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

August 29, 2014

Vice President, Operations
Entergy Nuclear Operations, Inc.
Indian Point Energy Center
450 Broadway, GSB
P.O. Box 249
Buchanan, NY 10511-0249

SUBJECT: INDIAN POINT NUCLEAR GENERATING, UNIT NOS. 2 AND 3 – REGULATORY AUDIT REPORT FOR MAY 27-30, 2014, AUDIT AT THE INDIAN POINT FACILITY TO SUPPORT REVIEW OF NEAR TERM TASK FORCE RECOMMENDATION 2.1: FLOODING HAZARD REEVALUATION REPORT (TAC NOS. MF3313 AND MF3314)

Dear Sir or Madam:

By letter dated December 23, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13364A006), Entergy Nuclear Operations, Inc. (Entergy or the licensee), submitted its required response for Indian Point Nuclear Generating, Unit Nos. 2 and 3 to Near Term Task Force Recommendation 2.1: Flooding Hazard Reevaluation Report (FHRR), in response to the U.S.Nuclear Regulatory Commission's (NRC) letter, Request for Information Pursuant to Title 10 of the *Code of Federal Regulations* Part 50, Section 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident, dated March 12, 2012 (ADAMS Accession No. ML12053A340).

The purpose of the May 27-30, 2014, audit at the IPEC facility in Buchanan, New York, was for the NRC staff to review the data, models, and methods applied in the licensee's flood hazard reevaluation, supporting documentation, and calculation packages; and to discuss these issues with the Entergy's subject matter experts, staff, and contractors.

The Indian Point Energy Center (IPEC) FHRR relied on complex methodologies to estimate flooding hazards at the site. Several of the flooding scenarios evaluated are not in the current licensing basis (CLB), nor were they evaluated for the purposes of the Individual Plant Examination of External Events (IPEEE) analysis. Almost all of the analyses rely on numerically-based computer codes that were not available at the time that the analyses supporting the CLB or the IPEEE were performed. In many cases, engineering judgment was an important part of the IPEC FHRR. Consequently, decisions concerning modeling abstractions, the specification of boundary conditions, the definition of input parameters, or other assumptions can impact the calculated flood water height estimated by these analyses.

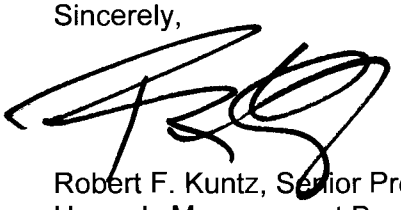
Following a preliminary review of the IPEC FHRR submitted on December 23, 2013 (ADAMS Accession No. ML13364A005), the NRC staff identified several questions concerning various aspects of the flood hazard calculations for the site. For example, the staff observed that specific details concerning many of the analyses and their attendant assumptions were not

sufficiently described in the main body of the IPEC FHRR document or in supporting references. Because this information is necessary for the NRC staff to perform its review of the IPEC FHRR analyses, the staff decided to conduct an audit of the report and the associated calculations. An audit was then conducted at the IPEC site on May 27-30, 2014.

The plan for this audit, dated May 5, 2014, can be found in ADAMS at Accession No. ML14121A431. A copy of the audit report, reflecting the NRC staff's findings during the site audit, is enclosed herewith. Enclosure 1 is the audit report which identifies the NRC staff and contractors and subcontractors that participated in the audit, as well as their respective function and the specific objectives of the audit. Enclosure 2 contains the Entergy contractor and subcontractor responses to NRC staff requests, and the staff's observations from the audit.

If you have any questions, please contact me at 301-415-3733 or via email at Robert.Kuntz@nrc.gov.

Sincerely,



Robert F. Kuntz, Senior Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

Enclosures:
1. FHRR Audit Report
2. Audit Report – Information needs

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AUDIT REPORT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO NEAR-TERM TASK FORCE RECOMMENDATION 2.1

FLOODING HAZARD REEVALUATION REPORT

ENTERGY NUCLEAR OPERATIONS, INC.,

INDIAN POINT NUCLEAR GENERATING, UNIT NOS. 2 AND 3

DOCKET NOS. 50-247 AND 50-286

BACKGROUND AND AUDIT BASIS

By letter dated December 23, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13364A006), Entergy Nuclear Operations, Inc. (Entergy or the licensee), submitted its required response for Indian Point Nuclear Generating, Unit Nos. 2 and 3 (Indian Point) to Near Term Task Force Recommendation 2.1: Flooding Hazard Reevaluation Report (FHRR), in response to the U.S.Nuclear Regulatory Commission's (NRC's) letter, Request for Information Pursuant to Title 10 of the *Code of Federal Regulations* Part 50, Section 50.54(f) (hereafter referred to as the 50.54(f) letter) Regarding Recommendations 2.1, 2.3, and 9.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident, dated March 12, 2012 (ADAMS at Accession No. ML12053A340). The licensee's submittal relied on several methodologies, for which NRC staff guidance was not used or goes beyond the existing staff guidance. In using these methodologies, the data, models, and analytical methods can be extremely important and can have large effects on the resulting calculated flooding heights at the site. Some details of how Entergy applied these methodologies, which the NRC staff must understand to complete its review, are not present in the Indian Point Energy Center (IPEC) FHRR.

In its initial review of the IPEC FHRR, the NRC staff has identified questions in four areas regarding the information submitted by the licensee: (1) storm surge analysis, (2) local intense precipitation (LIP), (3) riverine flooding (including dam failures) and (4) documentation contained in calculation packages and references in the electronic reading room (ERR).

With respect to evaluation of probable maximum precipitation (PMP), which serves as input to local intense precipitation and riverine flooding evaluations, Entergy performed a "site-specific" evaluation rather than using previously accepted methodologies and guidance contained in the Standard Review Plan (SRP). This could result in substantially lower precipitation values that might be calculated using previously accepted methodlogies. The NRC staff required further information to develop a better understanding of how the licensee calculated and applied the PMP, and how the licensee's analysis compares to the standard methodology.

In the area of storm surge analysis, Entergy performed a probabilistic storm surge analysis (PSSA), which is a different method than the methods previously reviewed by the NRC staff. The NRC staff determined that it needed more information about the methodology used to implement the PSSA; the licensee's use and interpretation of available data, models, and methods (including use of engineering judgment); computer codes; the identification, treatment, and propagation of uncertainties; and the basis for certain relevant modeling decisions. Accordingly, the NRC staff conducted an audit of the IPEC FHRR at the IPEC site.

The purpose of the audit was for the NRC staff to review the data, models, and methods applied in the licensee's flood hazard reevaluation, supporting documentation, and calculation packages; and discuss these issues with Entergy's subject matter experts, staff, and contractors. The audit allowed the staff to better understand the modeling results, and will aid the staff as it continues its review of the licensee's 50.54(f) submittal in order to make conclusions as to: (1) whether the licensee had responded appropriately to the 50.54(f) letter, (2) whether the responses are sufficient to determine whether or not the reevaluated flood causing mechanisms are, or are not, bounded by the current design-basis flood hazard, and (3) whether the staff needs additional information from the licensee to complete its review. The audit also assisted the NRC staff in identifying any additional information that it may need, as it continues its review of the IPEC FHRR.

At the beginning of the audit, the licensee and its contractors presented information on Entergy's approach to performing both the PSSA and the PMF analyses. The PSSA presentation described how the PSSA relied on the Joint Probability Method (JPM) to estimate storm surge at the IPEC site, including discussions about how: (1) the JPM process steps were implemented; (2) the JPM results were benchmarked (validated) against deterministic-based estimates of storm surge at the site; and (3) engineering judgment, and error and uncertainty analyses were incorporated in the analyses.

The presentation on the PMF calculation for the IPEC site reviewed the following topics: probable maximum precipitation, local intense precipitation, snow-melt, dam failures, and probable maximum flood estimation. For each topic, the methodology used to evaluate the hazard was discussed, as well as the use of engineering judgment and the treatment of conservatism in its analysis. There was also a discussion concerning the use of the FLO-2D computer software to perform flood routing calculations at the site.

Both presentations were extensive and provided valuable insights into the analyses upon which the FHRR was based. The presentation materials provided additional detail and context concerning how the respective flood hazard analyses were performed. As a consequence, the NRC staff's information needs identified in the audit plan were sufficiently resolved for staff to generally understand the licensee's FHRR methodology/analysis. However, as the staff's detailed review progresses, the staff may issue Requests for Additional Information, at a later date.

During the audit, the NRC staff and its contractors were provided a walking tour of the IPEC site. This walkdown provided important physical context for the briefings and analyses that were performed. The walkdown covered several areas of the facility cite, including: (1) the main runoff route for local intense precipitation (e.g., the steep road leading down to the waterfront); (2) the transformer yard, alleyways, downspouts, and manholes, and their treatment

in FLO-2D; (3) the switchgear rooms, diesel generators and auxiliary feedwater and makeup water pumps; (4) the site grade and discharge canal; and (5) the staging area for sandbags and portable tiger dams.

At the end of the audit, Entergy agreed to place several additional documents in the ERR, including: (1) certain specific maps and high resolution figures of the IPEC site; (2) corrected references in the FHRR and other documents; (3) spreadsheets and summary tables that the staff had requested and used during its audit; and (4) additional references needed by the staff. As a result of the audit, the licensee also revised its FLO-2D analysis and submitted it on August 18, 2014. The staff is continuing its review of the licensee's FHRR and supporting analyses.

Regulatory Audit Scope or Methodology

The area of focus for the audit was the Indian Point Recommendation 2.1 Flood Hazard Reevaluation Report and supporting documentation.

Audit Team Activities

The onsite audit was conducted at the Indian Point facility from May 27, 2014, through May 30, 2014. The NRC audit team staff was as follows:

Support:
Kenneth Erwin, NRC Audit Team Lead
Douglas Pickett, NRC Senior Project Manager
Wayne Schmidt, Senior Reactor Analyst, Region I

Storm Surge Methodology:
Henry Jones, NRC Audit Team Member, Storm Surge Lead
Michelle Bensi, NRC Audit Team Member
Chris Bender, Taylor Engineering, Inc., NRC Audit Team Member
Don Resio, Taylor Engineering, Inc., NRC Audit Team Member

Local Intense Precipitation / Riverine Flooding / Dam Failure Methodology:
Barbara Hayes, NRC Audit Team Member, PMP Lead
Kevin Quinlan, NRC Audit Team Member
Rajiv Prasad, PNNL, NRC Audit Team Member
Steve Breithaupt, PNNL, NRC Audit Team Member

INDIAN POINT ENERGY CENTER FLOOD HAZARD REEVALUATION REPORT MAY 2014 HYDROLOGY AUDIT REPORT – INFORMATION NEEDS

Serial No.	FHRR Section	Information Need(s) [1]	Action (Post Audit)
1	FHRR (in general)	There appear to be instances of incorrect references in the body of the flood hazard reevaluation report (FHRR) or missing/incorrect references in the reference list. Have available a copy of the FHRR with any incorrect references clearly identified and corrected. *NRC staff notes: The licensee provided a revision of the FHRR during the audit. As a result, the staff learned that revisions were made by the licensee (and its contractors) since docketing of the initial FHRR, that include, corrections to references as well as more substantive amendments (e.g., Figure 51 in the docketed FHRR was identified during the audit as being incorrect).*	Following the audit, the licensee submitted a revised FHRR for the Indian Point site that includes both corrections and revisions identified by the staff during the audit.
2	FHRR (in general)	Have available electronic copies of the calculation packages below; as well as the means to access them (preferably on licensee computers rather than through the use of the electronic reading room (ERR): • AREVA Document No. 32-9207390-000, "Probable Maximum Hurricane for Indian Point Energy Center [IPEC]," 2013. • AREVA Document No. 38-9216321-000, "Acquisition of Coastal Flood Analysis Data from Federal Emergency Management Agency Region II Indian Point Energy Center Flooding Hazard Re-evaluation," August, 2013. • AREVA Document No. 32-9196317-000, "Indian Point Energy Center Flood Hazard Re-evaluation – Probable Maximum Seiche" • AREVA Document No. 32-9193356-000, "Flood Hazard Re-evaluation – Combined Effect Floods – Coastal Processes for Indian Point Energy Center" • AREVA Document No. 32-9196319-000, "IPEC Deterministic Probable	The calculation packages cited were made available in the licensee's ERR. The NRC staff plans to issue a request for additional information (RAI), as needed, to request that the licensee docket information contained in the calculation packages if it serves as a basis for conclusions documented in the staff assessment.

[1] In this column of the NRC Staff's audit report, the staff's pre-audit information needs are reproduced (in normal font), followed by the staff's post-audit comments (in italics). Items identified for future action are shown in the final column ("Action (Post-Audit)").

Serial No.	FHRR Section	Information Need(s) [1]	Action (Post Audit)
		Maximum Storm Surge Calculation" • AREVA Document No. 32-9213352-000, "Flood Hazard Re-evaluation – Probabilistic Storm Surge for Indian Point Energy Center" *NRC staff notes: The licensee's subject matter experts (SMEs) provided an overview of their approach to the probabilistic calculation of storm surge. During the break-out session that followed, the calculation packages identified above were made available by the licensee in CD format and were added to the ERR . NRC staff and the licensee's SMEs referred to the calculation packages, as necessary, to support discussions throughout the audit to better understand the approach/methodology used to calculate storm surge.*	
3	3.1: Local Intense Precipitation	Have available a clear description of the current licensing basis (CLB) related to local intense precipitation (LIP). Also, have available a brief and clear description of the individual plant examination of external events (IPEEE) analysis related to the LIP. *NRC staff notes: The licensee's SMEs provided an overview of their approach to the calculation of LIP flooding. This issue was assessed and documented in IPEC's earlier IPEEE submittal. The Entergy team informed the NRC staff that LIP is not part of the plant's design/licensing basis.*	The staff reviewed the material requested in the Audit Plan. The information needs were sufficiently resolved for the staff to understand the licensee's methodology and analysis. The staff may issue RAIs to address concerns.
4	3.1: Local Intense Precipitation 3.2: Flooding in Rivers and Streams	Have available the knowledgeable SMEs who performed the site-specific probable maximum precipitation (PMP) analysis described in AREVA Document No. 32-9196314-000. Also, have available an example storm analysis (including computation software and runs/simulations, if necessary) to walk the NRC staff through the analysis. Be prepared to define terms used in the site-specific PMP analysis – e.g., "extreme rainfall event," "transpositionability," "maximum average dew point," and others. *NRC staff notes: The licensee's SMEs provided an overview of their approach to*	The staff reviewed the material requested in the Audit Plan. The information needs were sufficiently resolved for the staff to understand the licensee's methodology and analysis. The staff may issue RAIs to address concerns.

Serial No.	FHRR Section	Information Need(s) [1]	Action (Post Audit)
		the estimation of a site-specific PMP for the site. During the break-out session, the licensee discussed how the site-specific PMP was estimated, as well as the meaning of certain specific technical terms. The AREVA document cited in the audit plan was also made available by the licensee during the audit to facilitate those discussions.	
5	3.1: Local Intense Precipitation 3.2: Flooding in Rivers and Streams	Have available storm data that were used in the site-specific PMP analysis. Have available a knowledgeable SME to explain how the storm data was analyzed, including details of any statistical analyses. Be prepared to explain how the storm data and/or results from storm data analyses were used in the site-specific PMP estimation and how this varies from the storm data used in the National Oceanic and Atmospheric Administration (NOAA)/National Weather Service (NWS) Hydrometeorological Report (HMR) HMR51. *NRC staff notes: The licensee's SMEs provided an overview of their approach to the estimation of site-specific PMP values for the site. During the break-out session that followed, the licensee had SMEs available to describe the estimation of site-specific PMP and how that estimation deviated from the HMR51 methodology.*	The staff reviewed the material requested in the Audit Plan. The information needs were sufficiently resolved for the staff to understand how the licensee's FHRR methodology and analysis deviated from HMR51. The staff may issue RAIs to address concerns.
6	3.1: Local Intense Precipitation 3.2: Flooding in Rivers and Streams	Have available a list of assumptions that were made in the site-specific PMP analysis. Have available a knowledgeable SME to discuss the justifications and/or data supporting these assumptions. *NRC staff notes: The licensee's SMEs provided an overview of their approach to the estimation of a site-specific PMP for the site. During the break-out session, the licensee identified the assumptions associated with the estimation of a site-specific PMP as well as the reasoning behind those assumptions. The licensee's SMEs also discussed temporal rainfall issues among other things.*	The staff reviewed the material requested in the Audit Plan and spoke to the licensee's SMEs. The information needs were sufficiently resolved for staff to understand the licensee's PMP assumptions and justifications. Staff may issue RAIs to address concerns.
7	3.1: Local Intense	Have available any references which describe the methodology used in the site-	The staff reviewed the material requested in the

Serial No.	FHRR Section	Information Need(s) [1]	Action (Post Audit)
	Precipitation 3.2: Flooding in Rivers and Streams	specific PMP estimation. Have available a knowledgeable SME to discuss the differences between values resultant from the site-specific PMP estimation used in the FHRR, and values which would have been derived from the NOAA/NWS HMR methodology. Be prepared to discuss the level of conservativeness associated with these values and how these results could affect the flood hazard analysis at or near the IPEC site. *NRC staff notes: The licensee's SMEs provided an overview of their approach to the estimation of a site-specific PMP for the site. During the break-out session, the licensee discussed the differences between the site-specific PMP methodology and the NOAA/NWS HMR methodology. With respect to the HMR methodology itself, the licensee's SMEs expressed the opinion that the Generic HMR 51/52 methodology was not appropriate for the IPEC and that a case-specific PMP study was performed.*	Audit Plan and spoke to the licensee's SMEs. The information needs were sufficiently resolved for staff to develop an improved understanding of the licensee's approach. Further staff review may be necessary to better-understand the level of conservatism in the licensee's site-specific analysis. The staff may issue RAIs to address any further concerns.
8	3.1 Local Intense Precipitation	Have available a knowledgeable SME to discuss how the hierarchical hazard assessment (HHA) approach described in NUREG/CR-7046 was applied to determine the LIP flood at and near the IPEC site. *NRC staff notes: The licensee's SMEs provided an overview of how the HHA approach was used to estimate a LIP-based flood at the site. No analysis was done of results that would be associated with the PMP values that would be derived from HMR 51. During the break-out session, the LIP calculation using case 3 described in Appendix B of NUREG/CR-7046 "Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United States of America" was discussed. An issue was identified by the licensee's SMEs with FLO-2D modeling treatment of "rain on building." The licensee's SMEs noted that a corrective action is on-going to determine the impact.*	The staff reviewed the material requested in the Audit Plan. The staff's information needs were sufficiently resolved for the staff to better understand the licensee's approach. The staff may issue RAIs to address concerns.
9	3.1: Local Intense Precipitation	Have available a map of IPEC site and vicinity clearly showing topographic and hydraulic features and structures that influence local site drainage.	The audit included meaningful discussion of key drainage issues. Though staff did receive a

Serial No.	FHRR Section	Information Need(s) [1]	Action (Post Audit)
		NRC staff notes: Discussions of key topographic and hydraulic features that influence local site drainage were discussed at the audit. In addition, a walking tour of the site was conducted, in which key topographic features were identified. The staff subsequently requested that the necessary higher-resolution maps (specifically computer graphics files) be added to the ERR and the licensee added this map to the ERR.	watershed map related to riverine and dam failure flooding, staff is awaiting detailed map relevant to local drainage and will review in conjunction with revised LIP analysis.
10	3.1: Local Intense Precipitation	Have available the FLO-2D documentation (input and output files; calculation packages) and a knowledgeable SME to discuss: • Precipitation transformation • Building runoff • Channel routing • Obstructions in the floodplain • Hydraulic control structures *NRC staff notes: The licensee's SMEs provided an overview of their approach to the calculation of a site-specific PMP using the FLO-2D computer code. During the break-out session, the licensee's SMEs noted that precipitation transformed directly into runoff in FLO-2D and that no infiltration or abstractions were used. As a result of those discussions, the staff requested that certain specific references be added to the ERR including information identifying the location of specific IPEC facility features including AutoCAD/GIS data files for transformer yard doors as well as doors of other site critical features.*	The staff reviewed the material requested in the Audit Plan and spoke to the licensee's SMEs. Based on those discussions, the licensee determined it would resubmit a revised FLO-2D analysis as part of the FHRR. This was submitted on August 18, 2014. The staff conducted a clarification phone call with the licensee on 06/20/2014 to discuss the scope of the resubmittal. The staff understands that key features of the revised FLO-2D resubmittal will include discussion of the following issues: • Roof run-off issues • Potential flow discontinuities in model • Mesh resolution • Model configuration as it relates to complicated flow areas • Flow near buildings • Criteria from the FLO-2D user's manual • Any potential complications with supercritical flow conditions RAI(s) may be issued following the staff's review of the licensee's resubmittal and additional ERR references.

Serial No.	FHRR Section	Information Need(s) [1]	Action (Post Audit)
11	3.1: Local Intense Precipitation	Have available the FLO-2D documentation (input and output files; calculation packages) and a knowledgeable SME to discuss: Quality control checks Sub-grid scale flow balances *NRC staff notes: The licensee's SMEs provided an overview of their approach to using the FLO-2D computer code. During the break-out session, the licensee's SMEs noted that FLO-2D calculations were performed under an Appendix B approved QA program (safety related). The licensee noted that FLO-2D software underwent a commercial grade dedication process. Relevant information was also made available by the licensee during the audit.*	The staff reviewed the material requested in the Audit Plan and spoke to the licensee's SMEs. Based on those discussions, the licensee determined it would resubmit a revised FLO-2D analysis as part of the FHRR (See item #10, above.) The staff also determined that additional documentation was needed in the ERR. RAI(s) may be issued following the staff's review of licensee's resubmittal and additional ERR references.
12	3.1: Local Intense Precipitation	Have available the FLO-2D documentation (input and output files; calculation packages) and a knowledgeable SME to discuss: • Water surface elevation results • Velocity results *NRC staff notes: The licensee's SME's provided relevant information during the audit. During the break-out session, detailed discussions concerned FLO-2D as well as the issue related to the treatment of "rain on buildings" features. Other relevant information was also made available by the licensee during the*	The staff reviewed the material requested in the Audit Plan and spoke to the licensee's SMEs. Based on those discussions, the licensee determined it would resubmit a revised FLO-2D analysis as part of the FHRR; (See item #10 above). The staff also reviewed the material requested in the Audit Plan and determined that additional documentation was needed in the ERR. RAI(s) may be issued following the staff's

Serial No.	FHRR Section	Information Need(s) [1]	Action (Post Audit)
		audit.	review of the licensee's resubmittal and additional ERR references.
13	3.2: Flooding in Rivers and Streams	Have available a knowledgeable SME to discuss how the hierarchical hazard assessment (HHA) approach described in NUREG/CR-7046 was applied to determine the probable maximum flood (PMF) at and near the IPEC site. *NRC staff notes: The licensee's SMEs provided an overview of how the HHA approach was applied to the calculation of the PMF. No analysis was done of results that would be associated with the PMP values that would be derived from HMR51. During the break-out session, the licensee's SMEs noted that the model parameters initially selected were very conservative regarding initial losses, neglecting most of the upstream dams and use of conservative starting pool elevations at spillway crest,. The licensee's SMEs also noted that one iteration was performed and once the PMF elevation was below site grade the process was ended. The licensee also had relevant background information available during these discussions.*	The staff reviewed the material requested in the Audit Plan and met with the SMEs. The staff's information needs were sufficiently resolved for the staff to better understand the licensee's approach. The staff may issue RAIs to address concerns.
14	3.2: Flooding in Rivers and Streams	Have available a knowledgeable SME to discuss the selection of the centering and orientation for the basin-wide PMP storm for estimation of the PMF. Be prepared to present justifications and/or data support for this selection. *NRC staff notes: For the purposes of the basin-wide PMF calculation discussion, the licensee's SMEs noted that the storm center was taken as the center of the watershed. The licensee's SMEs also noted that the HMR52 computer program internally computes storm orientation to maximize rainfall depth within the user-defined watershed. Evaluation of additional storm centers was judged not to provide additional value and the licensee's SMEs relied on expert judgment to determine that the one storm orientation used would produce the most severe flooding possible. The licensee had other relevant background information available during these discussions.*	The staff reviewed the material requested in the Audit Plan and spoke to the licensee's SMEs. These actions lead to partial resolution of the staff's earlier questions. Further staff review is necessary to better understand the level of conservatism in the licensee's analysis approach. Thestaff may issue RAIs to address concerns.

Serial No.	FHRR Section	Information Need(s) [1]	Action (Post Audit)
15	3.2: Flooding in Rivers and Streams	Have available a knowledgeable SME to discuss reasonable alternative centering locations and orientations for the site-specific PMP storm for estimation of the PMF. Be prepared to discuss how these alternative centering locations could affect the flood hazard at or near the IPEC site and the associated levels of conservatism. *NRC staff notes: No alternative centering locations or orientations for the site-specific PMP were used by the licensee's SMEs who relied upon expert judgment in determining that all other alternative locations would result in less severe flooding near the IPEC site. The licensee had SMEs available to discuss the issues. Relevant information was made available by the licensee during the audit.*	The staff reviewed the material requested in the Audit Plan and spoke to the licensee's SMEs. These actions lead to partial resolution of the staff's earlier questions. Further staff review will be necessary to better understand the level of conservatism in the licensee's analitical approach. Thestaff may issue RAIs to address concerns.
16	3.2: Flooding in Rivers and Streams	Have available a map of the domains used for Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) and Hydrologic Engineering Center River Analysis System (HEC-RAS) that clearly shows rivers, tributaries, dams and other hydraulic structures, reservoirs, watershed boundaries, and the location of gage stations. The map should clearly show the domains used for HEC-HMS and HEC-RAS, as well as the locations of cross sections used for HEC-RAS analyses. *NRC staff notes: The licensee's SMEs provided a large scale map during the audit showing the requested information. An electronic copy was also requested for the ERR and was subsequently provided.*	The staff reviewed the material requested in the Audit Plan and found it sufficient. An electronic copy was later provided to the ERR as requested for follow-up.
17	3.2: Flooding in Rivers and Streams	Have available the HEC-HMS documentation (input and output files; calculation packages) and a knowledgeable SME to discuss: • Precipitation transformation • Channel routing characteristics • Reservoir characteristics *NRC staff notes: The licensee's SMEs provided an overview of the approach to*	The staff reviewed the material requested in the Audit Plan and concluded that it still has questions. The staff subsequently requested that additional documentation be placed in the ERR concerning the HEC-HMS computer modeling. Upon receipt of the requested information in the ERR, the staff will review it and determine if it has any additional

Serial No.	FHRR Section	Information Need(s) [1]	Action (Post Audit)
		the PMF calculation using the HEC-HMS computer code. Relevant information (i.e., the input/output files and calculation packages) was made available by the licensee for the staff to review during the audit break-out session, and the SMEs were on hand to aid in the interpretation of that information. Specific points discussed included unit hydrograph parameters used, infiltration loss rates, channel routing methods and available dam data for selected dams. During the breakout session, the licensee's SMEs noted: • *Precipitation transformation was performed via the Snyder Method with calibration and verification.* • *Routing was performed with Muskingum and Muskingum-Cunge.* • *Three dams were modeled based on publically-available information and the Corps of Engineers' Phase I reports (no flood control dams were incorporated),* • *Initial losses during the PMF were zero.* • *Constant losses changed during calibration, and were initially estimated from the minimum published typical infiltration rate for each hydrologic soil group.* • *8-point cross-section was used for Muskingum-Cunge.*	questions.
18	3.2: Flooding in Rivers and Streams	Have available the HEC-HMS documentation (input and output files; calculation packages) and a knowledgeable SME to discuss: • Quality control checks (if applicable) • Model calibration *NRC staff notes: The licensee's SMEs provided an overview of their approach to the calculation of the PMF using the HEC-HMS computer code. Relevant information (i.e., the input/output files and calculation packages) was made available by the licensee for the staff to review during the audit break-out session and SMEs were on hand to aid in the interpretation of that information. Specific points noted by the licensee's SMEs during the break-out sessions*	The staff reviewed the material requested in the Audit Plan and concluded that it still has questions. The staff subsequently requested that additional documentation be placed in the ERR concerning the HEC-HMS computer modeling. Upon receipt of the requested information in the ERR, the staff will review it and determine if it has any additional questions.

Serial No.	FHRR Section	Information Need(s) [1]	Action (Post Audit)
		included the following: • *19 sub-watersheds were included in the model, 12 of which were gaged and used for model calibration/verification.* • *3 calibration and 3 verification floods were used including:* o *2011 modern flood of record downstream* o *most recent Green Island gage (previous peak 1936, no reliable data available)* • *Calibration/verification fits are ultimately based on engineering judgment.*	
19	3.2: Flooding in Rivers and Streams	Have available the HEC-HMS documentation (input and output files; calculation packages) and a knowledgeable SME to discuss: • Discharge results *NRC staff notes: The licensee's SMEs provided an overview of their approach to the calculation of the PMF using the HEC-HMS computer code. Relevant information (i.e., the input/output files and calculation packages) was made available by the licensee for the staff review during the audit break-out session and SMEs were on hand to aid in the interpretation of that information. Specific points noted by the licensee's SMEs during the break-out sessions focused on zero initial losses. Watershed average verified constant loss Initial estimates of constant loss rates were based on the low end of values of typical loss rates for each hydrologic soil group*	The staff reviewed the material requested in the Audit Plan. The staff's information needs were sufficiently resolved for staff to better understand the licensee's approach. The staff may issue RAIs to address concerns.
20	3.2: Flooding in Rivers and Streams	Have available the HEC-RAS documentation (input and output files; calculation packages) and a knowledgeable SME to discuss: • Boundary conditions (upstream and downstream) • Tributary and lateral inflows • Channel routing characteristics *NRC staff notes: The licensee's SMEs provided an overview of their approach to the calculation of the PMF using the HEC-HMS computer code. Relevant*	The staff reviewed the material requested in the Audit Plan. The staff's information needs were sufficiently resolved for staff to better understand the licensee's approach. The staff may issue RAIs to address concerns.

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		information was made available by the licensee for staff review during the audit break-out session and SMEs were on hand to aid in the interpretation of that information. Specific points noted by the licensee during the break-out sessions focused on PMF hydraulics, including • *Flow was unsteady.* • *Very-high downstream boundary condition was used - higher than the 10% exceedance high tide (5.35 ft used vs. 4.5 ft calculated in deterministic storm surge calculation).* • *Manning's coefficient selection was based on visual observation and FEMA flood studies, with limited calibration.* • *No lateral inflows were used; all sub-watersheds achieve confluence with the Hudson River upstream of the IPEC model boundary (boundary is 24 miles upstream of IPEC; tidal boundary is at the Troy Lock and Dam 109 Miles upstream of IPEC)*	
21	3.2: Flooding in Rivers and Streams	Have available the HEC-RAS documentation (input and output files; calculation packages) and a knowledgeable SME to discuss: • Quality control checks • Model calibration *NRC staff notes: The licensee's SMEs provided an overview of their approach to the PMF calculation using the HEC-HMS computer code. Relevant information (i.e., the input/output files and calculation packages) was made available by the licensee for the staff to review during the audit break-out session and SMEs were on hand to aid in the interpretation of that information. During the break-out session, the licensee's SMEs noted that model calibration was limited because of a lack of data and tidal characteristics. Two floods were used; the Manning's n value that resulted in the highest water surface elevation was selected for use in the model. The SMEs noted that they could not use Hurricane Irene (2011) data because the event had a very significant storm*	The staff reviewed the material requested in the Audit Plan and spoke to the licensee's SMEs. These actions lead to partial resolution of the staff's earlier questions. Further staff review is necessary to better-understand the level of conservatism in the licensee's analysis approach. The staff may issue RAIs to address concerns.

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		surge component; the same issue encountered for Hurricane Sandy. The SMEs also noted HEC-RAS cannot reliably model storm surges.	
22	3.2: Flooding in Rivers and Streams	Have available the HEC-RAS documentation (input and output files; calculation packages) and a knowledgeable SME to discuss: • Water surface elevation results *NRC staff notes: The licensee's SMEs provided an overview of their approach to the calculation of the PMF using the HEC-HMS computer code. Relevant information (i.e., the input/output files and calculation packages) was made available by the licensee for the staff to review during the audit break-out session and SMEs were on hand to aid in the interpretation of that information.*	The staff reviewed the material requested in the Audit Plan and spoke to the licensee's SMEs. The staff's information needs were sufficiently resolved for the staff to better understand the licensee's approach.
23	3.3: Dam Breaches and Failures	Have available a knowledgeable SME to discuss how the HHA approach described in NUREG/CR-7046 was applied to determine the flooding from dam failure mechanisms at and near the IPEC site. *NRC staff notes: The licensee's SMEs provided an overview of how the HHA approach was applied to the PMF calculation attributed to dam failure. No analysis was done of results that would be associated with the PMP values that would be derived from HMR 51. During the break-out session, the licensee's SMEs discussed their HHA approach in more detail. The licensee also had relevant background information available during those discussions. During the break-out session, the licensee's SMEs noted that no individual PMP centerings were used in order to maximize dam failure contribution.*	The staff reviewed the material requested in the Audit Plan and spoke to the licensee's SMEs. The staff's information needs were sufficiently resolved for the staff to better understand the licensee's approach. The staff may issue RAIs to address concerns.
24	3.3: Dam Breaches and Failures	Have available a knowledgeable SME to discuss the centering and orientation for the basin-wide PMP storm used for estimation of the maximum flooding from the dam failure flood causing mechanism. Be prepared to present justifications and/or data support for this selection.	The staff reviewed the material requested in the Audit Plan and spoke to the licensee's SMEs. These actions lead to partial resolution of the staff's earlier questions. Further staff review is necessary to better understand the level of

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		NRC staff notes: The licensee's SMEs provided an overview of their approach to the centering and orientation of the basin-wide PMP. During the break-out session, the licensee discussed the significance of reasonable alternative PMP centering and orientation on the PMF calculation and the potential for dam failure. The licensee also had relevant background information available during those discussions. During the break-out session, the licensee's SMEs noted the following: • *Issue of centering PMP over individual dam watersheds would not provide appreciable value* • *Dam failure scenario forced a Conklingville dam failure and combined it with the PMP storm applied to the center of the watershed (Conklingville dam watershed is 8.3% of watershed above IPEC, and Ashokan and Rondaout are even smaller),* • *Conklingville dam is 240 miles upstream of IPEC; breach flow from dams further upstream is likely to dissipate. Dams closer to IPEC are much smaller (combined volume max 1.4 million acre-ft vs. 1.8 million acre-ft).* • *No attenuation for the Conklingville dam failure therefore represents failure of dams that could contribute to IPEC PMF* • *Initial screening criterion was dam breaches that would be 1,000,000 cfs (without attenuation) because most dams are far from IPEC (no dams on the Hudson River within 100 miles)* • *Due to Individual dam watersheds relative to overall watershed, PMP over centroid was considered to result t in highest calculated PMF based on expert judgment* • *HHA was used -- no attenuation was necessary. More severe combinations would have triggered use of additional detailed modeling (or USBR attenuation equations) to consider attenuation.*	conservatism in the licensee's analitical approach. The staff may issue RAIs to address concems.
25	3.3: Dam Breaches and Failures	Have available a knowledgeable SME to discuss reasonable alternative centering locations for the site-specific PMP storm for estimation flooding from	The staff reviewed the material requested in the Audit Plan and spoke to the licensee's SMEs.

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		dam failures. Be prepared to discuss how these alternative centering locations could affect the flood hazard at or near the IPEC site. *NRC staff notes: The licensee's SMEs provided an overview of their approach to analysis related to dam breaches and failures. The licensee's SMEs did not perform additional simulations of PMP storms centered over the centroid of watersheds upstream to individual dams. The licensee's SMEs determined that flooding at IPEC by such storms would not result in more severe flooding at the IPEC site based upon expert judgment. The licensee also had relevant background information available during those discussions.*	These actions lead to partial resolution of the staff's earlier questions. Further staff review is necessary to better understand the level of conservatism in the licensee's analitical approach. The staff may issue RAIs during subsequent review of the licensee's submission.
26	3.3: Dam Breaches and Failures	Have available a map of the domain that clearly shows the locations of dams and reservoirs considered in dam failure analysis, as well as the rivers and tributaries along which any flood resulting from dam failures would be routed. *NRC staff notes: The licensee's SMEs provided an appropriate map and explained various features in the map.*	The staff reviewed the material requested in the Audit Plan and requested that an electronic copy of the map be placed in the ERR. An appropriate digital map was subsequently provided in the ERR.
27	3.3: Dam Breaches and Failures	Have available the HEC-HMS and HEC-RAS documentation (input and output files; calculation packages) and a knowledgeable SME to discuss: • Selection of reservoirs and dams for failure analysis • Breach flood routing characteristics *NRC staff notes: The licensee's SMEs provided an overview of their approach in using the HEC-HMS and HEC-RAS computer code in the dam failure analysis. Relevant information was made available by the licensee for the staff, including the rationale for the selection of certain dam modeling parameters, and SMEs were on hand to aid in the interpretation of that information. During the break-out sessions, the licensee's SMEs noted the following with respect to the dam modeling exercise:* • *No attenuation of dam breach flood flows.*	The staff reviewed the material requested in the Audit Plan and concluded that it still had questions. The staff subsequently requested that additional documentation be placed in the ERR. Upon receipt of the requested information in the ERR, the staff will review it and determine if it has any additional questions.

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		• *Forced hydrologic failure of the Conklingville Dam (FERC regulated structure) although it did not overtop during the PMF.* *Selection of dams based on largest heights, storage volumes, and proximity to the IPEC site.*	
28	3.4: Storm Surge	Have available the following documents and appropriate references, as well as a knowledgeable SME to discuss the methodology used for the deterministic characterization of storm surge, including:	
		• The application of the SLOSH model as a screening tool, including the assumptions used to implement model simplifications, grid resolution near the Indian Point facility, and no river inflow at the upstream boundary Comparisons of SLOSH model results with measurements to validate the SLOSH model's ability to simulate storm surge near the Indian Point facility.	There was partial resolution of the staff's earlier questions in this area. The staff may issue RAIs requesting results from additional computer runs done with the ADCIRC computer code to account for limitations in the screening tool.
		• The development and application of probability distributions applied to develop the SLOSH model input parameter combinations. As part of this discussion, provide information on the upper limits applied for the meteorological forcing parameters. If this upper limit involved the estimation of an MPI central pressure, describe how this was done. If this was done via an upper limit derived based on Extreme Value Statistics, describe how this was done. Also, discuss the application of the Extreme Value Statistics (EVS) performed to estimate the probability of strong storms in the study region. Include the probability distributions used for different storm parameters and any references to their previous application to this region. If there are no previous applications of the specific distributions used here, provide a plot of the data and the fit to the data provided by the specific distributions used in this effort.	There was partial resolution of the staff's earlier questions in this area. The staff may issue RAIs requesting additional justification of capping of PMH wind fields as well as additional information on relation of Rmax as applied in WRT analysis and probability distribution development. The staff mayalso inquire if any comparisons of WRT Rmax values and data have been made.
		• The application of the ADCIRC model within the deterministic analysis and any modeling difficulty encountered (such as instability for strong storms).	The staff concluded that additional documentation in this area is still needed. Thestaff plans to issue an RAI requesting additional discussion of any ADCIRC

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			model instability encountered running the deterministic or probabilistic storms and any corrective actions taken.
		• Comparisons of the SLOSH and ADCIRC results for similar storms and whether the results indicate suitable model results for application of SLOSH	There was partial resolution of the staff's earlier questions in this area. The staff may issue RAIs requesting results from additional computer runs done with the ADCIRC computer code to account for limitations in the screening tool.
		• Comparisons of the ADCIRC tidal model results to confirm consistency between the simulated and predicted tidal phasing, range, and amplitude.	The staff's information needs were sufficiently resolved for the staff to better understand the licensee's approach. The staff may issue RAIs to address concerns.
		• The development of the still water elevation, wave crest elevation, and limit of run-up for Combined Flood Event Alternatives 1, 2, and 3	The staff's information needs were sufficiently resolved for the staff to better understand the licensee's approach. The staff may issue RAIs to address concerns.
		• Provide evidence that wave setup is not important at the site.	There was partial resolution of the staff's earlier questions in this area. The staff may issue RAIs requesting results from additional computer runs done with ADCIRC to account for limitation in screening tool.
		• Details of methods applied to develop the flow velocity and hydrodynamic loads at the site	The staff's information needs were sufficiently resolved for the staff to better understand the licensee's approach. The staff may issue RAIs to address concerns.
		• Discuss the source of the bathymetry data and interpolation method applied in	The staff's information needs were sufficiently

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		the development of the ADCIRC model mesh. Discuss the scope of changes made to the Federal Emergency Management Agency (FEMA) Region II mesh to refine the area near the Indian Point facility. • Provide input files necessary to recreate two of the SLOSH and ADCIRC model results in Tables 3.4-10 and 3.4 12.	resolved for the staff to better understand the licensee's approach. The staff may issue RAIs to address concerns. The staff's information needs were sufficiently resolved for the staff to better understand the licensee's approach. The staff may issue RAIs to address concerns.
		NRC staff notes: The licensee's SMEs provided an overview of their approach to the calculation of probabilistic storm surge at the IPEC site. During the break-out session, the licensee's SMEs noted the following: • *SLOSH model was used as a as a screening tool.* • *Model simplifications: grid resolution near the IPEC site was judged to have no impact because final runs were made in ADCIRC.* • *Sensitivity results were presented during the audit for parameter discretization sizes and ranges.* • *No stability issues were experienced with ADCIRC.* • *Comparisons of the SLOSH and ADCIRC results were favorable for river surge results. Differences were found for results in the NY Harbor area.* • *Wave set-up is included in the empirically-based calculation for wave run-up. The component of wave set-up that was not included was deep water waves breaking at the IPEC bulkhead. For these waves, the licensee expressed the view that existing site conditions (flat areas, structures, etc.) are such that momentum is lost.* • *Coupled ADCIRC and numerical wave model (e.g. SWAN, STWAVE) was not performed here for several reasons:* o *Wind and surge at the site are effectively decoupled activities; in particular with the assumption of steady state storm tracks. That is, most tracks will not result in significant waves at the site* o *Given the predicted inundation, most waves are depth limited.*	

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		○ *It was decided that a more conservative approach would be to calculate deep water waves using simplified procedures, but assume the worst wind and worst fetch direction, and add to the highest surge still water elevation (including tide and river flood).* • *The input files necessary to recreate two of the SLOSH and ADCIRC model results were provided.* • *Bathymetry used with ADCIRC was provided by FEMA.*	
29	3.4: Storm Surge	Have available appropriate documents and references, as well as an SME who is knowledgeable about the probabilistic characterization of storm surge to discuss the following: • Rationale for selecting 2 x 10^{-6} as the appropriate level to establish the reevaluated storm surge elevation • Interpretation of the hazard curve and annual exceedance probability (AEP) of 2 x 10^{-6} light of the use of deterministic models and event combinations and any associated potential bias inherent in models employed as well as any uncertainties that were considered or neglected. *NRC Staff notes: The licensee's SMEs provided an overview of their approach to the calculation of probabilistic storm surge at the IPEC site. Through the course of the audit, the SMEs stated that conservatisms in the probabilistic storm surge calculations provide justification for the selection of the 2 x 10^{-6} number. The interpretation of the hazard curve (e.g., whether the hazard curve can be interpreted as a mean curve) and AEP of 2 x 10^{-6} remains unclear due to the use of deterministic models and event combinations, associated potential bias inherent in models employed, as well as uncertainties that were neglected.*	The staff spoke to the licensee's SMEs. Based on those conversations, the staff may issue RAIs to further address these issues.
30	3.4: Storm Surge	Have available appropriate documents, codes, and references as well as an SME who is knowledgeable about the probabilistic characterization of storm surge to discuss the following: • Characterization and propagation of relevant sources of aleatory variability	The staff spoke to the licensee's SMEs. Based on those conversations, the licensee made presentation materials and supplemental written responses from the audit available to staff in the ERR. The staff plans

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		(e.g., probability density functions associated with storm parameters and model errors). • The means by which epistemic uncertainties in related data, models and methods were addressed, including, but not limited to, the following topics: o alternate technical interpretations of relevant data, including considerations of different means of selecting, interpreting, and filtering data from the HURDAT database. o alternate technical interpretations of relevant probability density (mass) functions used to characterize aleatory uncertainty associated with storm parameters (e.g., intensity, storm track, radius to maximum winds, and storm translational speed) o alternate technically defensible models and modeling decisions • The means by which epistemic uncertainties were quantified and propagated (e.g., development of logic trees, if applicable). *NRC staff notes: The licensee's SMEs provided an overview of their approach to the calculation of probabilistic storm surge at the IPEC site. During the break-out sessions that followed, an AREVA subcontractor (Dr. Emanuel) described the methods used to develop the probability distributions for storm parameters, including consideration of historic and synthetic data (with multiple geographic filters) as well as the use of nonparametric methods and extreme value analysis. The licensee described the consideration of epistemic uncertainty via "benchmarking" and justification for conservative assumptions. Epistemic uncertainties were not explicitly quantified or propagated. The licensee provided supplemental information in the form of presentation materials addressing the items listed above and written response to specific follow-up questions (e.g., questions related to bootstrap algorithms employed for verification analyses). Additionally, the licensee referenced a 2006 Emanuel paper that looked at probability distribution comparisons to historical data.*	to issue RAIs, as needed, to request that the licensee docket information contained in the presentation materials or supplemental materials if it serves as a basis for conclusions documented in the staff assessment. The staff may also request additional or more detailed information regarding modeling decisions.
31	3.4: Storm Surge	Have available an electronic copy of the Excel® spreadsheet	Staff may issue RAI requesting justification for

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		JPM_SLOSH_ADCIRC_103013.xlsx referenced in Appendix H of calculation package 32-9213352-000 as well as personnel knowledgeable in its contents and usage. *NRC staff notes: The subject spreadsheet identified in the audit plan was made available to the staff prior to the audit as part of an RAI response. The staff asked various questions related to the spreadsheet on topics such as treatment of probability mass associated with combinations of parameters assigned "-999" surge values, confidence in results near the 2 x 10^{-6} level and selection of computer runs for refinement using ADCIRC. As a result, the staff was able to develop an understanding of the spreadsheets' contents and usage.*	confidence in results near 2 x 10^{-6} level (may require additional simulations to bolster confidence in the 2 x 10^{-6} values
32	3.4: Storm Surge	Have available relevant documentation and an SME who is knowledgeable about the probabilistic characterization of storm surge to discuss any sensitivity studies performed to support the probabilistic storm surge analysis (PSSA). *NRC staff notes: The licensee's SMEs provided an overview of their approach to the calculation of probabilistic storm surge at the IPEC site. Results of sensitivity studies were discussed. In addition, presentation materials were prepared summarizing parameter sensitivity (e.g., as low, moderate, or high). In addition, supplemental materials were presented related to sensitivity studies of parameter ranges and discretization considered in the joint probability method (JPM) integration.*	The licensee has made presentation materials from the audit available to staff in the ERR. The staff plans to issue RAIs, as needed, to request that the licensee docket information contained in the presentation materials if it serves as a basis for conclusions documented in the staff assessment. The staff may also request additional or more detailed information regarding sensitivity studies.
33	3.4: Storm Surge	Have available appropriate documents, codes, and references as well as an SME who is knowledgeable about the probabilistic characterization of storm surge to discuss the following: • Probability distributions associated with storm parameters and error terms (as applicable) in the JPM integral. • Basis for distribution models and parameters selected, including any	The staff will continue its review of information contained in the ERR (e.g., calculation packages) with the improved understanding afforded by the clarifying information presented during the audit. The staff plans to issue RAIs, as needed, to request that the licensee docket information contained in the

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		analyses performed using expert judgment, based on existing studies, or based on available data (e.g., HURDAT) including selection, interpretation, and filtering of available data. *NRC staff notes: The licensee's SMEs provided an overview of their approach to the calculation of probabilistic storm surge at the IPEC site. SMEs provided significant clarifying information regarding the methodology used to develop probability distributions associated with storm parameters in the JPM integral. A significant portion of the audit was spent discussing the basis for the distribution models selected (e.g., data and methods used to derive distributions, geographic filters applied to datasets, and the means by which temporal correlation in the datasets was addressed). The NRC staff was also afforded the opportunity to discuss the synthetic dataset with the external SME responsible for its development.*	calculation packages if it serves as a basis for conclusions documented in the staff assessment. If necessary, the staff may also request additional or more detailed information regarding the datasets utilized, judgments applied, and probability distributions ultimately selected.
34	3.4: Storm Surge	Have available appropriate documents, codes, and references as well as an SME who is knowledgeable about the probabilistic characterization of storm surge to discuss the selected discretization shown in FHRR Tables 3.4-5 through 3.4-9, including (but not limited to) discussion of the basis for the selected discretization and the treatment of the contribution of probability mass associated with parameter values outside the range of parameters shown in Tables 3.4-5 through 3.4-9. *NRC staff notes: The licensee's SMEs provided an overview of their approach to the calculation of probabilistic storm surge at the IPEC site. The SMEs prepared a supplemental presentation to illustrate the sensitivity of results to various decisions related to parameter ranges and discretization, including the impact of excluding probability mass outside the ranges of the parameters considered. The NRC staff also raised questions related to exclusion of probability mass assigned to parameter combinations that were later deemed meteorologically impossible.*	The licensee has made presentation materials from the audit available to staff in the ERR. The staff expects to issue RAIs related to the impact of discretization, selected parameter ranges, and treatment of probability mass that was assigned to combinations of parameters later deemed meteorologically impossible.

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35	3.4: Storm Surge	Have available relevant codes, references, and documentation as well as an SME who is knowledgeable about the probabilistic characterization of storm surge to discuss the basis for the calculated omni-directional storm rate including (but not limited to) the basis for the selected capture zone and any sensitivity studies that were performed or alternate methods that were considered. NRC also requests that the licensee have available a tabulation of the events (including event dates) that were used to compute the omni-directional storm rate (as referenced in Section 6.2 of calculation package 32-9213352-000). *NRC staff notes: The licensee's SMEs provided an overview of their approach to the calculation of probabilistic storm surge at the IPEC site. The SMEs prepared presentation materials related to the omni-directional storm rate and provided clarifying information relative to information contained in the calculation packages. The licensee also provided the tabulation of events used to compute the omni-directional rate. Lambda (the storm rate coefficient) was presented in documents using two different units for values presented. The licensee's SME reported that GZA (an AREVA subcontractor) reevaluated lambda to reflect geographic variability. Results are in terms of four shoreline segments (the limits of which were based on observed landfall trends). In general, lambda equal to 0.047 is expected to be appropriate for storms contributing to the 1 x 10^{-6} return period flood.*	The staff will continue its review of information contained in the ERR (e.g., calculation packages) with the improved understanding afforded by the clarifying information presented during the audit. The staff plans to issue RAIs, as needed, to request that the licensee docket information contained in the calculation packages if it serves as a basis for conclusions documented in the staff assessment. If necessary, the staff may also request additional or more detailed information regarding the evaluation of the omni-directional rate.
36	3.4: Storm Surge	Have available relevant documentation and an SME who is knowledgeable about the probabilistic characterization of storm surge to discuss the use and interpretation of deterministic load combinations (e.g., a 25-year river flow in conjunction with the storm surge event) in conjunction with the probabilistic characterization of storm surge and the basis for those decisions. *NRC staff notes: The licensee's SMEs provided an overview of their approach to the calculation of probabilistic storm surge at the IPEC site. The SMEs described the rationale for their judgment that the combination of a 25-year river flow in*	The licensee has made presentation materials from the audit available to the staff in the ERR. The staff plans to issue RAIs, as needed, to request that the licensee docket information contained in the calculation packages or presentation materials if it serves as a basis for conclusions documented in the staff assessment. If necessary, the staff may also request additional or more detailed information regarding deterministic load combinations.

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		conjunction with a storm surge event is conservative. Their rationale was based on differences in characteristics between events that create large surges and events that deposit a large amount of rain on the watershed as well as considerations associated with the lack of coherence in the arrival of the peak surge and the arrival of a peak river flow. The licensee's SMEs noted that a 25-year flood was assumed to occur in conjunction with the PMSS. That rainfall event is considered to be conservative and as a further conservatism it is assumed to occur with the PMSS a probability of 1. Presentation materials presented during the audit provided graphics to support the rationale provided.	
37	3.4: Storm Surge	Have available relevant documentation and an SME who is knowledgeable about the probabilistic characterization of storm surge to discuss components of the PSSA that relied on engineering judgment or experience, including (but not limited to) the filtering of data, statistical methods used to develop probability density functions (PDFs), selected PDFs, event combinations considered (e.g., treatment of concurrent tides and river flows), model selection, and model parameters. *NRC staff notes: The licensee's SMEs provided an overview of their approach to the calculation of probabilistic storm surge at the IPEC site. The SMEs identified several places where engineering judgment was applied. Moreover, throughout the audit, the staff discussed the development of synthetic data, filtering of historic data, methods used to develop (or verify) probability density functions, treatment of tides and river flows, use of numerical models (SLOSH and ADCIRC), and other relevant decisions. Throughout the discussions, the staff further identified components of the analysis that utilized (explicitly or implicitly) engineering judgment or experience.*	The staff will continue its review of information contained in the ERR (e.g., calculation packages) with the improved understanding afforded by the clarifying information presented during the audit. The staff plans to issue RAIs, as needed, to request that the licensee docket information contained in the calculation packages if it serves as a basis for conclusions documented in the staff assessment. If necessary, the staff may also request additional or more detailed information regarding judgments applied during the analysis.

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38	3.4: Storm Surge	Have available relevant codes, references, and documentation; and an SME who is knowledgeable about the probabilistic characterization of storm surge to discuss the results of verification and validation exercises, including the means by which the Joint Probability Method (JPM) integration accounted for model errors. *NRC staff notes: Entergy contractors provided supplemental information describing the basis for exclusion of an error term from the JPM integral. The bases provided were centered on a judgment that various modeling decisions were conservative (e.g., based on benchmarking studies) or that verification studies showed results were sufficient that an error term was not required.*	The licensee has made supplemental material (contained in presentations) from the audit available to the staff in the ERR. The staff plans to issue RAIs, as needed, to request that the licensee docket information contained in the presentation materials if it serves as a basis for conclusions documented in the staff assessment. Pending the results of further review, the staff may request additional or more detailed information regarding treatment of uncertainties.

sufficiently described in the main body of the IPEC FHRR document or in supporting references. Because this information is necessary for the NRC staff to perform its review of the IPEC FHRR analyses, the staff decided to conduct an audit of the report and the associated calculations. An audit was then conducted at the IPEC site on May 27-30, 2014.

The plan for this audit, dated May 5, 2014, can be found in ADAMS at Accession No. ML14121A431. A copy of the audit report, reflecting the NRC staff's findings during the site audit, is enclosed herewith. Enclosure 1 is the audit report which identifies the NRC staff and contractors and subcontractors that participated in the audit, as well as their respective function and the specific objectives of the audit. Enclosure 2 contains the Entergy contractor and subcontractor responses to NRC staff requests, and the staff's observations from the audit.

If you have any questions, please contact me at 301-415-3733 or via email at Robert.Kuntz@nrc.gov.

Sincerely,

/RA/
Robert F. Kuntz, Senior Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket Nos. 50-247 and 50-286

Enclosures:
1. FHRR Audit Report
2. Audit Report – Information needs

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