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

November 4, 2015

Mr. Mano Nazar
President and Chief Nuclear Officer
Nuclear Division
NextEra Energy
P.O. Box 14000
Juno Beach, FL 33408-0420

SUBJECT: TURKEY POINT NUCLEAR GENERATING, UNIT NOS. 3 AND 4 - SUPPLEMENT TO STAFF ASSESSMENT OF RESPONSE TO 10 CFR 50.54(f) INFORMATION REQUEST - FLOOD-CAUSING MECHANISMS REEVALUATION (CAC NOS. MF1114 AND MF1115)

Dear Mr. Nazar:

The purpose of this letter is to transmit a supplement to the U.S. Nuclear Regulatory Commission (NRC) staff's assessment for Turkey Point Nuclear Generating, Units 3 and 4 (Turkey Point) reevaluated flood hazard information that was issued to you by letter dated December 4, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14324A816). The supplement updates the original staff assessment to address changes in the NRC's approach to the steps following the review of the flood hazard reevaluations as directed by the Commission. The letter also addresses the next steps associated with the mitigation strategies assessment with respect to the reevaluated flood hazards.

By letter dated March 12, 2012 (ADAMS Accession No. ML12053A340), the NRC issued a request for information pursuant to Title 10 of the *Code of Federal Regulations*, Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The request was issued as part of implementing lessons learned from the accident at the Fukushima Dai-ichi nuclear power plant. Enclosure 2 to the 50.54(f) letter requested licensees to reevaluate flood-causing mechanisms using present-day methodologies and guidance. By letter dated March 11, 2013 (ADAMS Accession No. ML130950216), Florida Power and Light Company (the licensee) responded to this request for Turkey Point. This response was supplemented by letters dated January 31, 2014, February 26, 2014, April 25, 2014 and August 7, 2014 (ADAMS Accession Nos. ML14055A365,(ML14073A065, ML14149A479 and ML14234A085). The NRC staff has completed its review of the information provided, as documented in the staff assessment and the enclosed supplement to the staff assessment. This closes out the NRC's efforts associated with CAC Nos. MF1114 and MF1115.

The enclosed supplement to the NRC staff assessment updates the staff's conclusions in accordance with the flood hazard reevaluation approach described in NRC letter dated September 1, 2015 (ADAMS Accession No. ML15174A257), concerning the coordination of requests for information regarding flooding hazard reevaluations and mitigating strategies for beyond-design-basis external events. This letter describes the changes in the NRC's approach to the flood hazard reevaluations that were approved by the Commission in its Staff Requirements Memorandum (ADAMS Accession No. ML15209A682) to COMSECY-15-0019 (ADAMS Accession No. ML15153A104) that described the NRC's mitigating strategies and flooding hazard reevaluation action plan.

As documented in the NRC staff assessment and the enclosed supplement, the staff has concluded that the licensee's reevaluated flood hazard information is suitable for the assessment of mitigation strategies developed in response to Order EA-12-049 (i.e., defines the mitigating strategies flood hazard information described in guidance documents currently being finalized by the industry and NRC staff) for Turkey Point. Further, the licensee's reevaluated flood hazard information is suitable for other assessments associated with Near-Term Task Force Recommendation 2.1 "Flooding".

The reevaluated flood hazard results for local intense precipitation, seiche, tsunami, and storm surge were not bounded by the current design-basis flood hazard. In order to complete its response to Enclosure 2 to the 50.54(f) letter, the licensee is expected to submit a revised integrated assessment or a focused evaluation(s), as appropriate, to address these reevaluated flood hazards, as described in the NRC's September 1, 2015, letter.

If you have any questions, please contact me at (301) 415-6185 or by email at Anthony.Minarik@nrc.gov.

Sincerely,

Anthony Minarik, Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket Nos. 50-250 and 50-251

Enclosure:
Supplement to Staff Assessment of Flood
Hazard Reevaluation Report

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SUPPLEMENT TO

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO FLOODING HAZARD REEVALUATION REPORT

NEAR-TERM TASK FORCE RECOMMENDATION 2.1

RELATED TO THE FUKUSHIMA DAI-ICHI NUCLEAR POWER PLANT ACCIDENT

TURKEY POINT NUCLEAR GENERATING, UNIT NOS. 3 AND 4

DOCKET NOS. 50-250 AND 50-251

1.0 INTRODUCTION

This document is a supplement to the U.S. Nuclear Regulatory Commission (NRC) staff assessment that was transmitted by letter dated April 16, 2015 (NRC, 2014c) to Florida Power and Light Company (the licensee) for Turkey Point Nuclear Generating, Units 3 and 4 (Turkey Point). With the exceptions of Table 3.1.2-1 and the Reference section, this supplement only contains the sections that were changed to resolve the open items and reflect the changes in the NRC's approach to the flood hazard reevaluations that were approved by the Commission in its Staff Requirements Memorandum (SRM) (NRC, 2015a) to COMSECY-15-0019 (NRC, 2015b), which described the NRC's mitigating strategies and flooding hazard reevaluation action plan. Table 3.1.2-1 at the end of the supplement is reproduced from the staff assessment for convenience. Instead of repeating the Reference section in its entirety, only the additions to the list of references are included in the supplement.

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2.0 REGULATORY BACKGROUND

2.1 Applicable Regulatory Requirements

There are no changes or updates to this section of the NRC staff assessment.

2.2 Enclosure 2 to the 50.54(f) Letter

By letter dated March 12, 2012 (NRC, 2012a) the NRC issued a request for information Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The 50.54(f) letter requests all power reactor licensees and construction permit holders reevaluate all external flooding-causing mechanisms at each site. The reevaluation should apply present-day methods and regulatory guidance that are used by the NRC staff to conduct early site permit (ESP) and combined license (COL) reviews. This includes current techniques, software, and methods used in present-day standard engineering practice. If the reevaluated flood-causing mechanisms are not bounded by the current plant design-basis flood hazard, an integrated assessment may be necessary.

Enclosure

2.2.1 Flood-Causing Mechanisms

There are no changes or updates to this section of the NRC staff assessment.

2.2.2 Associated Effects

There are no changes or updates to this section of the NRC staff assessment.

2.2.3 Combined Effects Flood

There are no changes or updates to this section of the NRC staff assessment.

2.2.4 Flood Event Duration

There are no changes or updates to this section of the NRC staff assessment.

2.2.5 Actions Following the Flooding Hazard Reevaluation Report (FHRR)

For the sites where the reevaluated probable maximum flood elevation is not bounded by the current design-basis flood hazard for all flood-causing mechanisms, the 50.54(f) letter requests licensees and construction permit holders to:

- Submit an Interim Action Plan with the FHRR documenting actions planned or already taken to address the reevaluated hazard.

- Perform an integrated assessment subsequent to the FHRR to: (a) evaluate the effectiveness of the current licensing basis (i.e., flood protection and mitigation systems); (b) identify plant-specific vulnerabilities; and (c) assess the effectiveness of existing or planned systems and procedures for protecting against and mitigating consequences of flooding for the flood event duration.

After issuance of the 50.54(f) letter, the NRC changed the approach to the steps following the review of the flood hazard reevaluations, as directed by the Commission, to permit use of focused evaluations as an alternative to an integrated assessment. NRC letter dated September 1, 2015 (NRC, 2015c), describes the changes in the NRC's approach to the flood hazard reevaluations.

If the reevaluated flood hazard is bounded by the current design-basis flood hazard for all flood- causing mechanisms at the site, licensees are not required to perform an integrated assessment or a focused evaluation(s) at this time.

3.0 TECHNICAL EVALUATION

There are no changes or updates to this section of the NRC staff assessment.

3.1 Site Information

There are no changes or updates to this section of the NRC staff assessment.

3.2 Local Intense Precipitation and Associated Site Drainage

The licensee's FHRR includes a reevaluation of the flood hazard, including associated effects, from local intense precipitation (LIP). The licensee did not report a single reevaluated flood hazard elevation for LIP. Instead, the licensee's analysis of flood hazard from LIP determined peak water depths and water surface elevations at specific locations under two different LIP scenarios, referred to as Scenario A and Scenario B. Scenario A LIP occurs during normal plant operations when no special flood protection measures required for hurricane readiness are in place. Scenario B LIP occurs when the plant is operating under hurricane readiness procedures. Analysis of Scenario B LIP is focused on the Condenser Pits, Unit 3 Component Cooling Water (CCW3) Area, and Unit 4 Component Cooling Water (CCW4) Area. Under normal conditions, rainwater entering these open-air structures can escape by passive drainage, but when hurricane readiness procedures are in place, rainwater is prevented from draining out of these areas because floor drains are plugged and stoplogs are inserted in doorways. The current licensing basis (CLB) states that when hurricane readiness procedures are implemented, pumps are placed in these areas to remove rainwater.

The licensee reported in its April 25, 2014, request for additional information (RAI) response (Kiley, 2014c), a reevaluated flood elevation for LIP Scenario B of 20.8 ft (6.3 m) in the CCW3 Area. The reevaluated flood elevation for LIP Scenario B in the Condenser Pits is 14.5 ft (4.4 m). For LIP Scenario A, the licensee reported maximum flood water depths and elevations at 33 discrete "points of interest" (POIs) at potentially vulnerable locations in the plant area; the greatest depth of water (above ground surface) at a POI location is reported as 1.7 ft (0.5 m), corresponding to elevation 17.2 ft (5.2 m). Reevaluated maximum water elevations for both scenarios are above the plant grade elevation of 15.7 ft (4.8 m).

This flooding mechanism is considered in the CLB (as discussed above and in Section 3.1.5), but is not evaluated in the current design-basis. Thus, there is no previously specified elevation for flooding hazard related to LIP.

The licensee used FLO-2D Pro (hereafter referred to as FLO-2D), a two-dimensional hydrodynamic computer model, to calculate the flooding due to LIP (FLO-2D, 2012). The licensee did not report any site-specific validation of the model. The licensee's reevaluation of flood hazard for LIP is based on the one-square-mile (2.6 km^2) probable maximum precipitation (PMP), which the licensee obtained from the U.S. National Weather Service (NWS) Hydrometeorological Reports (HMR) No. 51 (National Oceanic and Atmospheric Administration (NOAA), 1978) and No. 52 (NOAA, 1982). The one-hour, one-square-mile (2.6 km^2) PMP depth for the Turkey Point site given by HMR 52 is 19.4 inches (493 mm). Table 3.2-1 provides the values of PMP for periods of less than one hour. The NRC staff notes that a reasonable

estimate of the site's LIP PMP is the application of an appropriate NOAA HMR estimate for any rainfall duration used in NUREG/CR-7046, regardless of temporal distribution of the rainfall. The licensee obtained 1-sq. mile PMP depths for durations ranging between 5-minutes and 1-hour using HMR-52. Therefore, the NRC staff confirmed that the licensee selected appropriate rainfall rate values to satisfy the 50.54(f) information request.
For its reevaluation of potential flooding from LIP, the licensee used these values to create a synthetic hydrograph for the one-hour PMP event. Table 3.2-2 summarizes the synthetic hydrograph, which places the highest rates of rainfall in the middle of the one-hour PMP event.

The licensee noted (in response to an RAI), that the choice of a center-weighted temporal rainfall distribution for analysis is based on the synthetic rainfall distributions presented in the TR-55 methodology (Soil Conservation Service, 1986), which consistently places the most intense rainfall near the middle of the storm. The licensee also performed a sensitivity study, using FLO-2D, to compare the effects on results of the center-, front-, front-third-, end-third-, and end- loaded rainfall distributions. The licensee's sensitivity analysis found that the center- loaded distribution resulted in bounding flood elevations at all but two POIs that had slightly higher flood elevations from a rainfall distribution with a later peak. To bound its analysis, in its subsequent simulations the licensee considered several temporal rainfall distributions and reported the highest peak water surface elevation predicted at each location.

The licensee modeled the Turkey Point site and its surrounding area using a five-foot (1.5 m) FLO-2D grid with elevations obtained from an October 2012 topographic survey. Elevations for the surrounding area were obtained from a 2008 LiDAR survey of Miami-Dade County. In its FHRR Section 4.1.2, the licensee states that the plant drainage system (including catch basins, floor drains, and associated piping) was conservatively assumed not to be functioning during the modeled LIP event.

The licensee used FLO-2D to simulate the generation and flow of runoff from the one-hour PMP event, represented by applying the rainfall over the model grid at one-minute increments, as indicated in Table 3.2-2. Figures 3.2-1 and 3.2-2 illustrate the results of one model run for Scenario A. Figure 3.2-2 shows the locations of POIs. The licensee did not provide similar figures for Scenario B in its FHRR.

The licensee's initial approach for modeling of runoff from rainfall on building roofs was based on modeling assumptions that included treating roof drains as blocked, assuming no roof storage of rain, and routing all rainfall incidents on a roof to computational cells immediately outside the building perimeter. In its letter dated February 26, 2014 (Kiley, 2014b), the licensee reported that it had found that the FLO-2D model treated building grid elements as having the same elevation as the adjacent ground, which could lead to erroneous results. Subsequently, this issue was ultimately resolved by the licensee as a supplemental submission to the hazard report in April 2014, as described below.

By letter dated April 25, 2014 (Kiley, 2014c), the licensee revised its response to report that new analyses resulted in changes to the elevations for both Scenario A and B, with Scenario B having a higher peak LIP flood elevation than previously reported. Additional documentation was included in calculation packages in the licensee's electronic reading room, and in FLO-2D input and output files submitted on the docket. Instead of using FLO-2D's protocol for handling rainfall incident on buildings, the licensee's revised modeling treated building roofs as part of the modeled region and explicitly includes roof elevations and slopes in the topographic data input to the model. Ground elevations near the POIs are adjusted to match actual measured ground elevations at the POIs. The CCW areas, Condenser Pits, and some interior building structures are explicitly represented in the model input. The "Levee" feature of the FLO-2D software is used to represent flood barriers on the site and parapets at the edges of some of the building roofs. Manning's roughness coefficient *n* for the reactor block area was conservatively set at 0.05.

For LIP Scenario A, the licensee reported maximum flood water depths and elevations at 33 POIs; the greatest depth of water (above ground surface) at a POI location is reported as 1.7 ft (0.5 m), corresponding to elevation 17.2 ft (5.2 m), for a POI in the CCW3 Area. For LIP Scenario B in CCW3, the licensee's letter indicates a peak water depth of 5.0 ft (1.5 m); for CCW4 the peak water depth was 1.3 ft (0.4 m). The corresponding water surface elevation for CCW3 was reported as 20.8 ft (6.3 m). The licensee stated that the revised peak water level in CCW3 exceeded the peak levels previously reported for LIP Scenario B and "was found to challenge SSCs" in that area. The licensee stated that it would implement interim actions to block runoff into the CCW areas before the hurricane season and that it had entered the revised flooding results for the CCW area and the need for interim actions into its corrective action program.

The NRC staff reviewed details of the licensee's FLO-2D model implementation and determined that the approaches and assumptions were conservative. The model output files reviewed by NRC staff did not report any errors related to model stability or mass balance. Additionally, the NRC staff performed confirmatory analysis using FLO-2D with one of the licensee's input data sets and confirmed the licensee's results.

The NRC staff identifies the peak water surface elevation of 20.8 ft (6.3 m) determined for CCW3 Area for LIP Scenario B as the reevaluated flood hazard elevation for LIP during periods when hurricane preparedness measures are in place. For other time periods (LIP Scenario A), the NRC staff identifies the peak water surface elevation of 17.2 ft (5.2 m) as the reevaluated flood hazard elevation.

The licensee stated that it plans to evaluate how various combinations of potential facility modifications and flooding response measures would change the elevation, duration, and velocity of LIP flooding under both Scenario A and Scenario B. The NRC staff will review the basis for the licensee's conclusions regarding facility modifications as part of the NRC staff review of the LIP focused evaluation. The staff's assessment documented here is based on NRC staff review of the licensee's evaluation of site flooding under the current facility configuration as described in its FHRR and associated supplemental licensee submittals.

The RAIs issued by the NRC staff dated January 15, 2014 (NRC, 2014b), included several requests for clarification of statements made in the Turkey Point FHRR, regarding the locations of safety- related SSCs and the potential impacts of flooding on these safety-related SSCs. In its response dated January 31, 2014 (Kiley, 2014a), the licensee clarified that all safety-related SSCs near the Condenser Pits are at or above the top of the Condenser Pit and the Turbine Building at 18.0 ft (5.4 m) on the site datum (elevation 15.7 ft [4.8 m]). The licensee also provided information on the elevations of safety-related SSCs near the CCWs, the locations of three motor control centers near the Auxiliary Building doors, and its analysis of the potential for floodwater entering the Auxiliary Building through those doors. In that same letter (Kiley, 2014a), the licensee also explained that the CCW areas were not treated as having blocked drainage under Scenario A because it is expected that water in those areas could drain out the open doorway into the yard area which slopes away from the CCW area. This is in contrast to Scenario B, in which stoplogs would prevent water from leaving the area. Subsequently, by letter dated February 26, 2014 (Kiley, 2014b), the licensee provided detailed information on the locations and local grade elevations of the 33 POIs considered in the FLO-2D modeling.

The licensee reported in its FHRR, that flow velocities predicted by the FLO-2D modeling of LIP Scenario A reached up to approximately 2.6 ft per second (0.8 m/s). The licensee did not report flow velocities from later revisions of its modeling and did not discuss the potential effects from the water velocities predicted by the model. By a letter dated February 26, 2014 (Kiley, 2014b), the licensee stated that neither of the LIP scenarios generates unique debris, sedimentation, groundwater ingress, or waterborne projectiles because runoff would be across impervious surfaces and velocities would be bounded by the velocity of probable maximum storm surge. The NRC staff notes that peak water velocities from LIP could occur on surfaces not exposed to storm surge.

The licensee performed a calculation to evaluate the potential buildup of water from the Turbine Building Area to the Condenser Pits during LIP Scenarios A and B. The calculation assumed that all precipitation that falls on a 62,000 square-foot (5,760 m^2) area of the Turbine Building runs off into the Condenser Pits, that there is no lag in the delivery of runoff to the Condenser Pits, and that the runoff is distributed equally between the two 16 ft (4.9 m) deep Condenser Pits, which have identical dimensions and have a combined surface area of 7,740 ft^2 (719 m^2). For Scenario B, the licensee also assumed that all outlets from the Condenser Pits were blocked due to the implementation of hurricane readiness procedures. The licensee calculated the maximum water depth in the Condenser Pits for a one-hour LIP event as 14.8 ft (4.5 m), corresponding to a water surface elevation of 14.5 ft (4.4 m). In its January 31, 2014, response to RAIs (Kiley, 2014a), the licensee identified this elevation as the reevaluated bounding flood level for LIP in the Condenser Pits. The licensee stated that this water level would not affect safety-related SSCs. The NRC staff notes that this elevation is below the 15.7 ft (4.8 m) elevation of SSCs near the condenser pits.

The licensee presented a single set of flood event duration parameters for LIP (Kiley, 2014b), with no distinction between Scenarios A and B. However, the licensee's discussion of flood duration notes that LIP events related to tropical cyclones and LIP events related to stand-alone storms have different warning/preparation times. Additionally, the enclosed spaces in which water accumulates under Scenario B can be expected to have a longer duration of both inundation and recession than free-draining areas. In response to an RAI, the licensee indicated that for LIP Scenario B in CCW areas, external flooding from hurricane storm surge could add to the volume of water that would need to be managed by adding small amounts of leakage through exterior wall seals and stoplogs. This would increase the duration of elevated water levels for Scenario B (Kiley, 2014b). Additionally, the NRC staff notes that tropical storm rainfall antecedent to a tropical cyclone-related LIP event could increase the volume of water requiring management in an enclosed space, thus adding to the duration of a Scenario B LIP flood event. These observations indicate that different sets of duration parameters need to be considered when addressing the hazards of these two different LIP scenarios.

The NRC staff confirmed the licensee's conclusion that the reevaluated flood hazard for LIP and associated site drainage is not bounded by the current design-basis flood hazard. Therefore, the licensee is expected to submit a focused evaluation for LIP and associated site drainage consistent with the process outlined in COMSECY-15-0019 (NRC, 2015c) and associated guidance that will be issued. Under this approach, the NRC staff anticipates that licensees will perform and document a focused evaluation for LIP and associated site drainage that evaluates the impact of the LIP hazard on the site and implements any necessary programmatic, procedural or plant modifications to address this hazard exceedance. The NRC staff anticipates that licensees will submit letters providing a summary of the evaluation and, if needed, regulatory commitments to implement and maintain appropriate programmatic, procedural or plant modifications to protect against the LIP hazard.

3.3 Streams and Rivers

There are no changes or updates to this section of the NRC staff assessment.

3.4 Failure of Dams and Onsite Water Control/Storage Structures

There are no changes or updates to this section of the NRC staff assessment.

3.5 Storm Surge

The licensee reported in its FHRR submittal, that the reevaluated hazard, including the associated effect of wave runup, for site flooding due to probable maximum storm surge (PMSS) is 19.1 ft (5.8 m). This evaluation was later revised, as discussed further below. This flood-causing mechanism is described in the licensee's current design-basis. The current design-basis hazard for site flooding due to storm surge is a still water elevation of 16 ft (4.8 m).

The NRC staff reviewed the flooding hazard from storm surge, including associated effects, against the relevant regulatory criteria based on present-day methodologies and regulatory guidance below.

The licensee selected the design hurricane in accordance with NUREG/CR-7046, NUREG- 0800, and Japan Lessons-Learned Directorate (JLD) Interim staff Guidance (ISG) JLD-ISG-2012-06. Using the NWS23 methodology (NOAA, 1979) and analyzing a number of storm radii, headings and forward speeds, the licensee determined the critical probable maximum hurricane (PMH) parameters of storm size, pressure, and wind fields for a storm making landfall near Turkey Point (Table 3.5-1). The licensee provided a region- specific hurricane climatology study to support the selection of the radius of maximum wind parameter in FHRR Section 4.4.9.5.

The NRC staff verified that the licensee's meteorological parameters for the reevaluated storm surge analysis were derived in accordance with NRC guidance and reflect the historical record for the site as well as storms occurring since the CLB. Table 3.5-1 shows the licensee's meteorological parameters for the severe storms (Category 4 to Category 5) that were analyzed.

The licensee performed storm surge analyses using the Delft3D software package. The licensee performed wave transformation using Simulating WAves Nearshore (SWAN), a spectral wave model that evaluates the refracted wave height and wave angle based on a spectrum of waves using linear wave theory. The main inputs to SWAN include the water depth, the wave spectra, and the friction factor. The licensee stated in its FHRR (Kiley, 2013), that the output from the SWAN model includes significant wave height, wave period, wave dissipation, and wave direction at each point within the computational grid (Deltares, 2009). The licensee created the physical features of the numerical models from regional and local bathymetry and topography and calibrated and validated the model to observed tides and historical Hurricanes Andrew and Donna. The licensee used a triple-nested grid with a coarse regional grid consisting of squares of 6.2 miles by 6.2 miles (10 km by 10 km), a medium-fine grid consisting of 1,706-ft by 1,706-ft (520-m by 520-m) squares, and a fine grid consisting of 492-ft by 492-ft (150-m by 150-m) squares.

The antecedent water level conditions including 10 percent exceedance high tide (1.41 ft (0.43 m)) and potential sea level rise (0.39 ft (0.12 m)) are included in the numerical model with an estimated sea level rise for the remaining 20-year licensed life of Turkey Point.

The licensee followed the guidance provided in American National Standards Institute (ANSI) American Nuclear Society (ANS) -2.8-1992 (ANSI/ANS, 1992) for the wave runup evaluations based on methodologies and equations from the USACE (USACE, 1984). The licensee evaluated different wave approach directions, but noted that the critical direction is east to west, perpendicular to the coast and Turkey Point. The licensee concluded that waves with heights greater than one foot would break at the breakwater. The licensee's PMSS still water level is 17.3 ft (5.3 m) and includes the effects of 10-percent exceedance high tide, probable maximum surge, wave setup, and sea level rise. The licensee calculated wave runup of 1.8 ft (0.55 m) for a vertical wall condition using equations from the USACE (USACE, 1984). The maximum water level calculated by the license by combining the PMSS and coincident windwave runup is 19.1 ft (5.8 m). Table 3.5-1 summarizes the licensee results of the storm surge evaluation at Turkey Point.

The Turkey Point FHRR (Kiley, 2013) only evaluated the wave runup for the east side of the powerblock. However, the licensee later updated this submittal by letter dated August 7, 2014 (Kiley, 2014e), and addressed wave runup around the entire powerblock.

The existing eastern powerblock barrier is flood protected to 19.7 ft (6.0 m). The licensee determined that the reevaluated PMSS (storm surge stillwater level, wave runup and sea level rise) at the existing eastern powerblock flood barriers is 19.1 ft (5.8 m), which the licensee stated provides a margin of 0.6 ft (0.18 m).

The existing northern, southern and western powerblock barriers are flood protected to a storm surge stillwater level of 17.7 ft (5.4 m). By letter dated August 7, 2014 (Kiley, 2014e), for each of these barriers, the licensee provided a specific margin for a reevaluated PMSS. The NRC staff calculated the associated reevaluated PMSS for each of these barriers (north, south, and west walls). On the northern flood protection barrier, the reevaluated PMSS reaches elevation 18.0 ft (5.49 m), which exceeds the barrier by 0.3 ft (0.09 m). The reevaluated PMSS on the west and south flood protection walls reach elevation 17.4 ft (5.3 m) and 17.9 ft (5.46 m), respectively, which gives associated margins of 0.3 ft (0.09 m) and exceeds the barrier by 0.2 ft (0.06 m). These values are summarized in Table 3.5-2.

The NRC staff verified the reevaluated licensee Delft3D PMSS stillwater level. Based on NUREG/CR-7046 and RG 1.59 (1977 Revision), the licensee used site-specific antecedent water levels and wave effects (e.g., wave runup) to calculate the reevaluated PMSS of 19.1 ft (5.8 m). The current standard practice is to run storm surge simulations with the antecedent water conditions to take into account non-linear effects. This was performed in the licensee reevaluated Delft3D storm simulations.

The NRC staff assessed the licensee's results by using a hurricane modeling system that combines various wind models, the WAM offshore and STWAVE nearshore wave models, and the ADCIRC circulation model (Luettich et al., 1992, Westerink et al., 1994, Luettich and Westerink 2004). In parallel with the initial ADCIRC runs, the large-domain, discrete, time-dependent spectral wave model WAM (Komen et al., 1994) is run to calculate directional wave spectra that serves as boundary conditions for the local-domain, near-coast wave model STWAVE (Smith et al., 2001 and Smith, 2007.

The NRC staff's sea level rise (1 ft [0.30 m]), initial rise (0.9 ft [0.27 m]) and the 10 percent exceedance high tide (1.7 ft [0.52 m]) are combined to the ADCIRC antecedent stillwater level calculations which include wind wave and wave setup (STWAVE/WAM). No adjustment was made equal to the difference between the 10-percent exceedance high tide and mean tide level, thus adding additional conservatism.

The NRC staff's ADCIRC simulations are adjusted for Turkey Point site-specific storm surge characteristics in accordance with NRC guidance (RG 1.59 and NUREG-0800). The NRC staff's independent calculations are consistent with the licensee's FHRR results. Table 3.5-1 summarizes the licensee and NRC staff's meteorological parameters and storm surge results.

As part of its analysis, the licensee also provided information regarding associated effects such as: (1) increased hydrostatic and hydrodynamic loading, (2) waterborne projectiles and debris loading, and (3) other non-flood related mechanisms, such as currents and marine fouling. The NRC staff is not providing an assessment of these analyses in this staff assessment.

The NRC staff confirmed the licensee's conclusion that the reevaluated hazard for flooding from storm surge is not bounded by the current design-basis flood hazard. Therefore, the licensee is expected to submit a focused evaluation confirming the capability of flood protection and available physical margin or a revised integrated assessment consistent with the process and guidance discussed in COMSECY-15¬0019 (NRC, 2015c).

3.6 Seiche

The licensee reported in its FHRR, that the reevaluated hazard, including associated effects, for site flooding due to seiche does not inundate the plant site. This flood-causing mechanism is not described in the licensee's current design-basis.

The NRC staff reviewed the flooding hazard from seiche, including associated effects, against the relevant regulatory criteria based on present-day methodologies and regulatory guidance below.

Turkey Point is located adjacent to the west shore of Biscayne Bay and the licensee reported that there are no records of seismic seiches within the bay. However, because the bay is a semi-enclosed body of water, seiche oscillation may occur due to atmospheric forcing. The licensee stated that it is likely that such oscillations would occur along the principal axis of the bay in the north-south direction with a natural period of oscillation estimated to be approximately 36.8 minutes.

The licensee stated that because storm surges during a PMH event would overtop offshore keys and other barrier islands, seiche oscillations within the bay would not be expected to coincide with large storm surge events like the PMSS. In addition, the licensee noted that the natural period of oscillation is much greater than the period of wind-waves and shorter than the period of storm surge waves. The licensee also considered other contributions to seiche, such as sea breeze or seismic or atmospheric forcing, but concluded that these phenomena would not produce resonance responses in Biscayne Bay. Therefore, the licensee concluded that natural oscillations within the bay do not result in a resonance, and flooding of the plant area due to a seiche event in Biscayne Bay is precluded.

The NRC staff agrees with the licensee and notes that due to the low elevation of offshore keys and barrier islands the features would no longer function as a physical boundary that could contribute to a within-bay seiche, making it unlikely that such a seiche could add to the elevation of the PMSS from the PMH.

The NRC staff confirmed the licensee's conclusion that the reevaluated hazard for flooding from seiche alone does not inundate the plant site. However, because flooding from seiche is not included within the design-basis, the licensee is expected to submit a or focused evaluation confirming the capability of flood protection and available physical margin or a revised integrated assessment consistent with the process and guidance discussed in COMSECY-15¬0019 (NRC, 2015c).

3.7 Tsunami

The licensee reported in its FHRR, that the reevaluated hazard, including associated effects for site flooding due to tsunami, is 14.8 ft (4.5 m) with coincident wind-wave runup. This flood- causing mechanism is not described in the licensee's current design-basis.

The NRC staff reviewed the flooding hazard from tsunami, including associated effects, against the relevant regulatory criteria based on present-day methodologies and regulatory guidance below.

The licensee obtained records of historical tsunami runup events along the U.S. Atlantic coast from the National Geophysical Data Center (NGDC) tsunami database (NGDC, 2008) and the catalog by Lockridge et al., (2002) for the Delaware-New York coast. For paleo-tsunami events, the licensee indicated that an extensive literature search and review of borehole logs from the site revealed no evidence for paleo-tsunami deposits. The licensee used the Atlantic and Gulf of Mexico Tsunami Hazards Assessment Group (AGMTHAG) to evaluate potential tsunamigenic source mechanisms (AGMTHAG, 2008). The licensee stated that the major tsunamigenic sources that may affect the southeastern U.S. coasts include submarine landslides and earthquakes. The licensee identified transoceanic tsunamis because of earthquakes in the Azores-Gibraltar (east Atlantic) plate boundary and tsunamis generated in the northeastern Caribbean region as the primary candidates of the probable maximum tsunami (PMT) generation that could affect Turkey Point.

The licensee simulated tsunami propagation and the effects of near shore bathymetric variation at the Florida Atlantic coast in a two-dimensional computer model. For most cases, the licensee used the Delft3D-FLOW computer program (Deltares, 2009), including the critical case tsunami from the Azores-Gibraltar Boundary source, but used the Boussinesq wave model FUNWAVE- TVD for the Florida Escarpment and Cape Fear tsunami sources.

The licensee obtained a maximum tsunami water level at Turkey Point of 12.1 ft (3.7 m) for the postulated PMT generated by earthquake in the Azores-Gibraltar fracture zone. The reported coincident wind wave runup is 2.7 ft (0.82 m). This wind wave runup is added by the licensee to the tsunami maximum water level of 12.1 ft (3.7 m) with adjusted antecedent water level resulting in a maximum water level of 14.8 ft (4.5 m). This result indicates that the site is not inundated by tsunami hazards.

Detailed numerical modeling of likely PMT sources has been performed by the NRC staff to determine their impact on the Turkey Point site. The NRC staff used the Boussinesq-based numerical model COULWAVE (Lynett and Liu, 2002) for three different types of tsunami sources. The sources include a near field landslide source immediately offshore of Biscayne Bay (the Florida Straits source), a number of far field landslide sources with extremely large local waves (the Canary Islands source, the Mid-Atlantic source, and the Puerto Rico Trench source), and a far field earthquake source (the Puerto Rico Subduction Zone source). For all conditions, the most conservative source parameters were employed, even when arguably unphysical, to provide an absolute upper limit on the possible tsunami effects at the Turkey Point site. The NRC staff's independent calculation is consistent with the licensee's FHRR. The NRC staff confirmed the licensee's conclusion that the reevaluated tsunami hazard does not inundate the plant site. However, because the hazard from tsunami is not included within the design-basis, the licensee is expected to submit a focused evaluation confirming the capability of flood protection and available physical margin or a revised integrated assessment consistent with the process and guidance discussed in COMSECY-15¬0019 (NRC, 2015c).

3.8 Ice-Induced Flooding

There are no changes or updates to this section of the NRC staff assessment.

3.9 Channel Migrations or Diversions

There are no changes or updates to this section of the NRC staff assessment.

4.0 REEVALUATED FLOOD HEIGHT, EVENT DURATION AND ASSOCIATED EFFECTS FOR HAZARDS NOT BOUNDED BY THE CURRENT DESIGN-BASIS

The NRC staff confirmed that the reevaluated hazard results for LIP, seiche, tsunami, and storm surge were not bounded by the current design-basis flood hazard. Therefore, the NRC staff anticipates that the licensee will perform additional assessments (i.e., integrated assessment or focused evaluation) of plant response for Turkey Point, as described in NRC letter dated September 1, 2015 (NRC, 2015c). The NRC staff reviewed the following flood hazard parameters needed to perform the additional assessments or evaluations of plant response:

- Flood event duration (see Figure 2.2.4-1 and Table 4.0-1), including warning time and intermediate water surface elevations that trigger actions by plant personnel, as defined in JLD-ISG-2012-05.

- Flood height and associated effects, as defined in JLD-ISG-2012-05 (see Tables 4.0-2, 4.0-3, 4.0-4).

The NRC staff requested that the licensee provide a basis for the flood event duration parameters via an RAI (NRC, 2014b). In its response (Kiley, 2014b), the licensee summarized the flood duration parameters for PMSS, LIP and PMT, as shown in Table 4.0-1. The NRC staff notes that the bases and justification for flood duration parameters (e.g., warning time based on existing forecasting resources or agreements) may be further evaluated as part of the integrated assessment or focused evaluation.

The NRC staff requested that the licensee provide the flood height and associated effects (as defined in Section 9 of JLD-ISG-2012-05) that are not described in the FHRR via an RAI (NRC, 2014b). The licensee's response (Kiley, 2014b) summarizes the relevant values for each associated effect, which are shown in Tables 4.0-2 and 4.0-3. Table 4.0-4 provides soil/sediment horizontal and vertical pressure associated with the PMSS.

Based upon the preceding analysis, the NRC staff confirmed that the reevaluated flood hazard information defined in the sections above is appropriate input to other assessments or evaluations associated with Near-Term Task Force Recommendations, including the assessment of mitigation strategies developed in response to Order EA-12-049 (i.e., defines the mitigating strategies flood hazard information described in guidance documents currently being finalized by the industry and NRC staff).

5.0 CONCLUSION

The NRC staff has reviewed the information provided for the reevaluated flood-causing mechanisms of Turkey Point. Based on its review, the NRC staff concludes that the licensee conducted the hazard reevaluation using present-day methodologies and regulatory guidance used by the NRC staff in connection with ESP and COL reviews.

Based upon the preceding analysis, the NRC staff confirmed that the licensee responded appropriately to Enclosure 2, Required Response 2, of the 50.54(f) letter. In reaching this determination, the NRC staff confirmed the licensee's conclusions that (a) the reevaluated flood hazard results for local intense precipitation, storm surge, seiche, and tsunami are not bounded by the current design basis flood hazard; (b) additional assessments of plant response will be performed for the local intense precipitation, storm surge, seiche, and tsunami flood-causing mechanisms, and (c) the reevaluated flood-causing mechanism information is appropriate input to additional assessments or evaluations of plant response, as described in the 50.54(f) letter and COMSECY-15-0019 (NRC, 2015a), including the assessment of mitigation strategies developed in response to Order EA- 12-049 (i.e., defines the mitigating strategies flood hazard information described in guidance documents currently being finalized by the industry and NRC staff).

The NRC staff has no additional information needs at this time with respect to the Turkey Point FHRR.

6.0 REFERENCES

U.S. Nuclear Regulatory Commission (NRC) Documents and Publications:

NRC (U.S. Nuclear Regulatory Commission), 2014c, letter from Robert F. Kuntz, NRC,, to Mano Nazar, President and Chief Nuclear Officer, NextEra Energy, "Turkey Point Nuclear Generating Station, Unit Nos. 3 and 4 – Staff Assessment of Response to 10 CFR 50.54(f) Information Request- Flood-Causing Mechanism Reevaluation (TAC NOS. MF1114 AND MF1115)", December 4, 2014, ADAMS Accession No. ML14324A816.

NRC (U.S. Nuclear Regulatory Commission), 2015a, SRM – COMSECY-15-0019 – Closure Plan for the Reevaluation of Flooding Hazards for Operating Nuclear Power Plants," , July 28, 2015, ADAMS Accession No. ML15209A682.

NRC (U.S. Nuclear Regulatory Commission), 2015b, "Closure Plan for the Reevaluation of Flooding Hazards for Operating Nuclear Power Plants," COMSECY-15-0019, June 30, 2015, ADAMS Accession No. ML15153A104.

NRC (U.S. Nuclear Regulatory Commission), 2015c, letter from William M. Dean, Director, to Power Reactor Licensees, "Coordination of Requests for Information for Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events," September 1, 2015, ADAMS Accession No. ML15174A257.

Codes and Standards

There are no additions to the references in this section.

Other References:

There are no additions to the references in this section.

Table 3.1.2-1 Current Design-Basis Flood Hazard

Flooding Mechanism	Stillwater Elevation ft (m) NAVD88	Associated Effects ft (m)	Current Design-Basis (CDB) Flood Elevation ft (m) NAVD88	Reference
Local Intense Precipitation and Associated Drainage	Not Discussed in CDB	Not Discussed in CDB	None Specified	FHRR section 3.1
Streams and Rivers	Not Analyzed (not applicable)	Not Discussed in CDB	None Specified	FHRR section 3.2
Failure of Dams and Onsite Water Control/Storage Structures	Not Analyzed (not applicable)	Not Discussed in CDB	None Specified	FHRR section 3.3
Storm Surge	16.0 (4.8)	Note (1)	Note (1)	FHRR sections 3.4 and 3.9
Seiche	Not Discussed in CDB	Not Discussed in CDB	Not Discussed in CDB	FHRR section 3.5
Tsunami	Not Discussed in CDB	Not Discussed in CDB	Not Discussed in CDB	FHRR section 3.6
Ice-Induced	Not applicable due to climate	Not applicable	Not applicable	FHRR section 3.7
Channel Migrations or Diversions	Not Discussed in CDB	Not Discussed in CDB	Not Discussed in CDB	FHRR section 3.8

1. The licensee's walkdown report (Kiley, 2012a) identifies 18.3 ft (5.6 m) MLW (16 ft (4.8 m) NAVD88) as the design-basis. The description of licensing basis protection describes model and analysis on which the flood protection is based. In conjunction with the discussion of licensing basis flood protection, the licensee stated: "Elevation 20 ft [6.1 m; MLW] and 22 ft [6.7 m; MLW] is required to provide protection for maximum wave run-up. The licensing and design-basis documents do not indicate an exact elevation to which waves are expected to reach. These documents imply that the maximum wave run-up is less than the elevation of protection provided." However, it is noted that the FHRR (Kiley, 2013) states: "The CLB determined that PMH-induced waves could induce 2.7 foot runup on vertical structures when the PMSS water level is at Elevation 16.0 ft [4.8 m]-NAVD88."

Table 4.0-1: Flood Event Duration for Flood-Causing Mechanisms Not Bounded by the Current Design-Basis

Flood-Causing Mechanism	Time Available for Preparation for Flood Event	Duration of Inundation of Site	Time for Water to Recede from Site
Elevated Winds	72 hours	73 hours	
PMSS	48 hours	2 hours(1)	3 hours (2)
LIP (Scenario A)	These values will be determined as part of the focused evaluation		
LIP (Scenario B)(3)	48 hours	0.5 hour	0.75 hour
PMT	2 hours	Not Applicable	Not Applicable

1. Stillwater value shown. Add 1 additional hour to include wave runup.
2. Stillwater values shown. Add 2 additional hours to include wave runup.
3. LIP coincident with PMSS

Table 4.0-2 Reevaluated Flood Hazard for Flood-Causing Mechanisms Not Bounded by the Current Design-Basis

Flood-Causing Mechanism	Stillwater Elevation ft (m) NAVD88	Associated Effects ft (m) (wave runup)	Reevaluated Flood Hazard ft (m) NAVD88	Reference
Local Intense Precipitation	Scenario A 17.2 (5.2) Scenario B 20.8 (6.3)	Not Applicable	17.2 (5.2) 20.8 (6.3)	Kiley, 2014c
Storm Surge	17.3 (5.3), including tides	1.8 (0.55)	19.1 (5.8)	FHRR Section 3.5
Seiche	Not Applicable	Not Applicable	Not Applicable	FHRR Section 3.6
Tsunami	12.1 (3.68) including tides	2.7 (0.82)	14.8 (4.51)	FHRR Section 3.7

Table 4.0-3 Associated Effects Inputs

Associated Effects Factor	Flooding Mechanism				
	PMP/LIP		PMSS	PMT	Seiche
	Scenario A	Scenario B			
Hydrodynamic loading at plant grade	Licensee to consider potential effects of LIP water velocity as part of the focused evaluation	Licensee to consider potential effects of LIP water velocity as part of the focused evaluation	Varies with elevation (Figure 3.5-1)	None	None
Debris loading at plant grade	None	None	Up to 20,000 lbs (9,100 kg) (110 lbs/in^2) (758 kPa)	Up to 65,300 lbs (370 lb/in^2)(1)	None
Sediment loading at plant grade	None	None	Horizontal: up to 64 psf (3.1 kPa) Vertical: up to 110 psf (5.3 kPa)	None	None
Sediment deposition and erosion	None	None	Scour up to 2 ft (0.61 m); Deposition bounded by PMSS elevation	Deposition bounded by PMT runup elevation	None
Concurrent conditions, including adverse weather	None(2)	High winds (Kiley, 2014b RAI 10 response)	High winds (Kiley, 2014b, RAI 10 response)	None	None
Groundwater ingress	None	None	None	None	None
Other pertinent factors (e.g., waterborne projectiles)	None	None	Up to 556,000 lbs (252,000 kg-force) (FHRR, Sect. 4.11)	None	None

1. PMT debris loading acts at maximum water level elevation, 12.1 ft NAVD88, not plant grade.
2. Applies to the time before the event and not during the event.

Table 5.0-1: integrated assessment Open Items

Deleted

to the flood hazard reevaluations that were approved by the Commission in its Staff Requirements Memorandum (ADAMS Accession No. ML15209A682) to COMSECY-15-0019 (ADAMS Accession No. ML15153A104) that described the NRC's mitigating strategies and flooding hazard reevaluation action plan.

As documented in the NRC staff assessment and the enclosed supplement, the staff has concluded that the licensee's reevaluated flood hazard information is suitable for the assessment of mitigation strategies developed in response to Order EA-12-049 (i.e., defines the mitigating strategies flood hazard information described in guidance documents currently being finalized by the industry and NRC staff) for Turkey Point. Further, the licensee's reevaluated flood hazard information is suitable for other assessments associated with Near-Term Task Force Recommendation 2.1 "Flooding".

The reevaluated flood hazard results for local intense precipitation, seiche, tsunami, and storm surge were not bounded by the current design-basis flood hazard. In order to complete its response to Enclosure 2 to the 50.54(f) letter, the licensee is expected to submit a revised integrated assessment or a focused evaluation(s), as appropriate, to address these reevaluated flood hazards, as described in the NRC's September 1, 2015, letter.

If you have any questions, please contact me at (301) 415-6185 or by email at Anthony.Minarik@nrc.gov.

Sincerely,

/RA Tekia Govan Acting for/

Anthony Minarik, Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket Nos. 50-250 and 50-251

Enclosure:
Supplement to Staff Assessment of Flood Hazard Reevaluation Report

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Letter to Mano Nazar from Anthony Minarik dated November 4, 2015

SUBJECT: TURKEY POINT NUCLEAR GENERATING, UNIT NOS. 3 AND 4 - SUPPLEMENT TO STAFF ASSESSMENT OF RESPONSE TO 10 CFR 50.54(f) INFORMATION REQUEST - FLOOD-CAUSING MECHANISM REEVALUATION (CAC NOS. MF1114 AND MF1115)

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