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

January 16, 2019

Mr. William R. Gideon
Site Vice President
Brunswick Steam Electric Plant
8470 River Rd. SE (M/C BNP001)
Southport, NC 28461

SUBJECT: BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2 – STAFF ASSESSMENT OF FLOODING FOCUSED EVALUATION (EPID NOS. 000495/05000324/L-2018-JLD-0016 AND 000495/05000325/L-2018-JLD-0016)

Dear Mr. Gideon:

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, under Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f), (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the NRC's Near-Term Task Force (NTTF) report (ADAMS Accession No. ML111861807). Enclosure 2 to the 50.54(f) letter requested that licensees reevaluate flood hazards for their sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses (ADAMS Accession No. ML12056A046). By letter dated March 11, 2015 (ADAMS Accession No. ML15079A385, non-public), Duke Energy Progress, LLC (Duke, the licensee) responded to this request for Brunswick Steam Electric Plant, Units 1 and 2 (Brunswick).

After its review of the licensee's response, by letter dated March 16, 2017 (ADAMS Accession No. ML17072A364), the NRC staff issued an interim staff response (ISR) letter for Brunswick. The ISR letter provided the reevaluated flood hazard mechanisms that exceeded the current design basis (CDB) for Brunswick and parameters that are suitable for other assessments associated with NTTF Recommendation 2.1, "Flooding." As stated in the letter, because the local intense precipitation (LIP), Streams and Rivers, Failure of Dams and Onsite Water Control/Storage structures, Tsunami and Combined Effects Storm Surge flood-causing mechanisms at Brunswick are not bounded by the plant's CDB, additional assessments of these flood hazard mechanisms are necessary.

By letter dated September 27, 2018 (ADAMS Accession No. ML18274A335), the licensee submitted the focused evaluation (FE) for Brunswick.

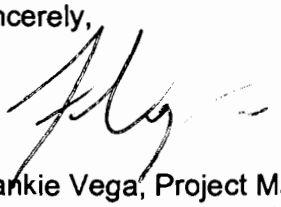
Enclosure 1 transmitted herewith contains Security-Related Information. When separated from Enclosure 1, this document is decontrolled.

The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood mechanism is bounded based on further reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is local intense precipitation. The purpose of this letter is to provide the NRC's assessment of the Brunswick FE.

As set forth in the attached staff assessment, the NRC staff has concluded that the Brunswick FE was performed consistent with the guidance described in Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178). Guidance document NEI 16-05, Revision 1, has been endorsed by Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation" (ADAMS Accession No. ML16162A301). The NRC staff has further concluded that the licensee has demonstrated that effective flood protection, if appropriately implemented, exists for the LIP, Streams and Rivers, Failure of Dams and Onsite Water Control/Storage structures, Tsunami and Combined Effects Storm Surge flood mechanisms during a beyond-design-basis external flooding event at Brunswick. This closes out the licensee's response for Brunswick for the reevaluated flooding hazard portion of the 50.54(f) letter and the NRC's efforts associated with EPID Nos. 000495/05000324/L-2018-JLD-0016 AND 000495/05000325/L-2018-JLD-0016.

If you have any questions, please contact me at 301-415-1617 or by e-mail at Frankie.Vega@nrc.gov.

Sincerely,



Frankie Vega, Project Manager
Beyond-Design-Basis Management Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket Nos: 50-325 and 50-324

Enclosures:
1. Staff Assessment Related to the
   Flooding Focused Evaluation for Brunswick (non-public)
2. Staff Assessment Related to the
   Flooding Focused Evaluation for Brunswick (public)

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE FOCUSED EVALUATION FOR

BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2

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

RECOMMENDATION 2.1 - FLOODING

EPID NOS. 000495/05000324/L-2018-JLD-0016 AND 000495/05000325/L-2018-JLD-0016

## 1.0 INTRODUCTION

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

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

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

Nuclear Energy Institute (NEI) 16-05, Revision 1, "External Flooding Assessment Guidelines" (ADAMS Accession No. ML16165A178), has been endorsed by the NRC as an appropriate methodology for licensees to perform the focused evaluation in response to the 50.54(f) letter.

The NRC's endorsement of NEI 16-05, including exceptions, clarifications, and additions, is described in NRC JLD-ISG-2016-01, "Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flood Hazard Reevaluation" (ADAMS Accession No. ML16162A301).

## 2.0 BACKGROUND

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

### Flood Hazard Reevaluation Report

By letter dated March 11, 2015 (ADAMS Accession No. ML15079A385, non-public), Duke Energy Progress, LLC (Duke, the licensee) submitted its flood hazard reevaluation report (FHRR) for Brunswick Steam Electric Plant, Units 1 and 2 (Brunswick). After reviewing the licensee's response, on March 16, 2017 (ADAMS Accession No. ML17072A364), the NRC issued an interim staff response (ISR) letter for Brunswick. The ISR letter discusses the reevaluated flood hazard mechanisms that exceeded the CDB for Brunswick and parameters that are a suitable input for the MSA and the FE. As stated in the ISR letter, because the local intense precipitation (LIP), Streams and Rivers, Failure of Dams and Onsite Water Control/Storage structures, Tsunami and Combined Effects Storm Surge flood-causing mechanisms at Brunswick are not bounded by the plant's CDB, additional assessments of the flood hazard mechanisms are necessary. The NRC staff subsequently issued the audit report and the staff assessment of the FHRR for Brunswick by letters dated November 15, 2017, and April 16, 2018 (ADAMS Accession Nos. ML17271A248 and ML18089A055, respectively). The NRC staff's conclusions regarding LIP, Streams and Rivers, Failure of Dams and Onsite Water Control/Storage structures, Tsunami and Combined Effects Storm Surge flood-causing mechanisms exceeding the Brunswick CDB remained unchanged from the information provided in the ISR letter.

### Mitigation Strategies Assessment

By letter dated March 21, 2018 (ADAMS Accession No. ML18081A034, non-public), the licensee submitted its MSA for Brunswick for review by the NRC staff. The MSAs are intended to confirm that licensees have adequately addressed the reevaluated flooding hazards within their mitigation strategies for beyond-design-basis external events. By letter dated October 30, 2018 (ADAMS Accession No. ML18284A388), the NRC issued its assessment of the Brunswick MSA. The NRC staff concluded that the Brunswick MSA was performed consistent with the guidance described in Appendix G of Nuclear Energy Institute 12-06, Revision 2, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide" (ADAMS Accession No. ML16005A625). The NRC's endorsement of NEI 12-06, Revision 2, is described in JLD-ISG-2012-01, Revision 1, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (ADAMS Accession No. ML15357A163). The NRC staff further concluded that the licensee has demonstrated that the mitigation strategies, if appropriately implemented, are reasonably protected from reevaluated flood hazards conditions for beyond-design-basis external events.

Focused Evaluation

By letter dated September 27, 2018 (ADAMS Accession No. ML18274A335), the licensee submitted its FE for Brunswick. The FEs are intended to confirm that licensees have adequately demonstrated, for unbounded mechanisms identified in the ISR letter, that: 1) a flood mechanism is bounded based on further reevaluation of flood mechanism parameters; 2) effective flood protection is provided for the unbounded mechanism; or 3) a feasible response is provided if the unbounded mechanism is local intense precipitation. These 3 options associated with performing an FE are referred to as Path 1, 2, or 3, as described in NEI 16-05, Revision 1. The purpose of this staff assessment is to provide the results of the NRC's evaluation of the Brunswick FE.

## 3.0 TECHNICAL EVALUATION

The licensee stated that its FE followed Path 2 of NEI 16-05, Revision 1, and utilized Appendices B and C for guidance on evaluating the site strategy. The Brunswick FE addresses the LIP, Streams and Rivers, Failure of Dams and Onsite Water Control/Storage structures, Tsunami and Combined Effects Storm Surge flood-causing mechanisms, which were found to exceed the plant's CDB as described in the FHRR and ISR letter. This technical evaluation will address the following topics: characterization and evaluation of flood parameters; evaluation of flood impact assessments; evaluation of available physical margin; reliability of flood protection features; and overall site response.

### 3.1 Characterization of Flood Parameters

The licensee assessed the potential impacts of the following flood-causing mechanisms that were not bounded by the CDB: LIP, streams and rivers, failure of dams and onsite water control/storage structures, Tsunami and Combined Effects Storm Surge. The FE uses the water surface elevations, associated effects (AE) and flood event duration (FED) parameters for the flooding mechanisms which were presented in the MSA. These parameters have already been reviewed by the NRC, as summarized by the NRC assessment letter dated October 30, 2018 (ADAMS Accession No. ML18284A388). The licensee used the AE and FED parameters as input to the Brunswick FE and concluded that, with the appropriate implementation of the modifications described in Section 6.2 of the FE, the site's flood strategy is effective in protecting structures, systems, and components (SSCs) that support key safety functions (KSFs). The licensee supported its conclusion of adequate flood protection by presenting its assessment of adequate available physical margin (APM) and reliable flood protection features for LIP, streams and rivers, failure of dams and onsite water control/storage structures, Tsunami and Combined Effects Storm Surge flooding mechanism. In its FE, the licensee stated that in order to respond to a potential Combined Effects Storm Surge event at Brunswick, additional actions are necessary to undertake site preparation (e.g., installation of temporary flood protection barriers); therefore, an evaluation of the overall site response was included in the FE.

3.2 Evaluation of Flood Impact Assessment for LIP

3.2.1 Description of Impact of Unbounded Hazard

According to Table 7-1 of the FE, the maximum LIP water elevations estimated at several critical doors ranged from 19.9 feet (ft.) National Geodetic Vertical Datum of 1929 (NGVD29) to 22.50 ft. NGVD29. The licensee stated that flood water ingress from a LIP event could affect the Reactor Building airlock doors with access openings at 20 ft. NGVD29. The Reactor Building is the only building containing safety-related SSCs that has a finished floor elevation (FFE) below the maximum LIP flood elevations. All safety-related structures (i.e., including the Reactor Building) are designed to protect safety-related components from water intrusion due to external flooding to a still water elevation of 22 ft. NGVD29, as documented in BNP design bases and described in Section 3.2.2 below.

The licensee stated that any leakage past the Reactor building airlock door openings will be intercepted by floor drains and routed to sump areas on the -17 ft. level of the Reactor Building. The licensee expects water to spread over this large Reactor Building area and not challenge any plant SSC.

The NRC staff reviewed the information provided by the licensee in order to assure that adequate flood parameters were used for the calculation of water ingress and water accumulation. The NRC staff confirmed the flood parameters used for the calculation of water ingress and water accumulation were consistent with previous information reviewed by the staff for the Brunswick MSA.

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

Table 7-1 of the FE shows the maximum LIP water surface elevations at various doors in the plant power block. This table also provides the FFE for each of these doors along with the APM calculated for each door. As stated in the FE and consistent with Brunswick's CDB, SSCs that support the KSFs are all located in safety-related structures which are designed to be protected to a still water elevation of at least 22 ft. NGVD29. However, as shown in Table 7-1 of the FE, the Reactor building has two doors with openings at 20 ft. NGVD29. Since these doors are below the flood water elevations, some leakage could occur. The licensee estimates that approximately 0.3 ft. of water could accumulate on the Reactor Building -17 ft. elevation. The licensee used this 0.3 ft. of water accumulation along with the heights of the lowest SSC pedestals on the room floor to calculate APM. Since all the safety-related SSCs are located on pedestals from 1 to 3 ft. off the floor at this elevation the licensee calculated a minimum APM of 0.7 ft. For the other buildings in the power block with floor elevation or entrance at 23 ft. and no door leakage, the APM was calculated using the difference between the doors' FFE and the LIP flood elevation expected at these doors. Based on this information and the conservative assumptions used in the LIP flood analysis, the licensee concludes that the APM for the LIP is adequate.

As documented in the MSA staff assessment, the staff reviewed the assumptions and input parameters used in the LIP analysis and agrees that the licensee's estimation of water surface accumulation is reasonable. Also, as stated in the MSA staff assessment, the staff reviewed the analysis done by the licensee regarding in-leakage water quantities and expected flood water depths at the -17 ft. level of the Reactor Building and confirmed that safety-related SSCs are not expected to be impacted by water accumulation at this elevation. The staff also confirmed the

APM values summarized in Table 7-1 of the FE. Therefore, the NRC staff concludes that the licensee has demonstrated that there is sufficient APM as described in Appendix B of NEI 16-05, Revision 1.

Evaluation of Reliability of Protection Features

Brunswick relies on permanent passive flooding protection features such as building concrete walls and floors, exterior doors, and seals to provide protection from the LIP flooding events. The licensee stated that concrete walls and floors for buildings containing SSCs that support KSFs are designed to withstand design basis wind, tornado, and missile loads. As shown in the FE, the maximum LIP flood elevations are expected to be low and resulting LIP water loads are not expected to exceed these design loads. The licensee also stated that below grade penetration seals, conduit seals and other below grade seals are maintained in accordance with the Brunswick's Engineering Procedure AD-EG-BNP-1619, "External Events Protection Program", Revision 0. These seals are also periodically inspected to ensure functionality. The licensee stated that the normally closed Reactor Building airlock doors were credited for LIP flooding mitigation. These are the only doors that will be relied upon to limit water intrusion. As stated above, no other doors will be challenged by the LIP event since they have FFEs above the estimated LIP event flood levels. The licensee also compared the roofs loads associated with the reevaluated LIP with rainfall loads considered in the Updated Final Safety Analysis Report (UFSAR). The licensee stated that roof loads associated with the reevaluated LIP were bounded by the rainfall roof loads considered in the UFSAR.

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

The staff reviewed the maximum estimated flood elevations at each of the doors in the plant's power block. As stated in the FE, these flood elevations at the Reactor Building airlock doors are expected to slightly exceed 1 ft.; therefore, the staff confirms that resulting hydrostatic loads at such doors are expected to be low and not to exceed design loads for such doors. The NRC staff also reviewed Brunswick's engineering procedure, AD-EG-BNP-1619, and confirmed that flood water intrusion barriers are included as part of the External Events Protection Program and are periodically inspected to ensure functionality. The staff also reviewed the licensee's water in-leakage analysis from the LIP event and confirmed that potential water in-leakage is unlikely to affect SSCs relied upon for protecting KSFs. The NRC staff concludes that the licensee has demonstrated that the flood protection features described above are reliable to maintain KSFs, as described in Appendix B of NEI 16-05, Revision 1.

3.2.3 Overall Site Response

For the LIP event, the licensee does not rely on any manual actions; therefore, there is no need to review overall site response.

3.3 Evaluation of Flood Impact Assessment for Combined Effects Storm Surge

3.3.1 Description of Impact of Unbounded Hazard

In Table 5.1 of its FE, the licensee provided the maximum reevaluated combined effects storm surge flood levels along the site's buildings. In addition to the flood levels presented in Table 5.1 of the FE, Table 7-3 provides maximum loading expected for each building door, potential leakage depths to rooms housing key SSCs, critical height of SSCs, and the credited flood protection features in each of the rooms. The licensee's detailed analysis of the potential impacts on key SSCs as a result of the combined effects storm surge flood event is provided in Brunswick calculation, BNP-MECH-FHR-009 "Combined Effects Flood Evaluation, Revision 1. As shown in the FE, the maximum reevaluated combined effects storm surge flood levels exceed the CDB flood elevations of 22 ft. NGVD29 at several locations along site safety-related buildings. The reevaluated combined effects storm surge levels also exceed flood protection barriers (also referred to as cliff edge barriers) designed to protect safety-related equipment to a flood water elevation of 26 ft. NGVD29. Therefore, the combined effects storm surge event will challenge SSCs relied upon to protect KSFs in the Reactor Buildings, Diesel Generator Building, Fuel Oil Tank Chamber Building, Control Building, and Service Water Building. The licensee credits both permanent and temporary flood protection features to protect key SSC against the reevaluated combined effects storm surge. The licensee stated that, with the modifications described in Section 6.2 of the FE, no key SSCs are impacted by flood waters during the combined effects storm surge event.

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

Brunswick relies on the use of permanent and temporary flood protection features to provide protection against the combined effects storm surge flood. Table 7-3 of the FE provides APM values for the flood protection features protecting the Reactor Building, Diesel Generator Building, Fuel Oil Tank Chamber Building, Control Building, and Service Water Building doors. These calculated values ranged from 0.8 ft. to 2.77 ft. APM depending on the storm surge effects on specific doors. For doors that have temporary barriers (i.e., cliff edge barriers) and are not subject to wave run-up, the licensee calculated the APM using the difference between top of the barrier elevation and the maximum stillwater elevation at the specific location. For watertight doors allowing in-leakage, the licensee calculated APM using the height to lowest KSF pedestal located in the room receiving in-leakage and the estimate in-leakage accumulation in such room. The licensee described the assumptions, inputs and methods used in the in-leakage analysis. The licensee concluded that adequate APM exists or will exist for the temporary and permanent flood protection features.

The staff reviewed the APM values summarized in the FE. Also, the staff reviewed the assumptions and input parameters used in the in-leakage analysis and agrees that the licensee's estimation of water ingress and accumulation is reasonable. Therefore, the NRC staff concludes that the licensee has demonstrated that, provided the changes and modifications described in Section 6.2 of the FE are put in place, there is sufficient APM, as described in Appendix B of NEI 16-05, Revision 1.

Evaluation of Reliability of Protection Features

As stated above, Brunswick relies on the use of permanent and temporary flood protection features to provide protection against the combined effects storm surge flood. Section 6.2 of the FE provides a summary of plant modifications and changes needed to ensure adequate APM and reliability of the flood protection features against the reevaluated combined effects storm surge. A summary of Brunswick's flood protection features is provided below:

- Existing concrete walls/floors for buildings containing SSCs that support KSFs – The licensee considered the hydrostatic, hydrodynamic, and debris loading impacts on safety-related structures. The licensee stated that loading associated with the reevaluated combined effects storm surge flood would have a negligible effect on structures since these were designed to resist tornado generated missiles; thus, combined effects storm surge related loads are bounded by the CDB.

- Existing seals for penetrations into buildings containing SSCs that support KSFs – The licensee stated that below-grade penetration seals, conduit seals, and other below grade seals are maintained in accordance with Brunswick engineering procedure AD-EG-BNP-1619, "External Events Protection Program", Revision 0, which ensures that water intrusion barriers are periodically inspected to ensure functionality. Therefore, the licensee stated that the plant equipment was not considered susceptible to groundwater intrusion or external flooding.

- External watertight doors - The licensee evaluated the hydrostatic, hydrodynamic, and debris loading associated with the re-evaluated combined effects storm surge on external watertight doors. These loads are summarized in Table 7-3 of the FE. Based on the load analysis described in Brunswick calculation BNP-MECH-FHR-009, the licensee credited the doors described in Section 7.3.2.3 of the FE as watertight and therefore, these doors would prevent in-leakage that would impact SSCs relied upon for KSFs. Based on the load analysis, the licensee also determined that a specific DG building door would be impacted by debris loading. As stated in Section 6.2 of the FE, the licensee committed to provide a new debris barrier to shield this door from this debris impact loading. Design specifications for planned improvements to these barriers are described in Brunswick's Engineering Change (EC) 413020, "Design Specification for Beyond Design Basis Flood Hazard (Combined Effects Storm Surge Flooding) protection enhancements and associated attachments".

- Temporary flood barriers - Cliff-edge flood protection barriers will be installed internal and/or external to plant structures (i.e., selected doors in the Control, Reactor and DG Buildings) in accordance with plant Procedure 0AI-68 "Brunswick Nuclear Plant Response to Severe Weather Warnings", Revision 52. These barriers will be installed at least 12 hours prior to a hurricane with predicted storm surge of 20 ft. or greater on site. As stated in Section 6.2 of its FE, the licensee committed to modify these barriers to increase their height to 27.5 ft. NGVD29 to achieve a minimum APM of 0.7ft.

- Design specifications for planned improvements to these barriers are described in Brunswick report EC 413020. The licensee also committed to replace two of these temporary barriers in the Control Building with permanent water tight doors providing permanent passive flood protection.

In addition to the proposed modifications described above, the licensee also committed to:

- Modify the existing Service Water Building security delay gate doors to shield ventilation openings from waves.

- Raise the elevation of the smoke removal vents on the Fuel Oil Tank Chamber (FOTC) roof to a level that provides permanent passive protection

- Provide a new debris barrier that protects all penetrations on the FOTC Roof

The NRC staff reviewed Brunswick calculation BNP-MECH-FHR-009, which provides detailed information on flood elevations, applicable AEs (i.e., static, hydrodynamic, and debris loads) and period of inundation at various points of interest throughout the site. Based on this information, the licensee identified several key areas where the reevaluated flood elevations exceeded flood protection levels. The staff reviewed the methodologies, assumptions, and input parameter values used to estimate the hydrostatic, hydrodynamic, and debris loads applied to the flood protection features and found these to be acceptable and reasonable. The staff also reviewed Brunswick EC 413020 which provides detailed engineering analysis used to evaluate the flood protection features and proposed modifications described above. The staff noted that the licensee used engineering codes and standards in these calculations and evaluations in accordance with NEI 16-05, Revision 1. The staff also noted that the commitments referenced above are being tracked with a completion date of June 1, 2022. If the modifications are completed as described by the licensee, the NRC staff concludes that the licensee has demonstrated that the flood protection features described above are reliable to maintain KSFs, as described in Appendix B of NEI 16-05, Revision 1.

3.3.3 Overall Site Response

As previously explained, the licensee relies on permanent and temporary protection features to provide flood protection against the reevaluated combined effects storm surge event. Actions needed to deploy these temporary protection features were included as part of plant Administrative Instruction 0AI-68, "Brunswick Nuclear Plant Response to Severe Weather Warnings", Revision 52. These barriers are expected to be installed at least 12 hours prior to a predicted storm surge of 20 ft. or greater arriving on site. Given the 48 hours credited in its FE for warning time and site preparation, the licensee determined that there is sufficient time for these flood protection barriers to be installed prior to the arrival of the storm. However, as stated above, these flood protection barriers are expected to be modified; therefore, it is expected that Administrative Instruction 0AI-68 be modified to incorporate such changes. The licensee stated that all actions needed for combined effects storm surge flood protection will be completed well in advance of storm surge arrival. Finally, the licensee stated that it used the guidance in NEI 16-05, Revision 1, Appendix C, to demonstrate adequate site response to the combined effects storm surge event.

Based on the licensee's FE description, as confirmed by the NRC staff's review of the licensee's procedure, 0AI-68, the staff concludes that the licensee's site response evaluation has been performed in accordance with NEI 16-05, Revision 1, Appendix C, and is therefore acceptable.

3.4 Evaluation of Flood Impact Assessment for Streams and Rivers

3.4.1 Description of Impact of Unbounded Hazard

The licensee calculated the peak water surface elevation associated with streams and rivers for the Brunswick site to be 15.46 ft. NGVD29, which remains below plant grade at 20.0 ft. NGVD29. Since the reevaluated streams and rivers flood is lower than the site grade elevation, no impacts were identified to key SSCs.

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

Brunswick relies on the passive protection of site topography to provide protection from the streams and rivers flooding mechanism. The APM for the streams and rivers was estimated at 4.5 ft. in relation to the site grade of 20.0 ft. NGVD29. The staff concludes that the licensee has demonstrated that there is sufficient APM, as described in Appendix B of NEI 16-05, Revision 1.

Since the site's topography is already credited as part of the Brunswick's design-basis flood protection, the NRC staff concludes that a reliability analysis of this feature is not necessary in accordance with the guidance found in NEI 16-05, Revision 1.

3.4.3 Overall Site Response

The licensee does not rely on any personnel actions or new modifications to the plant in order to respond to the streams and river flooding event. As described above, the licensee's evaluation relied on the site's topography to demonstrate adequate flood protection. Therefore, there is no need to review overall site response for this mechanism.

3.5 Evaluation of Flood Impact Assessment for Failure of Dams

3.5.1 Description of Impact of Unbounded Hazard

The licensee calculated the maximum water surface elevation associated with dam failure at the Brunswick site to be [redacted] ft. NGVD29, which remains below plant grade at 20.0 ft. NGVD29. Since the reevaluated dam failure flood is lower than the site grade elevation, no impacts were identified to key SSCs.

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

Brunswick relies on the passive protection of site topography to provide protection from the dam failure flooding mechanism. The APM for the dam failure was estimated at [redacted] ft. in relation to the site grade of 20.0 ft. NGVD29. The staff concludes that the licensee has demonstrated that there is sufficient APM, as described in Appendix B of NEI 16-05, Revision 1.

Since the site's topography is already credited as part of the Brunswick's design-basis flood protection, the NRC staff concludes that a reliability analysis of this feature is not necessary in accordance with the guidance found in NEI 16-05, Revision 1.

3.5.3 Overall Site Response

The licensee does not rely on any personnel actions or new modifications to the plant in order to respond to the dam failure flooding event. As described above, the licensee's evaluation relied on the site's topography to demonstrate adequate flood protection. Therefore, there is no need to review overall site response for this mechanism.

3.6 Evaluation of Flood Impact Assessment for Tsunami

3.6.1 Description of Impact of Unbounded Hazard

The licensee calculated the peak water surface elevation associated with tsunami for the Brunswick site to be 10.2 ft. NGVD29, which remains below plant grade at 20.0 ft. NGVD29. Since the reevaluated Tsunami flood is lower than the site grade elevation, no impacts were identified to key SSCs.

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

Brunswick relies on the passive protection of site topography to provide protection from the Tsunami flooding mechanism. The APM for the tsunami was estimated at 9.8 ft. in relation to the site grade of 20.0 ft. NGVD29. The staff concludes that the licensee has demonstrated that there is sufficient APM, as described in Appendix B of NEI 16-05, Revision 1.

Since the site's topography is already credited as part of the Brunswick design-basis flood protection, the NRC staff concludes that a reliability analysis of this feature is not necessary in accordance with the guidance found in NEI 16-05, Revision 1.

3.6.3 Overall Site Response

The licensee does not rely on any personnel actions or new modifications to the plant in order to respond to the tsunami flooding event. As described above, the licensee's evaluation relied on the site's topography to demonstrate adequate flood protection. Therefore, there is no need to review overall site response for this mechanism.

4.0 AUDIT REPORT

The July 18, 2017(ADAMS Accession No. ML17192A452), generic audit plan describes the NRC staff's intention to issue an audit report that summarizes and documents the NRC's regulatory audit of the licensee's FE. The NRC staff's Brunswick audit was limited to the review of the calculations and procedures described above. Because this staff assessment appropriately summarizes the results of the audit, the NRC staff concludes that a separate audit report is not necessary, and that this document serves as the audit report described in the staff's July 18, 2017, letter.

5.0 CONCLUSION

The NRC staff concludes that Duke performed the Brunswick FE in accordance with the guidance described in NEI 16-05, Revision 1, as endorsed by JLD-ISG-2016-01, and that the licensee has demonstrated that effective flood protection will exist for the reevaluated flood

hazards when the licensee completes its regulatory commitments to improve the plant's ability to withstand the postulated flood hazards. Furthermore, the NRC staff concludes that Brunswick screens out of performing an integrated assessment based on the guidance found in JLD-ISG-2016-01. As such, in accordance with Phase 2 of the process outlined in the 50.54(f) letter, additional regulatory actions associated with the reevaluated flood hazard following completion of the licensee's regulatory commitments, are not warranted. The licensee has satisfactorily completed providing responses to the 50.54(f) activities associated with the reevaluated flood hazards.

SUBJECT: BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2 – STAFF ASSESSMENT OF FLOODING FOCUSED EVALUATION DATED JANUARY 16, 2019

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