stop log and flood barrier installations) as well as the required timeline for installation. The safety-related service water pumps, motors and associated electrical equipment, which provide the only KSF in the intake structure, are protected from LIP flooding by their elevation (>21.7 ft. MSL) above the pump room floor.

Ref. 41, Attachment 6 includes an action trigger to initiate required LIP flood protection actions within ≥ 12 hours of a consequential LIP storm forecasted arrival on site from: local weather forecasts, CAENS, or CONVEX. The site LIP flood protection actions (TSAs) have been validated as being able to be implemented in approximately 5 hours, which is at least approximately 7 hours less than the time predicted for the consequential LIP storm to reach the Millstone site.

Effective LIP flood protection requires not only the procedural installation of the LIP flood protection barriers, but also plant modifications to add LIP flood barriers at various door locations and qualified penetration seals at various locations around the site to establish a reliable flood protection boundary.

The reevaluated maximum tsunami flood level is bounded by the CLB PMH storm surge flood level, but the warning time for the tsunami is less than that for the

PMH. Shallow flooding (up to 0.7 ft.) above the MPS2 nominal site grade of 14 ft. MSL is possible. The tsunami is predicted to reach the Millstone site approximately 8.7 hours after the occurrence of the initiating event (Ref. 13).

Ref. 41, Attachment 7 includes an entry condition to initiate required actions based on a tsunami warning from CAENS and / or CONVEX. The required actions include installation of the site tsunami flood protection features, which are the same procedural flood gate closure, stop log and flood barrier installations as for the LIP, in response to notification of tsunami warning. The site tsunami flood protection features have been validated as being able to be implemented (TSAs) in approximately 5 hours, which is approximately 3 hours less than the time predicted for the tsunami to reach the Millstone site.

This FE demonstrates that the planned site response is adequate to protect the MPS2 KSFs from both the reevaluated LIP and tsunami flood hazards.

Reevaluated storm surge flood hazard - Integrated Assessment

This assessment demonstrates that the existing flood protection features provide effective flood protection and that the overall site response is adequate for the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard. In addition, this assessment demonstrates an effective mitigation / feasible response strategy with margin for the loss of the AFW and service water functions during the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard scenario.

A procedural change is currently being processed which will add steps to Ref. 41 to ensure that the fire water pump diesel fuel tank is filled to maximum level prior to the storm surge arriving on site. If the service water pump is shut down due to the intake storm surge water level > 22 ft. MSL, this will provide approximately 10 hours of diesel fuel for fire pump operation to provide fire water cooling capability for the EDG before the fire pump diesel fuel tank would require refilling during the reevaluated combined effects with $\leq$ 1E-4 AEP probabilistic storm surge flood hazard, or during the CDB / CLB storm surge flood.

The submittal of this Focused Evaluation and Integrated Assessment completes the actions related to external flooding required by the NRC in the March 2012 Request for Information under 10 CFR 50.54(f) for the MPS2 reevaluated LIP, tsunami and storm surge combined effects with probabilistic flood-causing mechanisms.

ATTACHMENT 2

MILLSTONE POWER STATION UNIT 3 FLOODING FOCUSED EVALUATION / INTEGRATED ASSESSMENT SUMMARY

DOMINION ENERGY NUCLEAR CONNECTICUT, INC
MILLSTONE POWER STATION UNIT 3

Millstone Unit 3 Power Station
Flooding Focused Evaluation / Integrated Assessment Summary

January 2020
Letter Serial #19-475
Attachment 2

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1 EXECUTIVE SUMMARY

Dominion has reevaluated the flooding hazards at Millstone Power Station Unit 3 (MPS3) in accordance with the Nuclear Regulatory Commission's (NRC) March 12, 2012, 10 CFR 50.54(f) request for information (RFI) (Ref. 1). 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 (NTTF) report. This information was submitted to the NRC in a flood hazard reevaluation report (FHRR) on March 12, 2015 (Ref. 13). The NRC's assessment of the FHRR (with the exception of storm surge) is documented in the NRC's letter to Dominion, "Staff Assessment of Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation," dated October 3, 2018 (Ref. 17). The storm surge is assessed in the NRC's letter to Dominion, "Supplement to Staff Assessment of Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation," dated October 7, 2019 (Ref. 20).

In all, eight flooding mechanisms were evaluated to determine if any challenged the Current Licensing Basis (CLB); and, two mechanisms were found to exceed the CLB at MPS3. The mechanisms are listed below:

1. Tsunami
2. Storm Surge

Associated effects (AE) and flood event duration (FED) parameters were assessed and submitted as a part of the FHRR. No changes to the tsunami flooding analysis have been performed since the issuance of the FHRR Staff Assessment (Ref. 17), thus the analyses provide input to the Focused Evaluation (FE) process. However, it should be noted that additional analyses have been utilized to evaluate the Storm Surge flooding mechanism.

The Flooding FE evaluated the impact of the tsunami flood-causing mechanism on the site strategy for effective flood protection in accordance with Path 2 of NEI 16-05, Rev. 1 (Ref. 5) guidance. The Flooding FE concludes that the strategies for maintaining key safety functions (KSFs) during the reevaluated tsunami flood hazard provide effective flood protection through the demonstration of adequate Available Physical Margin (APM), reliable flood protection features, and feasible overall site response.

The Flooding IA evaluated the impact of the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard in accordance with Path 5 of NEI 16-05, Rev. 1 (Ref. 5) guidance. The Flooding IA demonstrates that effective flood protection is available for the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard scenario; that effective mitigation / feasible response strategies are available for the reevaluated combined effects with 1E-5 AEP probabilistic storm surge flood hazard scenario.

Submittal of this FE/IA completes the Dominion response to external flooding evaluations required by the March 12, 2012 10 CFR 50.54(f) letter for the MPS3 tsunami and storm surge flood-causing mechanisms.

2 BACKGROUND

On March 12, 2012, the NRC issued Ref. 1 to request information associated with Near-Term Task Force (NTTF) Recommendation 2.1 for flooding. The RFI directed licensees, in part, to submit a Flood Hazard Reevaluation Report (FHRR) to reevaluate the flood hazards for their sites using present-day methods and guidance used for early site permits and combined operating licenses. In its March 12, 2015 letter to the NRC, Serial No. 15-106 (Ref. 13), Dominion Nuclear Connecticut, Inc. (DNC, now known as Dominion Energy Nuclear Connecticut, Inc. or DENC) submitted the "Millstone Power Station Units 2 and 3 Flood Hazard Reevaluation Report in Response to March 12, 2012 Information Request Regarding Flooding Aspects of Recommendation 2.1." Additional information was provided to the NRC in Refs. 16 and 18.

The reevaluated flood hazard information in the FHRR was confirmed as appropriate input to additional assessments supporting plant response (except for storm surge) in the NRC's letter to Dominion, "Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation" dated December 21, 2016 (Ref. 15) and the storm surge was confirmed as such in the NRC's letter to Dominion, "Millstone Power Station, Units 2 and 3 – Supplement to Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation" (Ref. 19). The NRC's letter to Dominion, "Staff Assessment of Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation," dated October 3, 2018 (Ref. 17) and "Millstone Power Station, Units 2 and 3 – Supplement to Staff Assessment of Response to 10 CFR 50.54(f) Information Request – Flood – Causing Mechanism Reevaluation," dated October 7, 2019 (Ref. 20) provided documentation supporting the conclusions summarized in the interim staff responses.

In all, eight flood-causing mechanisms were evaluated to determine if any challenged the Current Licensing Basis (CLB); and two mechanisms (tsunami and storm surge) were found to exceed the CLB at MPS3 and required further evaluation.

During the NRC's review of the reevaluated storm surge flood hazard information submitted in the FHRR, Dominion and the NRC concluded that in order to reduce the uncertainty around the FHRR's reevaluated 1E-6 Annual Exceedance Probability (AEP) probabilistic storm surge analysis, a more frequent 1E-4 AEP probabilistic storm surge analysis would be performed. Thus, the NRC did not include a review of the reevaluated storm surge flood hazard information in the Staff Assessment of the FHRR. Dominion performed a reevaluated 1E-4 AEP probabilistic storm surge analysis and submitted the results of the analysis in a supplement to the FHRR (Ref. 18). The NRC's assessment of the supplemental FHRR is documented in the NRC's letter to Dominion, "Supplement to Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation," dated April 3, 2019 (Ref. 19).

Associated effects (AE) and flood event duration (FED) parameters were assessed and submitted as a part of the FHRR. Additional analyses were developed for the supplemental FHRR and a lower probability storm surge scenario analysis to evaluate the storm surge flood-causing mechanism was also prepared. However, no additional tsunami analyses have been performed since the issuance of the FHRR Staff Assessment (Ref. 13).

Following the Commission's directive to NRC Staff in Ref. 9, the NRC issued a letter to the industry (Ref. 10) indicating that new guidance is being prepared to replace instructions in Ref. 9 and provide for a "graded approach to flooding reevaluations." This "graded approach" modified the requirements for plants and allowed for "more focused evaluations of local intense precipitation and available physical margin in lieu of proceeding to an integrated assessment." NEI prepared the new "External Flooding Assessment Guidelines" in NEI 16-05, which was endorsed by the NRC in Ref. 3. NEI 16-05 (Ref. 5) indicates that each flood-causing mechanism not bounded by the design basis 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 Flood Mitigation
- Path 5: Scenario Based Approach

Non-bounded flood-causing mechanisms in Paths 1, 2, or 3 require a Focused Evaluation (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 (IA).

The reevaluated tsunami flood-causing mechanism is appropriately evaluated in accordance with NEI 16-05, Rev. 1, Path 2 guidance by a Flooding FE of the site strategy for effective flood protection. NEI 16-05, Appendix B includes guidance for evaluation of passive and active features, and Appendix C for the evaluation of site response. The reevaluated storm surge flood-causing mechanism is appropriately evaluated in accordance with Path 5 of NEI 16-05, Rev. 1 guidance in a Flooding IA of the site strategy using a scenario based approach of blended responses for flood mitigation.

3 REFERENCES

Please note that not all references are cited within the main document. Some are included as general background reference.

1. U.S. 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," March 12, 2012 (ADAMS Accession No. ML12053A340).
2. Millstone Licensing Assignment LA006022, "Perform an integrated assessment in response to the results of the Combined Effects flood hazards for MPS Units 2 & 3," March 10, 2015.
3. U.S. NRC JLD-ISG-2016-01, Rev. 0, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flooding Hazard Reevaluation; Focused Evaluation and Integrated Assessment," July 2016, (ML16162A301).
4. U.S. NRC COMSECY-15-0019, "Closure Plan for the Reevaluation of Flooding Hazards for Operating Nuclear Power Plants", June 30, 2015 (ML15153A105).
5. Nuclear Energy Institute 16-05, Rev. 1, "External Flooding Assessment Guidelines," June 30, 2016.
6. Letter from David L. Skeen, U.S. Nuclear Regulatory Commission, to Joseph E. Pollock, Nuclear Energy Institute, "Trigger Conditions for Performing an Integrated Assessment and Due Date for Response," December 3, 2012 (ML12326A912).
7. U.S. NRC JLD-ISG-2012-05, "Guidance for Performing the Integrated Assessment for External Flooding," November 30, 2012 (ML12311A214).
8. U.S. NRC COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," November 21, 2014 (ML14238A616).
9. U.S. NRC "Staff Requirements Memoranda to COMSECY-14-0037, "Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards," March 30, 2015 (ML15089A236).
10. U.S. NRC Letter, "Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events," September 1, 2015 (ML15174A257).

11. U.S. NRC NUREG/CR-7046, "Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United States of America," December 2010.
12. Nuclear Energy Institute 12-06, Rev. 4, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," December 12, 2016 (ML16354B421).
13. Dominion Nuclear Connecticut, Inc. Letter, "Millstone Power Station Units 2 and 3 Flood Hazard Reevaluation Report in Response to March 12, 2012 Information Request Regarding Flooding Aspects of Recommendation 2.1," March 12, 2015 (Serial No. 15-106).
14. U.S. 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," March 1, 2013 (ML13044A561).
15. U.S. NRC Letter, "Millstone Power Station, Units 2 and 3 - Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10CFR50.54(f) Information Request – Flood-Causing Mechanism Reevaluation," December 21, 2016 (Serial No. 16-494).
16. Dominion Nuclear Connecticut, Inc. Letter, "Millstone Power Station Units 2 and 3 Mitigating Strategies Assessment (MSA) Report," June 28, 2017 (Serial No. 17-268).
17. U.S. NRC Letter, "Millstone Power Station Units 2 and 3 – Staff Assessment of Response to 10CFR50.54(f) Information Request – Flood-Causing Mechanism Reevaluation," October 3, 2018 (Serial No. 18-386).
18. Dominion Energy Nuclear Connecticut, Inc. Letter, "Millstone Power Station Units 2 and 3 Supplement to Dominion Flooding Hazard Reevaluation Report," January 4, 2019 (Serial No. 18-447).
19. U.S. NRC Letter to Dominion, "Millstone Power Station, Units 2 and 3 – Supplement to Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation," April 3, 2019 (Serial No. 19-169).
20. U.S. NRC Letter to Dominion, "Millstone Power Station, Units 2 and 3 – Supplement to Staff Assessment of Response to 10CFR50.54(f) Information Request – Flood – Causing Mechanism Reevaluation," October 7, 2019 (Serial 19-426).

21. Dominion (Bechtel) Calculation 25785-000-K0C-0000-00007, Rev.0, Beyond Design Basis Evaluation of Water In-Leakage to MPS3 Main Steam Valve Building, Service Building, and Waste Disposal Building Including Primary Grade Water Pump House due to Local PMP.
22. Dominion Engineering Technical Evaluation, ETE-CPR-2017-1001, Rev. 0, MPS 2 & 3 Flooding Vulnerability Walk-downs.
23. Dominion Engineering Technical Evaluation, ETE-MP-2014-1028, Rev. 1, Conduit/Piping Penetrations & Flood Protection Features Identification, Millstone Unit 3.
24. Dominion Engineering Technical Evaluation, ETE-CPR-2017-1003, Rev. 0, Millstone Unit 3 Beyond Design Basis Flooding Assessment.
25. Dominion Engineering Technical Evaluation, ETE-CPR-2017-1004, Rev. 0, Impact of Reevaluated Flood Hazards on FLEX Mitigating Strategies, Millstone Units 2 & 3.
26. Dominion (Zachry) Calculation 14-027, Rev. 0, Detailed Tsunami Modeling for Millstone Power Station.
27. Dominion (Zachry) Calculation, 18-075, Rev. 0, Millstone Power Station Annual Exceedance Probability 1.0E-04 for Probabilistic Storm Surge Analysis.
28. Dominion (Zachry) Calculation, 18-110, Rev. 0, Combined Effects Flood Analysis at Millstone Power Station Units 2 & 3.
29. Dominion (Zachry) Calculation, 19-005, Rev. 0, Probabilistic Stillwater Flood Elevation Analysis for an AEP of 1E-5 at Millstone Power Station.
30. Dominion (Zachry) Calculation, 19-007, Rev. 0, Combined Effects Flood Analysis for Storm Surge Annual Exceedance Probability 1E-5 for Millstone Power Station.
31. Dominion (Zachry) Calculation, NAI-1996-002, Rev. 2, MP3 Intake Structure Intake.
32. Dominion (Zachry) Calculation 15-175, Rev. 0, Design Basis Flooding Evaluation of the MPS3 Intake Structure.
33. Dominion Engineering Technical Evaluation, ETE-CPR-2012-0008, Rev. 7, Beyond Design Basis – FLEX Strategy Basis Document and Final Integrated Plan, Millstone Unit 3.
34. MPS Common Engineering Procedure C EN 104I, Rev. 011, Condition Monitoring of Structures.

35. Dominion Corporate Procedure, CO-PROC-000-HRP-NUCLEAR, Rev. 12, Hurricane Response Plan (Nuclear).
36. MPS Procedure C OP 200.6, Rev. 008-00, Storms and Other Hazardous Phenomena.
37. MPS Procedure AOP 3569, Rev. 022-00, Severe Weather Conditions.
38. Dominion Nuclear Standard, DNES-AA-GN-1003, Design Effects and Considerations.
39. Dominion Nuclear Fleet Administrative Procedure, MA-AA-113, Yard Control.
40. Millstone Power Station Unit 3 Final Safety Analysis Report, Rev. 29.02
41. Millstone Unit 3 Technical Requirements Manual, Rev. 193.00, 3/4.7.6.
42. MPS Surveillance Procedure SP 3665.2, Rev. 11, Intake Structure Condition Determination with Vacuum in the Condenser.
43. Millstone Power System Operating Procedure, OP 3335B, Reactor Plant Aerated Drains, Millstone Unit 3.
44. Millstone Power System Operating Procedure, AOP 3560, Loss of Service Water, Millstone Unit 3.
45. Millstone Power System Operating Procedure, EOP 3505A, Loss of Spent Fuel Pool Cooling, Millstone Unit 3.
46. Dominion Calculation, MISC-11787, Rev. 0, Addendum D, Evaluation of Secondary Heat Removal Requirements Following Extended Loss of AC Power (ELAP), Millstone Cases with Preemptive Shutdown.
47. Millstone Power System Operating Procedure, EOP 3505, Loss of Shutdown Cooling and/or RCS Inventory, Millstone Unit 3.
48. Dominion Calculation, CE-2038, Rev. 0, Addendum A, Beyond Design Basis Flooding Evaluation of the MP2 Intake Structure.
49. Dominion Engineering Technical Evaluation, ETE-CPR-2017-1006, Rev. 0, Millstone Unit 3 Beyond Design Basis Flooding Focused Evaluation and Integrated Assessment.

4 TERMS AND DEFINITIONS

- AE – Associated Effects
- AEP – Annual Exceedance Probability
- APM – Available Physical Margin
- BDB – Beyond Design Basis
- CAENS – Connecticut Alert Notification System

- CDB – Current Design Basis
- CLB – Current Licensing Basis
- CONVEX – Connecticut Valley Exchange
- DB – Design Basis
- DNC – Dominion Nuclear Connecticut, Inc.
- ELAP – Extended Loss of AC Power
- ETE – Engineering Technical Evaluation
- FE – Focused Evaluation
- FED – Flood Event Duration
- FHRR – Flood Hazard Reevaluation Report
- FIAP – Flooding Impact Assessment Process
- FLEX – Diverse and Flexible Coping Strategies
- FSAR – Final Safety Analysis Report
- KSF – Key Safety Function
- LIP – Local Intense Precipitation
- LUHS – Loss of Ultimate Heat Sink
- MPS2 – Millstone Power Station Unit 2
- MPS3 – Millstone Power Station Unit 3
- MSA – Mitigating Strategies Assessment
- MSFHA – Mitigating Strategy Flood Hazard Assessment
- MSFHI – Mitigating Strategies Flood Hazard Information
- MSL – Mean Sea Level
- NACCS – North Atlantic Coast Comprehensive Study
- NEI – Nuclear Energy Institute
- NGVD29 - National Geodetic Vertical Datum of 1929
- NOAA – National Oceanic and Atmospheric Association
- NRC – Nuclear Regulatory Commission
- NSRC – National SAFER Response Center
- NTTF – Near-Term Task Force
- NTWC – National Tsunami Warning Center
- PMF – Probable Maximum Flood
- PMH – Probable Maximum Hurricane
- PMP – Probable Maximum Precipitation
- PMSS – Probable Maximum Storm Surge
- PSSA – Probabilistic Storm Surge Analysis

- RFI – Request for Information
- SAFER – Strategic Alliance for FLEX Emergency Response
- SERO – Station Emergency Response Organization
- SM – Shift Manager
- SSC – Structures, Systems, and Components
- STA – Shift Technical Advisor
- TRM – Technical Requirements Manual
- TSA – Time Sensitive Action
- US – Unit Supervisor

5 FLOOD HAZARD PARAMETERS FOR UNBOUNDED MECHANISMS

The results of the NRC review of the Millstone Power Station (MPS) FHRR (Ref. 13) and the supplemental FHRR (Ref. 18) are contained in the Staff Assessment (Ref. 8) and Supplement to the Staff Assessment (Ref. 20). These staff assessments document the NRC's conclusion that the MPS reevaluated flood hazard information is suitable input for other flooding assessments associated with the 10 CFR 50.54(f) letter.

Table 1 and Table 2 of the enclosure to Ref. 19 includes a summary of the current licensing basis and reevaluated (i.e., BDB) flood hazard parameters. In Table 2 of the enclosure to Ref. 15 and Table 3.1-2 of the enclosure to Ref. 17, the NRC lists the following eight flood-causing mechanisms for the design basis flood:

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

The NRC concluded that the following two flood mechanisms are not bounded by the current licensing basis flood hazard levels for MPS3 (Refs. 15 and 17):

- Tsunami
- Storm Surge

The Flooding FE evaluated the impact of the reevaluated tsunami flood-causing mechanism on the site strategy for effective flood protection in accordance with Path 2 of NEI 16-05, Rev. 1 guidance including Appendix B and Appendix C.

The Flooding IA evaluated the impact of the reevaluated storm surge flood-causing mechanism in accordance with Path 5 of NEI 16-05, Rev. 1 guidance.

Table 5.0 provides a summary of how the unbounded mechanism was addressed in this external flooding assessment.

Table 5.0 – External Flooding Assessment Summary

	Flood Mechanism	Summary of Assessment
1	Tsunami	Flood Parameters were not revised as part of this assessment. Path 2 (effective flood protection) was determined to be the appropriate path since, while nuisance flooding would occur in the service water pump cubicles, all KSFs and key SSCs would be protected during the tsunami event.
2	Storm Surge	Dominion Energy concluded (Ref. 18) that 1E-4 AEP PSSA provides a more realistic analysis than the 1E-6 PSSA presented in the FHRR (Ref. 13). Flood Parameters were revised (refer to Table 7.1). Path 5 (scenario based) was determined to be the appropriate path to account for the probabilistic nature of the storm surge analyses and for the demonstration of adequate responses strategies for the scenarios.

6 OVERALL SITE FLOODING RESPONSE

6.1 Description of Overall Site Flooding Response

6.1.1 Tsunami

A tsunami warning notification may be received from the following sources: Connecticut Valley Electrical Exchange (CONVEX) or Connecticut Alert Emergency Notification System (CAENS). The NOAA National Tsunami Warning Center (NTWC) provides tsunami detection, forecasts and warnings for the U.S. including the

Atlantic coast, operating 24 hours a day with a goal of issuing tsunami warnings within five minutes of detecting an earthquake having potential for generating a tsunami (Ref. 13). C OP 200.6, "Storms and Other Hazardous Phenomena" (Ref. 36), which establishes command and control of the site response, will be entered with the initiation of AOP 3569 (Ref. 37), or at the discretion of the SM or US.

The site response to a tsunami warning is similar to that for a PMH storm surge warning. The reevaluated maximum tsunami flood level is bounded by the storm surge flood level, but the warning time for the tsunami is less than that for the PMH. The tsunami is predicted to reach the Millstone site approximately 8.7 hours after the occurrence of the initiating event (Ref. 13). The FHRR (Ref. 13) predicts a reevaluated maximum tsunami flood elevation of 14.7 ft. MSL at the Millstone general site area, including the intake structures, the critical elevation of which is the MPS3 service water pump cubicles' floor elevation of 14.5 ft.

Due to its 24 ft. MSL nominal site grade elevation, the MPS3 main site / power block is not challenged by tsunami flooding in the general site area.

The safety related service water pumps are located in the intake structure, housed in water-tight cubicles with procedural hurricane storm surge flood protection (Ref. 41) to 25.5 ft. MSL (Ref. 40, Section 2.4.2.2). The TRM (Ref. 41) flood protection measures would also provide tsunami flood protection for the service water pumps. However, if not implemented prior to the tsunami arriving on site, the service water pump cubicles would experience only approximately 0.2 ft. of nuisance flooding on their floor elevation of 14.5 ft. MSL during the tsunami surge.

The Ref. 41 site response time for tsunami flooding is limited by the procedural implementation of the hurricane storm surge intake structure flood protection, i.e., monitoring sea water levels, and shutting the watertight doors of both service water pump cubicles and isolating the pump cubicle sump drain lines within 15 minutes of the sea water level exceeding 13 ft. MSL at the intake structure (Ref. 41). Considering this action sequence, it is not reasonable to conclude that the Ref. 41 flood protection would be implemented prior to the maximum predicted tsunami flood level arriving on site.

Therefore, to prevent the potential for any tsunami nuisance flooding impact in the service water pump cubicles, Ref. 37 was revised to include a tsunami warning as a potential flooding condition and to include an action trigger to initiate the Ref. 41 service water pump cubicle flood protection actions immediately upon receipt of notification of an impending tsunami and complete the flood protection actions within 2 hours.

With tsunami flood protection implemented at the intake structure prior to the tsunami arriving on site, flood water will be prevented from entering the safety-related service water pump cubicles. Thus, the safety-related service water pumps will be provided with tsunami flood protection. Therefore, the site response provides tsunami flood protection for MPS3 KSFs.

Ref. 25 assessed the impact of the reevaluated tsunami flood hazard on the FLEX mitigating strategies and concluded that the current FLEX mitigating strategies can be deployed as designed during the flood hazard. Therefore, the FLEX mitigating strategies are available for defense-in-depth flood response to the reevaluated tsunami flood hazard.

6.1.2 Reevaluated Combined Effects with Probabilistic Storm Surge

The site response to the current design basis and reevaluated combined effects with probabilistic storm surge flood levels relies on the actions provided in Refs. 37, 36, 41 and 35. Actions are initiated in response to a hurricane or tropical storm advisory (watch or warning), issued for an area when conditions pose a possible threat, generally within 36 to 48 hours. These actions include:

- Institute command and control of the hurricane preparedness and response activities,
- Perform appropriate notifications, emergency classifications, and requests for additional resources for assistance,
- Monitor sea water levels at the intake structure hourly,
- Obtain periodic reports on the developing storm conditions every 2 hours,
- Shut the watertight doors of both service water pump cubicles and isolate the service water pump cubicle sump drain lines, if the sea water level exceeds 13 ft. MSL (Ref. 41),
- Confirm or restore the demineralized water storage tank (DWST) level,

- Perform local inspections and actions for outside areas,
- Confirm or close selected doors in the power block,
- Erect sandbag walls at selected door locations in the power block to reduce the potential impact for flooding of the Cable Spreading, Switchgear, and turbine driven auxiliary feedwater (TDAFW) pump rooms, to resolve "Small Margin" conditions,
- Perform additional actions regarding plant operations, e.g. preemptively reducing RCS temperature to Hot Standby, as specified and as warranted by the severity of the storm forecast.

6.2 Summary of Plant Modifications and Changes

6.2.1 Plant Modifications for Tsunami Flood Protection

No plant modifications, inspections or physical changes are planned to address the tsunami flooding mechanism. However, as indicated in Section 6.1 above, AOP 3569, "Severe Weather Conditions" (Ref. 37) was revised to include a tsunami warning action trigger to initiate actions to flood-protect the service water pump cubicles immediately upon receipt of the notification of an impending tsunami.

6.2.2 Plant Modifications for Reevaluated Combined Effects with Probabilistic Storm Surge

No plant modifications, inspections or physical changes are planned to respond to the reevaluated combined effects with probabilistic storm surge flooding mechanism.

7 FLOOD IMPACT ASSESSMENT

7.1 TSUNAMI – NEI 16-05, PATH 2

7.1.1 Description of Flood Impact

Tsunami flooding is not included in the CLB because MPS is located on the North Atlantic coastline, where there is an extremely low probability of tsunamis. Therefore, tsunamis are not considered by the CLB to be credible natural phenomena which might affect the safety of the Millstone site (Ref. 40).

The FHRR (Ref. 13) reevaluated the tsunami flood-causing mechanism and predicted a reevaluated maximum tsunami flood elevation of 14.7 ft. MSL at the Millstone general site area, including the intake structures. The tsunami is predicted to reach the Millstone site approximately 8.7 hours after the occurrence of the initiating event (Ref. 13).

The MPS3 main site / power block with a 24 ft. MSL nominal site grade elevation is not challenged by the 14.7 ft. MSL tsunami maximum flood level. The service water pump rooms in the intake structure are housed in water-tight cubicles, which are flood protected to 14.5 ft. MSL by the cubicle floor elevations and to 25.5 ft. MSL (Ref. 40, Section 2.4.2.2) by implementing the procedurally required tsunami flood protection measures (Ref. 37). Without the procedural flood protection measures in place, the service water pump cubicles would experience approximately 0.2 ft. of nuisance flooding on their floor elevations of 14.5 ft. MSL.

Therefore, with the procedural tsunami flood protection measures implemented, SSCs that protect or support KSFs will not be adversely impacted by the reevaluated tsunami flood hazard.

Ref. 25 assessed the impact of the reevaluated tsunami flood hazard on the FLEX mitigating strategies and concluded that the current FLEX mitigating strategies can be deployed as designed during the flood hazard. Therefore, the FLEX mitigating strategies are available for defense-in-depth flood response to the reevaluated tsunami flood hazard.

7.1.2 Adequate APM Justification and Reliability of Flood Protection

The available physical margin (APM) determination is made using the guidance provided in Ref. 5 (NEI 16-05, Appendix B, Section B.1, "Determination of Adequate Available Physical Margin," and Section B.2, "Reliability of Flood Protection"). Adequate APM is part of demonstrating effective flood protection. Since the MPS3 current design basis flood protection for safety-related SSCs is the 24 ft. MSL nominal grade elevation at the main site / power block and 25.5 ft. at the intake structure, the respective APM for the key safety features is 9.3 ft. (24 ft. – 14.7 ft.) and 10.8 ft. (25.5 ft. – 14.7 ft.) during the reevaluated tsunami flood hazard.

Appropriate station procedures ensure that the service water cubicle water-tight doors, which are designed to conform to accepted engineering practices, are controlled and maintained.

The station design process requires that all design changes to the plant consider impact on the potential for flooding, and whether the activity affects: (A) any of the station's hazards evaluations for (1) seismic events, (2) external flooding, (3) storms such as hurricanes, high winds, and tornadoes, (4) extreme snow, ice, and cold, or (5) extreme heat; or (B) any flooding protective features such as culverts, drains and dikes (Ref. 38). Thus, the design change process provides programmatic assurance that the flooding protection design basis configuration will be maintained with adequate APM and reliability of flood protection for future design changes to the plant.

Therefore, adequate APM is achieved and reliability of flood protection is maintained for the intake structure tsunami flood protection.

7.1.3 Adequate Overall Site Response for Flood Protection

The planned site response to a tsunami is described in Section 6.1 above. The evaluation of adequate overall site response is performed in accordance with Ref. 5 (NEI 16-05, Appendix C, "Evaluation of Site Response," Sections C.1 – C.5). The following components are used to provide a comprehensive site response plan.

7.1.3.1 Defining Critical Path and Identifying Time Sensitive Actions (TSAs)

The critical path for the site response to a tsunami warning is shutting the watertight doors of both service water pump cubicles and isolating the pump cubicle sump drain lines at the intake structure (TSAs) to prevent flooding the safety related service water pumps as required by AOP 3569 (Ref. 37) prior to the tsunami arriving on site. The required minimum time and implementation requirements for the TSAs are provided in Ref. 37. The TSA actions are to be initiated promptly upon receipt of a tsunami warning (the tsunami warning action trigger in Ref. 37) notification from CONVEX or the Connecticut Alert Emergency Notification System (CAENS). The NOAA National Tsunami Warning Center (NTWC) provides tsunami detection, forecasts and warnings for the U.S. including the Atlantic coast, operating 24 hours a day with a goal of issuing tsunami warnings within five minutes of detecting an earthquake having potential for generating a tsunami (Ref. 13). Timely actions following tsunami warning notification allow for TSAs to be completed prior to a tsunami arriving on site with approximately 6 hours of margin. The other actions required in Ref. 37 prior to shutting the watertight doors of both service water pump cubicles and isolating the pump cubicle sump drain lines at the intake structure (i.e., performing required station management notifications and initiating site inspection and cleanup of loose material and debris) are non-TSAs. Performing station management notifications can be accomplished quickly, and site inspection and cleanup of loose material and debris can be accomplished simultaneously with shutting the watertight doors of both service water pump cubicles and isolating the pump cubicle sump drain lines at the intake structure without impacting the TSAs.

7.1.3.2 Demonstration all TSAs are Feasible

Once the tsunami action trigger has been initiated, implementation of the tsunami flood protection TSAs (i.e., shutting the watertight doors of both service water pump cubicles and isolating the pump cubicle sump drain lines at the intake structure) must be completed prior to the tsunami flood water arriving on site. Ref. 37 requires initiation of the tsunami trigger actions upon receipt of a tsunami warning. Instruction for implementing the tsunami flood protection actions is provided in Ref. 37. No tools or special qualifications are required to perform the tsunami flood protection TSAs.

The guidance provided in Ref. 12 (NEI 12-06, Appendix E, Section E.6.3.2, Validation for Level B TSAs) is applied to validate the feasibility of the tsunami flood protection TSAs. Ref. 37 includes the requirement of shutting the watertight doors of both service water pump cubicles and isolating the pump cubicle sump drain lines at the intake structure within 2 hours after receipt of a tsunami warning notification. The environmental conditions at the time of a tsunami warning can be considered as likely less severe than those during a hurricane storm surge. Upon receipt of a tsunami warning, Ref. 37 directs the initiation of the site tsunami flood protection actions within a predicted window of at least 8 hours prior to the tsunami arriving on site. Therefore, performing the tsunami flood protection TSAs within 2 hours provides approximately 6 hours of margin for the TSAs to be completed prior to the tsunami arriving on site. The 2-hour flood protection implementation time required by Ref. 37 is considered to be a Level B Reasonable validation of Level B TSAs under the guidance of NEI 12-06, Appendix E, Section E.6.3.2.

7.1.3.3 Establishing Unambiguous Procedural Triggers

Ref. 37 includes the tsunami warning action trigger for initiation of site response to a tsunami warning. Ref. 37 is entered upon notification of a tsunami warning and initiates the tsunami action trigger directly after the notification. The following tsunami warning flood protection actions are initiated by the Ref. 37 tsunami action trigger:

- Notify station management of tsunami;
- Initiate site inspection and cleanup of loose material and debris; and,
- Shut the watertight doors of both service water pump cubicles and isolate the pump cubicle sump drain lines at the intake structure.

Therefore, the site tsunami response procedure (Ref. 37) clearly and unambiguously defines the tsunami warning action trigger and required flood protection actions.

7.1.3.4 Proceduralized and Clear Organizational Response to a Flood

Surveillance Procedure SP 3665.2 (Ref. 42) requires monitoring of the weather forecasts and conditions, evaluation of the environmental conditions, and notification of the Shift Manager (SM) or Unit Supervisor (US) of degraded environmental conditions. SP 3665.2 is applicable at all times and performed a minimum of once per shift.

AOP 3569, "Severe Weather Conditions" (Ref. 37), is entered upon the Control Room being notified of a tsunami warning. Notification of a tsunami warning may be received from CONVEX or the Connecticut Alert Emergency Notification System (CAENS). C OP 200.6, "Storms and Other Hazardous Phenomena" (Ref. 36), which establishes command and control of the site response, will be entered with the initiation of AOP 3569, or at discretion of the SM or US.

Site response to a tsunami warning is initiated by the Ref. 37 action trigger. The tsunami flood protection actions initiated by the action trigger include: notifying station management of the tsunami warning; inspecting the site and cleaning up loose material and debris; and shutting the watertight doors of both service water pump cubicles and isolating the pump cubicle sump drain lines at the intake structure. Ref. 37 directs performance of both of these site tsunami flood protection actions with Ref. 43, Section 4.2.1 providing procedural instruction for isolation of the pump cubicle sump drain lines.

The above described procedural direction establishes clear organizational response to a potential tsunami flooding event with procedurally defined responsibility for command and control of station personnel for the site response to a tsunami warning.

Therefore, the station procedures clearly define the roles and responsibilities for each function of the MPS3 organization with respect to implementing the critical response action plan before, during, and after a tsunami flooding event.

7.1.3.5 Detailed Flood Response Timeline

The strategy for the successful flood response timeline considered the following:

- Monitoring and action triggers
- Lead time to event and margin for preparation
- Inspection activities
- Flood protection installation activities
- Event duration
- Flood protection removal activities

The detailed site tsunami flood response timeline is included in Ref. 37. Upon receipt of a tsunami warning, Ref. 37 directs the initiation of the site tsunami flood protection actions within a predicted window of at least 8 hours prior to the tsunami arriving on site. Procedural implementation and verification of the flood protection features (TSAs) is required within 2 hours. Therefore, a flood protection implementation time margin of approximately 6 hours prior to the consequential tsunami arriving on site is provided. As described in detail in Section 7.1.3.2 above, functional validation of the tsunami flood response timeline margin has been performed to demonstrate the feasibility of the detailed flood response timeline.

Additionally, this evaluation identified the following procedural enhancement to ensure that tsunami flooding will have no impact at the intake structure: Ref. 37 has been revised to include a tsunami warning as a potential flooding condition and to include an action trigger to initiate the service water cubicle flood protection actions within 2 hours of notification of an impending tsunami.

7.1.3.6 Accounting for the Expected Environmental Conditions

The environmental conditions are expected to have minimal impact on the deployment of the flood protection features in response to the tsunami warning action trigger. Advance warning of the tsunami approaching the site will provide sufficient time for personnel to perform the tsunami flood protection TSAs (shut the watertight doors of both service water pump cubicles and isolate the pump cubicle sump drain lines) to protect the service water pumps against tsunami flooding effects. As described above in Section 7.1.3.2, the TSA actions of shutting the watertight doors of both service water pump cubicles and isolating the pump cubicle sump drain lines are functionally validated with consideration that the actions will be performed during the environmental conditions of an approaching tsunami, which are considered to be likely less severe than those of an approaching hurricane storm surge. Therefore, no additional protective measures associated with any expected adverse environmental conditions are required.

7.1.3.7 Demonstration of Adequate Site Response

The MPS3 site response to a tsunami warning has been demonstrated as adequate by meeting the guidelines in NEI 16-05, Appendix C (Ref. 5). All TSAs have been identified and determined to be feasible in accordance with NEI 12-06, Appendix E (Ref. 12) validation guidance. The clearly defined and unambiguous tsunami warning action trigger promptly initiates the site tsunami warning response. Ample time is allowed to perform management notifications of potential tsunami conditions approaching the site; augment plant staff for response support, if required; inspect and prepare the site; shut the watertight doors of both service water pump cubicles; and isolate the pump cubicle sump drain lines (implement the tsunami flood protection TSAs within 2 hours following notification of a tsunami warning). The detailed procedural approach in Ref. 37 clearly establishes the organizational command and control structure for site response, and detailed procedural instructions will allow each organization to effectively complete the required actions. Finally, adverse environmental conditions are expected to have minimal impact on tsunami flood protection preparation efforts.

Accordingly, this flood impact assessment demonstrates that the overall site response to the reevaluated tsunami flood hazard is adequate in accordance with the guidance of NEI 16-05 (Ref. 5).

7.2 REEVALUATED COMBINED EFFECTS WITH PROBABILISTIC STORM SURGE – NEI 16-05, PATH 5

As discussed in NEI 16-05, Rev 1, Path 5 permits consideration of the likelihood of flood scenarios when applying standards ("feasible" versus "effective" flood strategy) for assessing flooding impacts, using the 1E-3 (with margin) to 1E-4 annual exceedance probability (AEP) range as the "high" and "low" likelihood threshold. Therefore, the approach in developing a probabilistic characterization of the flood hazard is principally concerned with defining flood-frequencies to an AEP greater than 1E-4. Flood scenarios with lesser AEPs are simply designated having a "low" likelihood.

Path 5 evaluations use a blend of strategies when effective mitigation strategy cannot be demonstrated for the most bounding flood parameters. The scenarios discussed below summarize the scenarios developed for the MPS3 reevaluated storm surge.

7.2.1 Flood-Frequency Development

7.2.1.1 Approach

The Supplement to the FHRR (Ref. 18) and the accompanying Staff Assessment (Ref. 20) provide details of the methodology and analyses used to develop the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard. This methodology was also used for the 1E-5 analyses. The analyses (Refs. 27, 28, 29, 30) include descriptions of:

- Joint Probability Method
- Hydrodynamic Modeling Storm Surge Interpolation

- Antecedent Water Levels
- Source of Storm Data
- Storm Recurrence Rate
- Statistical Analysis of Storm Data
- Tropical Storm Surge Frequency Curve Using Joint Probability Analysis
- Error and Uncertainty Estimates
- Extratropical Storm Surge Frequency Curve
- Mesh Refinements
- Combined Effects Numerical Simulation of Synthetic Hurricanes
- Total Water Levels Approach
- Wave Overtopping Calculation at Unit 2 Turbine Building
- Flood Loads, Debris Impact Loads, and Standing (Non-Breaking) Wave Loads
- Results and Conclusions

The following sections summarize the storm surge analyses and results.

7.2.1.2 Summary of Analyses

As stated in Refs. 27 and 29, the probabilistic storm surge analyses (PSSA) used a logic tree approach to obtain multiple flood frequency curves to support the calculation of a stillwater elevation associated with the specified AEP (1E-4 or 1E-5, respectively). Each logic tree branch carried a certain weight (i.e., probability), with the sum of the branch weights equal to one. The Joint Probability Method was used for developing flood frequency curves. Each logic tree path from the start to the end node produces a distinct flood frequency curve, which includes error and uncertainty. For each calculation, the error and uncertainty estimates include numerical modeling error, antecedent water level, and hurricane parameter variability. The mean tropical cyclone-induced storm surge flood frequency curve was calculated as the weighted average of 96 developed branches. Extratropical surge flood frequency curve was calculated based on NACCS simulated results using historical extratropical storm data and uncertainty bounds of the flood frequency curve were estimated by the bootstrapping method. The final storm surge flood frequency curve combines the probabilities and responses from both tropical and extratropical cyclones.

The combined effects analyses (Refs. 28, 30) developed the combined effects flooding elevation, associated hydrodynamic and wave loading, and wave overtopping rate and volume at MPS associated with the chosen AEP (1E-4 or 1E-5), including a projected 50-year sea level rise. The mean 1E-4 stillwater elevation was developed in the PSSA (Refs. 27, 29). The MPS structures analyzed in this calculation include the intake Structure and the Turbine Building. Total water levels (stillwater and wave runup) were calculated for the intake structure and Turbine Buildings. Hydrostatic, hydrodynamic, and debris impact loads were calculated for the intake structures and Turbine Building. Overtopping due to waves at the West Wall of Unit 2 Turbine Building was estimated.

7.2.1.3 Key Assumptions

A list of key assumptions in the storm surge and combined effects analyses is provided below. Refs. 27 and 28 provide more details. For definitions of terms used in this section not already listed in Section 4, refer to Refs. 27 and 28.

- The analysis results, which include mean and upper confidence water levels at the chosen AEP (1E-4 or 1E-5), are expected to vary slightly if new additional branches were added.
- The historical hurricane data trimmed by spatial and temporal filters applied in this analysis is adequate to characterize hurricane parameters in the vicinity of Millstone.
- The storm surge elevation associated with the chosen AEP (1E-4 or 1E-5) can be reliably determined by using, in part, approximately 80 years of observed hurricane data.
- Normal distribution was assumed for estimating prediction intervals for heading-dependent maximum wind speed (Vm) and central pressure deficit (CPD) functions.
- Lower weighting factors were used for logic tree branches that assume parameter independence.
- The probabilistic storm was assumed to be steady-state and symmetrical (i.e., storm parameters and track bearings were not varied with time) prior to landfall.
- No tidal time series were used for ADCIRC modeling. A constant water level at Elevation 1.16 feet North America Vertical Datum of 1988 (NAVD88) was used for all the numerical simulations. Tidal influences were included in the

calculated mean stillwater elevation at the chosen AEP (1E-4 or 1E-5). This method is consistent with the modeling approach used by the NACCS.

- A remaining active plant life of fifty (50) years was assumed for the purpose of calculating the Sea Level Rise component of the Antecedent Water Level.

7.2.1.4 Treatment of Uncertainties

NEI 16-05, Rev 1, Appendix D (Ref. 5), states that the "licensee should identify and address important sources of aleatory variability and epistemic uncertainty (e.g., alternate data sources, options for filtering data, or alternate functional forms for probability distributions) for each flood mechanism. The licensee may utilize simplifying and bounding assumptions to address uncertainty but should also clarify how they affect key insights and conclusions. Sensitivity studies examining the effect of key components and assumptions on flood hazard estimates may be used to address epistemic uncertainty".

The NRC confirms the proper incorporation of aleatory and epistemic uncertainty in its summary comments (Ref 20, Section 2.1):

> *Aleatory variability and epistemic uncertainty are incorporated into the storm surge evaluation to account for natural variability that is not captured in the deterministic models and uncertainties associated with a range of acceptable modeling decisions. Probability density functions of storm parameters (PDFs) are used to represent the aleatory/natural variability of the parameters based on historical data and are used to estimate the probability of exceeding specified surge elevations. Storm surge estimates obtained from numerical models are assumed to be median values and have a normal distribution. The standard deviation for this normal distribution accounts for the aleatory variability in storm surge given a set of known storm parameters. A logic tree is used to incorporate epistemic uncertainty in the storm hazard analysis.*

7.2.1.5 Results

The combined effects flooding results are provided in Sections 6.0 of Refs. 28 and 30. Table 7.1 summarizes the results for select items.

7.2.2 Comparison of Flood Scenarios

7.2.2.1 Define flood scenarios

During the NRC's review of the reevaluated storm surge flood hazard information submitted in the FHRR (Ref. 13), Dominion and the NRC concluded that in order to reduce the uncertainty around the FHRR's reevaluated 1E-6 Annual Exceedance Probability (AEP) probabilistic storm surge analysis, a more frequent AEP (1E-4) probabilistic storm surge analysis would be performed. Thus, the NRC did not submit a Staff Assessment for the reevaluated storm surge flood hazard information submitted in the FHRR. Dominion submitted the results of the 1E-4 AEP probabilistic storm surge analysis in a Supplement to the FHRR (Ref. 18).

Since the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard was assessed to have no impact on the MPS KSFs, a flood impact assessment was performed for a less probable combined effects with probabilistic storm surge flooding scenario. A 1E-5 AEP analysis was chosen for assessment of storm surges of less frequent occurrence than 1E-4 because, as the "Purpose" section of Ref. 29 indicates: "Guidance from U.S Army Corps of Engineers or other federal agencies for PSSA at lower frequencies (i.e., AEP less than 1E-5) are not well-established and such analyses would require additional evaluation of the methodology and input data used herein. Previous calculations indicate that there is inherently large uncertainty associated with the results at the AEP of 1E-6, when the storm surge stillwater frequency curves become very sensitive to perturbations of various input parameters. Therefore, the AEP of 1E-5 is a more severe event alternative to the previous 1E-4 analysis. Both 1E-4 and 1E-5 analyses are judged to have reasonable confidence levels in defining a mean stillwater elevation at the selected AEP levels."

Table 7.0 - Flood Scenario Definitions

Flood Scenario	Storm Surge AEP	Likelihood	Description
1	1E-4	High	Effective Protection
2	1E-5	Low	Feasible Response/Mitigation

Detailed characteristics of the flood scenarios referenced in Table 7.0 are provided in Table 7.1.

7.2.2.2 Characterization of flood parameters for each scenario

Table 7.1 - Flood Parameters for each Scenario

Flood Mechanism Parameter		Scenario 1 (1E-4 AEP)	Scenario 2 (1E-5 AEP)
1	Max Stillwater Elevations (Intake Structure/Power Block)	17.1 / 17.7 ft. MSL	19.6/20.2 ft MSL
2	Max Wave Run-up Elevations	42.6 ft. MSL maximum wave runup at intake structure seaward wall 30.2 ft. MSL maximum water level inside the intake structure 22.2 ft. MSL at the Power Block	48.0 ft. MSL maximum wave runup at intake structure seaward wall 34.3 ft. MSL maximum water level inside the intake structure 24.1 ft. MSL at the Power Block
3	Max Hydrodynamic/Debris Loading	Evaluated as Satisfactory	Evaluated as Satisfactory
4	Effects of Sediment Deposition/Erosion	Minimal	Minimal
5	Other Associated Effects	Minimal	Minimal
6	Concurrent Site Conditions	N/A	N/A
7	Effects on Ground Water	Minimal	Minimal
8	Warning Time	36 - 48 hours	36 - 48 hours

Table 7.1 - Flood Parameters for each Scenario			
Flood Mechanism Parameter		**Scenario 1 (1E-4 AEP)**	**Scenario 2 (1E-5 AEP)**
9	Period of Site Preparation	36 - 48 hours	36 - 48 hours
10	Period of Inundation	10 hours	9 hours
11	Period of Recession	10 hours	8 hours
12	Plant Mode of Operation	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 6
13	Other Factors	Minimal	Minimal

7.2.3 Flood Scenario 1— Effective Flood Protection

7.2.3.1 Flood Scenario 1 Summary

Breaking wave run-up along the slope adjacent to the MPS3 intake structure was calculated to be approximately 4.5 ft. above the maximum reevaluated combined effects with 1E-4 AEP probabilistic storm surge local stillwater elevation of 17.7 ft. MSL, resulting in a maximum total water level of 22.2 ft. MSL (Ref. 18) in front of the west side wall of the Turbine Building. Therefore, the maximum CDB/CLB flood level at the power block (19.7 ft. MSL stillwater + 4.1 ft. wave runup = 23.8 ft. MSL) bounds the reevaluated flood level. The reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard maximum stillwater flood level of 17.1 ft. MSL at the intake structure is bounded by the CDB/CLB stillwater elevation of 19.7 ft. MSL.

However, the reevaluated combined effects wave runup total water level (42.6 ft. MSL) at the intake structure exceeds the CDB/CLB combined effects wave runup total water level (41.2 ft. MSL).

The safety-related service water pumps and associated equipment are the only key SSCs located in the MPS3 intake structure. They are in the watertight service water pump rooms that are flood protected to 25.5 ft. MSL by the elevation of the water-stop in the pump rooms' 2 ft. thick concrete walls. Ref. 31 conservatively assumes that the reevaluated storm surge significant reflected wave crest elevation of 30.2 ft. MSL could exist inside the intake structure, external to the service water pump rooms, for the limited duration of the peak storm surge. The north and south walls of the service water pump rooms have unsealed electrical penetrations that are all located at or above elevation 31 ft. MSL, (i.e., above the significant reflected wave crest elevation). Section 3.6 of Ref. 31 concludes that there are no pathways that would allow water into the service water pump rooms during a combined effects storm surge flooding event and any in-leakage above the water-stop would be negligible and in the form of weepage.

Intake structure hydrostatic, hydrodynamic and debris loading analyses (Ref. 32) were performed for the reevaluated combined effects with probabilistic storm surge flood hazard evaluated by the FHRR (Ref. 13). Loads due to non-breaking waves were evaluated as hydrostatic and hydrodynamic loads. Debris impact loads are assumed to act at the water surface elevation (Ref. 28). The Ref. 32 evaluation concluded that the MPS3 intake structure can accommodate the FHRR reevaluated loads.

The MPS3 intake structure design is more robust than the MPS2 intake structure. Ref. 48 concluded that the MPS2 intake structure has sufficient structural capacity to accommodate the maximum hydrostatic, hydrodynamic and debris loading from both the reevaluated combined effects with 1E-4 AEP and 1E-5 AEP probabilistic storm surge flood hazards evaluated by this IA. Therefore, based on the Ref. 32 and 48 evaluations, it can be concluded that the MPS3 intake structure has sufficient structural capacity to accommodate the maximum hydrostatic, hydrodynamic and debris loading from both the reevaluated combined effects with 1E-4 AEP and 1E-5 AEP probabilistic storm surge flood hazards.

7.2.3.2 Adequate APM Justification and Reliability of Flood Protection

The APM determination is made using the guidance provided in Appendix B of NEI 16-05, "External Flooding Assessment Guidelines" (Ref. 5). Adequate APM against the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard is provided by plant site grade elevation and the procedural requirement to close watertight doors.

At the power block, the CLB combined effects storm surge wave run-up value of 23.8 ft. MSL bounds the reevaluated combined effects with 1E-4 probabilistic storm surge wave run-up value of 22.2 ft. MSL (Ref. 18). Since the MPS3 power block nominal site grade elevation is 24 ft. MSL and the elevation of the access openings in the safety-related structures is at least 24.5 ft. MSL, the power block key SSCs are flood protected from the reevaluated combined effects with 1E-4 probabilistic storm surge flood hazard with an APM $\geq$ 2.3 ft (24.5 ft. – 22.2 ft.).

The safety-related service water pumps and associated equipment are the only key SSCs located in the intake structure. They are located in the watertight service water pump rooms that are flood protected to 25.5 ft. MSL by the elevation of the water-stop in the pump rooms' 2 ft. thick concrete walls. As described in Section 7.2.3.1, the service water pump rooms provide flood protection for the service water pumps and associated equipment with an APM

= 31 – 30.2 = 0.8 ft. for the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard.

Therefore, adequate APM and reliable flood protection is available for all key SSCs that protect or support KSFs during the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard event.

7.2.3.3 Adequate Overall Site Response

The evaluation of adequate overall site response is performed in accordance with Appendix C of NEI 16-05 (Ref. 5). Existing site procedures provide 36 or more hours of warning / site preparation time, which is based on tropical cyclone watches and warnings issued by the National Hurricane Center. The primary flood protection against the reevaluated combined effects with 1E-4 AEP probabilistic storm surge is the MPS3 nominal site grade (24 ft. MSL) plus the elevation of the access openings in the safety-related structures ($\geq$ 24.5 ft. MSL) and the watertight service water pump cubicles in the MPS3 intake structure. The CDB flood protection bounds the flood levels of the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard. As a result, existing proceduralized site response preparatory actions described in Section 6.1 for an approaching hurricane storm surge include only a few actions for physical flood protection (i.e. installing temporary flood barriers and closing watertight doors are only required at a few locations and are completed well in advance of the storm surge arrival). No new site response actions or flood protection modifications were identified for the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard.

Accordingly, this flood impact assessment demonstrates that the overall site response to the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard is adequate in accordance with the guidance of NEI 16-05 (Ref. 5).

7.2.4 Flood Scenario 2 — Feasible Response/Mitigation Approach

7.2.4.1 Flood Scenario 2 Summary

Breaking wave run-up along the slope adjacent to the west side of the MPS3 Turbine Building was calculated to be approximately 3.9 ft. above the maximum local stillwater elevation of 20.2 ft. MSL, resulting in a combined effects with 1E-

5 AEP probabilistic storm surge flood hazard total water level of 24.1 ft. MSL at the west side wall of the Turbine Building (Ref. 30), which exceeds the CDB/CLB wave runup total water level of 23.8 ft. MSL.

The MPS3 nominal site grade elevation is 24 ft. MSL at the power block, and access openings to safety-related structures and facilities, except the service water pump rooms in the intake structure, are at elevation 24.5 ft. MSL or greater. Therefore, the main site/power block area of MPS3 is protected by the existing site grade and safety-related structure access openings from stillwater and wave actions (Ref. 30).

The reevaluated maximum stillwater flood level of 19.6 ft. MSL at the intake structure is bounded by the CDB/CLB stillwater elevation of 19.7 ft. MSL. However, the reevaluated combined effects wave runup total water level (48.0 ft. MSL) at the intake structure exterior wall exceeds the CDB/CLB combined effects wave runup total water level (41.2 ft. MSL).

The safety-related service water pumps, motors and associated equipment are the only SSCs located in the intake structure that provide a KSF (service water, i.e., ultimate heat sink). They are located in the watertight service water pump rooms that are flood protected to 25.5 ft. MSL by the elevation of the water-stop in the pump rooms' 2 ft. thick concrete walls. Ref. 31 conservatively assumes that the reevaluated storm surge significant reflected wave crest elevation of 31.7 ft. MSL could exist inside the intake structure, external to the service water pump rooms, for the limited duration of the peak storm surge. The existing electrical penetrations in the north and south walls of the service water pump rooms are unsealed and some are located at minimum elevation 31 ft. MSL, which is below the significant reflected wave crest elevation. Therefore, the service water pump rooms, and thus the service water pumps, motors and associated equipment, would be inundated by the significant reflected wave inside the intake structure during the combined effects with 1E-5 AEP probabilistic storm surge flood hazard event.

Additionally, the wave runup elevation (48.0 ft. MSL) at the exterior of the intake structure exceeds the elevation of the seaward wall parapet (42.0 ft. MSL) and the lowest elevation (44.3 ft. MSL) of the openings for the ventilation intakes and exhausts on the roof (top of roof elevation = 39 ft. MSL). Thus, the combined effects with 1E-5 AEP probabilistic storm surge wave runup would overtop the intake structure roof and some of the overtopping volume could enter the service water pump rooms through the ventilation intakes and exhausts via splashing and spray.

Intake structure hydrostatic, hydrodynamic and debris loading analyses (Ref. 32) were performed for the combined effects with probabilistic storm surge flood hazard evaluated by the FHRR (Ref. 13). Loads due to non-breaking waves were evaluated as hydrostatic and hydrodynamic loads. Debris impact loads are assumed to act at the water surface elevation (Ref. 28). The Ref. 32 evaluations conclude that the MPS3 intake structure can accommodate the FHRR reevaluated loads.

The MPS3 intake structure design is more robust than the MPS2 intake structure. Ref. 48 concluded that the MPS2 intake structure has sufficient structural capacity to accommodate the maximum hydrostatic, hydrodynamic and debris loading from both the reevaluated combined effects with 1E-4 AEP and 1E-5 AEP probabilistic storm surge flood hazards evaluated by this IA. Therefore, based on the Ref. 32 and 48 evaluations, it can be concluded that the MPS3 intake structure has sufficient structural capacity to accommodate the maximum hydrostatic, hydrodynamic and debris loading from both the reevaluated combined effects with 1E-4 AEP and 1E-5 AEP probabilistic storm surge flood hazards.

Therefore, the combined effects with 1E-5 AEP probabilistic storm surge flood hazard will not adversely impact any key SSCs located in the power block that protect or support KSFs. However, the combined effects with 1E-5 AEP probabilistic storm surge flood hazard will inundate the service water pumps, motors and associated equipment, resulting in the loss of the service water KSF, i.e., LUHS.

7.2.4.2 Adequate APM Justification and Reliability of Flood Protection

The APM determination is made using the guidance provided in Appendix B of NEI 16-05, “External Flooding Assessment Guidelines” (Ref. 5). Partial flood protection for the combined effects with 1E-5 AEP probabilistic storm surge flood hazard is provided by plant site grade elevation and the installation of temporary flood barriers and closure of watertight doors.

At the power block, the CLB combined effects storm surge wave run-up value of 23.8 ft. MSL is exceeded by the combined effects with 1E-5 probabilistic storm surge wave run-up value of 24.1 ft. MSL (Ref. 30). Since the MPS3 power block nominal site grade elevation is 24 ft. MSL and the elevation of the access openings in the safety-related structures is at least 24.5 ft. MSL, the power block key SSCs are flood protected from the combined effects with 1E-5 probabilistic storm surge flood hazard with an APM 24.5 – 24.1 $\geq$ 0.4 ft. Additionally, the access openings to safety-related structures in the power block are all located in the east side area of the Turbine Building where wave runup is prevented from occurring due to the west side of the MPS1, MPS2, and MPS3 power block buildings combining to essentially form a continuous barrier. Therefore, a more reasonable value of APM for the safety-related SSCs in the power block can be determined using the maximum stillwater elevation of ~20.2 ft. MSL east of the Turbine Building west wall, i.e. APM = 24.5 - ~ 20.2 = ~ 4 ft. for the safety-related SSCs in the power block (Ref 49).

The safety-related service water pumps, motors, and associated equipment are the only key SSCs located in the intake structure. They are located in the watertight service water pump rooms that are flood protected to 25.5 ft. MSL by the elevation of the water-stop in the pump rooms' 2 ft. thick concrete walls. However, as described in Section 7.2.4.1, the combined effects with 1E-5 AEP probabilistic storm surge flood hazard will inundate the service water pumps, motors and associated equipment, resulting in the loss of the service water KSF. Consequently, APM is not available for the safety-related service water pumps, motors and associated equipment.

7.2.4.3 Response Strategy for Combined Effects with 1E-5 AEP Probabilistic Storm Surge Flood Scenario (Effective Mitigation/Feasible Response)

Adequate APM and reliable flood protection is available for the SSCs located in the power block, but not for the service water pumps, motors and associated equipment, which are the only safety-related SSCs located in the intake structure, during the combined effects with 1E-5 AEP probabilistic storm surge flood hazard event. Therefore, the service water KSF is lost (i.e., LUHS occurs) in this scenario.

Loss of service water results in loss of several KSFs that require service water to maintain their operability. The KSFs that will experience a loss of function from loss of service water are listed below along with an assessment of the corresponding feasible response to the loss of function.

- Loss of emergency power provided by the emergency diesel generators (EDGs). Alternate emergency power is available using the Station Blackout (SBO) diesel generator, which is located in the MPS3 power block and flood protected by the nominal site grade elevation (24 ft. MSL) and by the floor elevations of the enclosures for the SBO diesel equipment (≥ 26 ft. MSL). The SBO diesel generator is not safety-related but is designed for hurricane force winds. Therefore, since the SBO diesel generator has effective flood protection, it is assumed to be available to provide emergency power to the KSFs required in this scenario.
- Loss of Spent Fuel Pool (SFP) Cooling. Alternate SFP cooling is available using SFP inventory makeup from the site Fire Water header in accordance with EOP 3505A (Ref. 45). More than sufficient time is available to initiate alternate SFP cooling, because with the maximum expected SFP heat load, the SFP will begin to boil in approximately 10 hours and boil off to a level 10 ft. above top of fuel in 50 hours after loss of SFP cooling (Ref. 33, Attachment 1, Table 9.1-1).
- Loss of Charging Pump Cooling, which results in loss of charging (i.e. RCS injection). Alternate charging pump cooling is available using fire water aligned in accordance with AOP 3560, Attachment B (Ref. 44). More than sufficient time is available after loss of normal charging to restore charging (initiate alternate charging pump cooling) because RCS inventory makeup to prevent loss of natural circulation is not required for 20.8 hours (Ref. 33, Attachment 1, Table 9.1-1).
- Loss of Reactor Plant Component Cooling (RPCC), which results in loss of the following:
    - Loss of MCC/Rod Control Air Conditioning Units (ACUs). With the unit shutdown the MCC/Rod Control ACUs are not required for at least 4 – 5 days at which time FLEX strategies are available for Containment cooling (Ref. 33, Attachment 1, Table 9.1-1).
    - Loss of Safety Injection Pump Cooling. Alternate safety injection pump cooling is available using fire water or domestic water aligned in accordance with AOP 3560, Attachment D (Ref. 44). Alternate safety injection pump cooling is required only in Mode 6 for Shutdown Cooling.

- Loss of the Control Building Chiller Heat Exchanger, which results in loss of the Control Building Chiller. Compensatory measures are available for loss of the Control Building chiller (Ref. 33, Attachment 1, Section 10.4.2.2.1).
- Loss of RHR / RCS Inventory (KSF for Shutdown Cooling). Alternate reactor decay heat removal is available using SG atmospheric dump valves (ADVs) and auxiliary feedwater (AFW), if unit is in Mode 5; or a safety injection pump to make up RCS from the RWST, if unit is in Mode 6 in accordance with EOP 3505 (Ref. 47).

The alternate means for accomplishing the required KSFs listed above are all performed inside structures located in the MPS3 power block and thus not impacted by the 1E-5 AEP storm surge flood levels or associated wind speeds.

Ref. 30 concluded that the duration of significant flooding (stillwater and wave runup) around the intake structure was approximately 8 to 9 hours. Wind speeds associated with the combined effects with 1E-5 AEP probabilistic storm surge flood hazard persist at $\geq$ 50 MPH for approximately 12 hours after the peak storm surge stillwater level occurs (Ref. 30, Attachment C, Figure 17 and Attachment D, Figure D-3). Thus, at 10 – 12 hours after the peak stillwater level is reached, which is approximately when loss of service water would occur, station personnel would be able to perform outdoor activities as well.

Therefore, the above listed required KSFs lost as a result of loss of service water during the combined effects with 1E-5 AEP probabilistic storm surge flood hazard all have feasible response alternates available for providing their corresponding functions in existing AOPs and/or EOPs.

Additionally, the Phase 3 FLEX strategy for establishing alternate service water, and thus recover the service water function, can be initiated in slightly more than 24 hours when the Phase 3 equipment, including the low pressure / high capacity pump, are delivered to the site from the NSRC facility (Ref. 33, Attachment 1, Chapter 5). Furthermore, since the power block would not be inundated, the FLEX strategies are available as defense-in-depth to provide any or all of the FLEX KSFs within the time requirements of the FLEX strategy time line (Ref. 33, Attachment 1, Table 9.1-1), if the emergency power distribution system is assumed to be unavailable due to a postulated failure of the SBO diesel generator (i.e., a postulated ELAP).

8 CONCLUSIONS

The results of the MPS FHRR (Ref. 13), the supplement to the FHRR (Ref. 18), the NRC's Staff Assessment (Ref. 17) and the NRC's Supplement to the Staff Assessment (Ref. 20) concluded that two (2) reevaluated flood-causing mechanisms (storm surge and tsunami) that were not bounded by the MPS3 current licensing basis required further evaluation. A Focused Evaluation performed for the reevaluated tsunami flood hazard documents further evaluation of the site strategy for effective flood protection. A Flooding Integrated Assessment performed for the reevaluated storm surge documents an effective flood strategy for scenarios with higher frequencies and feasible response strategy for scenarios with lower frequencies. These assessments were performed in accordance with the guidance of NEI 16-05, Rev. 1.

No plant modifications or additional procedure revisions are planned based on the results of the Focused Evaluation and the Integrated Assessment.

Reevaluated Tsunami Flood Hazard – Focused Evaluation

This FE demonstrates that the site response is adequate to protect the MPS3 KSFs from the reevaluated tsunami flood hazard. The MPS3 main site / power block is not challenged by tsunami flooding due to its 24 ft. MSL nominal site grade elevation, and the service water pumps in the intake structure are housed in water-tight cubicles, which are physically flood protected by the floor elevation of 14.5 ft. MSL and procedurally flood protected to 25.5 ft. MSL.

Reevaluated Storm Surge Flood Hazard – Integrated Assessment

The 1E-4 PSSA evaluation performed by the IA demonstrates that the nominal site grade elevation of 24 ft. MSL and the elevation of the access openings in the safety-related structures of at least 24.5 ft. MSL provide effective reliable flood protection for the main site/power block SSCs, FLEX equipment, and the watertight service water pump cubicles in the MPS3 intake structure. The CDB flood protection bounds the flood levels of the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard. As a result, existing proceduralized site response preparatory actions described in Section 6.1 for an approaching hurricane storm surge include only a few actions for physical flood protection (i.e., installing temporary flood barriers and closing watertight doors are only required at a few locations and are completed well in advance of the storm surge arrival). Therefore, adequate APM and reliable flood protection is available for all key SSCs that protect or support KSFs during the reevaluated combined effects with 1E-4 AEP probabilistic storm surge flood hazard event.

The 1E-5 PSSA evaluation performed by the IA demonstrates that the nominal site grade elevation of 24 ft. MSL and the elevation of the access openings in the safety-related structures of at least 24.5 ft. MSL provide effective reliable flood protection for the main site/power block SSCs and FLEX equipment. The service water pumps are inundated by the event with an associated assumed loss of SW/LUHS. However, the IA demonstrates a feasible strategy to mitigate this loss of SW/LUHS.

The submittal of the Focused Evaluation and the Integrated Assessment completes the actions related to external flooding required by the NRC in the March 2012 Request for Information under 10 CFR50.54(f) for the MPS3 reevaluated tsunami and combined effects with probabilistic flood-causing mechanisms.

ATTACHMENT 3

LIST OF COMMITMENTS

DOMINION ENERGY NUCLEAR CONNECTICUT, INC
MILLSTONE POWER STATION UNITS 2 AND 3

The following tables identify those actions committed to by Dominion Energy Nuclear Connecticut, Inc. in response to the Flooding Focused Evaluation / Integrated Assessment for Millstone Power Station Units 2 (MPS2) and Millstone Power Station Units 3 (MPS3), respectively. All other statements in the Flooding Focused Evaluation / Integrated Assessment Summary are provided for information.

Table 3-1 Millstone Power Station Unit 2 Commitments

Commitment	Due Date
Design, store, stage, and install flood protection barriers at key locations throughout the plant as described in Section 6.2 of the MPS2 Flooding Focused Evaluation / Integrated Assessment Summary. The installation of the flood barriers must align with the actionable timeline described in the applicable site procedures.	End of second MPS2 refueling outage after NRC approval of the MPS2 Flooding Focused Evaluation / Integrated Assessment Summary.
Define plant protective measures, validate time sensitive actions, provide installation and response timelines (including warning time and period of site preparation), and confirm site strategy in accordance with NEI 12-06, NEI 16-05, and the NEI document "Warning Time for LIP Events," ML15104A157.	End of second MPS2 refueling outage after NRC approval of the MPS2 Flooding Focused Evaluation / Integrated Assessment Summary.

Table 3-2 Millstone Power Station Unit 3 Commitments

Commitment	Due Date
Define plant protective measures, validate time sensitive actions, provide installation and response timelines (including warning time and period of site preparation), and confirm site strategy in accordance with NEI 12-06, NEI 16-05, and the NEI document "Warning Time for LIP Events," ML15104A157.	End of second MPS3 refueling outage after NRC approval of the MPS3 Flooding Focused Evaluation / Integrated Assessment Summary.