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

August 5, 2016

Mr. Bryan C. Hanson
President and Chief
Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: NUCLEAR REGULATORY COMMISSION REPORT FOR THE AUDIT OF EXELON GENERATION COMPANY, LLC'S FLOOD HAZARD REEVALUATION REPORT SUBMITTAL RELATING TO THE NEAR-TERM TASK FORCE RECOMMENDATION 2.1-FLOODING FOR OYSTER CREEK NUCLEAR GENERATING STATION (CAC NO. MF6111)

Dear Mr. Hanson:

By letter dated July 21, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15148A286), the U.S. Nuclear Regulatory Commission (NRC) informed you of the staff's plan to conduct a regulatory audit of Exelon Generation Company, LLC's (Exelon, the licensee) Flood Hazard Reevaluation Report (FHRR) submittal related to the Near-Term Task Force Recommendation 2.1-Flooding for Oyster Creek Nuclear Generating Station. The audit was intended to support the NRC staff review of the licensee's FHRR and the subsequent issuance of a staff assessment.

The audits conducted on August 18, 2015, and January 14, 2016, were performed consistent with NRC Office of Nuclear Reactor Regulation, Office Instruction LIC-111, "Regulatory Audits," dated December 29, 2008 (ADAMS Accession No. ML082900195). The purpose of this letter is to provide you with the final audit report which summarizes and documents the NRC's regulatory audit of the licensee's FHRR submittal.

If you have any questions, please contact me at (301) 415-6197 or by e-mail at Tekia.Govan@nrc.gov.

Sincerely,

Tekia V. Govan, Project Manager
Office of Nuclear Reactor Regulation
Japan Lessons-Learned Division
Hazards Management Branch

Docket No. 50-219

Enclosure:
Audit Report

cc w/encl: Distribution via Listserv

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NUCLEAR REGULATORY COMMISSION REPORT FOR THE AUDIT OF EXELON GENERATION COMPANY, LLC'S FLOOD HAZARD REEVALUATION REPORT SUBMITTALS RELATING TO THE NEAR-TERM TASK FORCE RECOMMENDATION 2.1-FLOODING FOR OYSTER CREEK NUCLEAR GENERATING STATION

BACKGROUND AND AUDIT BASIS

By letter dated March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f), "Conditions of license" (hereafter referred to as the "50.54(f) letter"). The request was issued in connection with implementing lessons-learned from the 2011 accident, at the Fukushima Dai-ichi nuclear power plant, as documented in The Near-Term Task Force review of insights from the Fukushima Dai-ichi accident. Recommendation 2.1 in that document recommended that the NRC staff issue orders to all licensees to reevaluate seismic and flooding for their sites against current NRC requirements and guidance. Subsequent staff requirements memoranda associated with SECY-11-0124 and SECY-11-0137, instructed the NRC staff to issue requests for information to licensees pursuant to 10 CFR 50.54(f).

By letter dated March 12, 2015, Exelon Generation Company, LLC (Exelon, the licensee) submitted its Flood Hazard Reevaluation Report (FHRR) for Oyster Creek Nuclear Generating Station (Oyster Creek) (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15085A046). The NRC is reviewing the aforementioned submittal and has completed a regulatory audit of the licensee to better understand the development of the submittal, identify any similarities/differences with past work completed, and ultimately aid in its review of the licensee's FHRR. This audit summary was completed in accordance with the guidance set forth in NRC Office of Nuclear Reactor Regulation, Office Instruction LIC-111, "Regulatory Audits," dated December 29, 2008 (ADAMS Accession No. ML082900195).

AUDIT LOCATION AND DATES

The audit was completed by document review via a webinar session in conjunction with the use of the licensee's established electronic reading room (ERR) and teleconferences on August 18, 2015, and January 14, 2016.

AUDIT TEAM

Title	Team Member	Organization
Team Leader, NRR/JLD	Tekia Govan	NRC
Technical Monitor	Michael Willingham	NRC
Technical Staff	Mike Lee	NRC
Technical Deputy Division Director	Andy Campbell	NRC
Technical Branch Chief	Aida Rivera-Verona	NRC
Technical Branch Chief	Christopher Cook	NRC
NRC Contractor	Philip Meyer	Pacific Northwest National Lab

A list of the licensee's participants can be found in Attachment 2.

DOCUMENTS AUDITED

Attachment 1 of this report contains a list which details the documents that were reviewed by the NRC staff, in part or in whole, as part of this audit. The documents were located in an electronic reading room during the NRC staff's review. The documents, or portions thereof, that were used by the NRC staff as part of the technical analysis and/or as reference in the completion of the staff assessment, were submitted by the licensee and docketed, as necessary, to complete the staff assessment. These documents are identified in Table 1.

AUDIT ACTIVITIES

In general, the audit activities consisted mainly of the following actions:

- Review background information on site topography and geographical characteristics of the watershed.

- Understand the selection of important assumptions and parameters that would be the basis for evaluating the individual flood causing mechanisms described in the 50.54(f) letter.

- Review model input/output files to computer analyses such as FLO-2D to have an understanding of how modeling assumptions were programmed and executed.

Table 1 summarizes specific technical topics (and resolution) of important items that were discussed and clarified during the audit. The items discussed in Table 1 may be referenced/mentioned in the staff assessment in more detail.

EXIT MEETING/BRIEFING

On April 29, 2016, the NRC staff closed out the discussion of the technical topics described above. The NRC staff requested that the licensee provide a revised local intense precipitation (LIP) analysis report and model input/output files on the docket for the NRC staff's use to develop the staff assessment, and place the revised LIP

calculation in the ERR for the NRC staff to reference. As of April 28, 2016, all requested documents relevant to this audit have been received on the docket.

Table 1: Oyster Creek Information Needs – Audit/Post-Audit Summary

INFO NEED	INFORMATION NEED DESCRIPTION	ACTION (POST-AUDIT)
1	**Consistency between Water Elevation Conversion Factors** Evaluation of the effects of flooding on water surface elevations at the Oyster Creek site is requested in the 50.54 letter. In the Oyster Creek FHRR, two conversions were used between NAVD88 and mean sea level (MSL): feet NAVD88 = feet MSL – 0.02 ft (in Enclosure 1) feet MSL = feet NAVD88 – 0.02 ft (in Enclosure 2) Examination of the National Oceanic and Atmospheric Administration (NOAA) Tide Benchmark page for the reference tide gage (Reference 9 of Enclosure 1) shows that the Enclosure 1 conversion is correct. The Enclosure 2 conversions are incorrect. In addition, the embedded reference to the NOAA benchmark webpage in Enclosure 2 does not work. The discrepancy between Enclosures 1 and 2 does not appear to affect the analysis of local intense precipitation (LIP), which used the correct conversion. It is requested that the licensee clarify the reported flood elevations in Enclosure 2 of the Oyster Creek FHRR.	In response to this information need request, the ERR file document was provided entitled, "OYS FHRR Audit IN Responses 8-14-15.pdf." The licensee confirmed that FHRR Enclosure 1 (the evaluation of flooding from LIP) used the correct conversion between elevations using the MSL and NAVD88 vertical datums. The licensee described the verification of the FHRR Enclosure 1 conversion using the National Geodetic Survey benchmark and the NOAA Orthometric Height Conversion tool. The licensee also confirmed during the August 18, 2015, audit that the elevation conversion factor used in FHRR Enclosure 2 is incorrect. The licensee stated in "OYS FHRR Audit IN Responses 8-14-15.pdf", that this would not have a significant impact on elevations reported in FHRR Enclosure 2. The NRC staff concluded that the information provided by the licensee in response to this information need request was sufficient.
2	**Local Intense Precipitation – Availability of Light Detection and Ranging (LiDAR) Data** Evaluation of the effects of flooding of LIP on water surface elevations at the Oyster Creek site is requested in the 50.54	In response to this information need request, the ERR file document entitled, "OYS FHRR Audit IN Responses 8-14-15.pdf," was provided. The licensee stated that 2-meter or 5-meter LiDAR data were available for the site, and that these data were not used in the LIP flooding analysis. The licensee clarified that the site

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	letter. Page 20 of the LIP Calculation Sheet ("10.0 Attachments") contains a caption for Figure A-01 of, "Existing ground surface elevations based on LiDAR data and site field survey." The text of the Oyster Creek FHRR states that photogrammetric data and a field survey were used to determine surface elevations. It is requested that the licensee clarify whether LiDAR data were available for the Oyster Creek site and if so, whether they were used. In either case, the NRC staff also requests that the licensee provide an estimate of the vertical error associated with the surface elevation data.	ground surface elevations used in the LIP flooding analysis were based on a combination of photogrammetric data obtained in 2004 and supplemental field survey data obtained in 2012. The licensee stated that the vertical error in the photogrammetry-based elevations was 0.17 ft, based on a comparison with the field survey data. The licensee confirmed that the Figure A-01 caption was in error and should read as follows: "Existing ground surface elevations based on photogrammetric and site field survey." The NRC staff noted that the referenced text in the LIP calculation package (ERR file entitled "LIP-121.6 OYS LIP Calculation Package-Rev 5_Final") was subsequently revised to read as follows: "Ground surface elevations in feet (NAVD88)." The NRC staff concluded that the information provided by the licensee in response to this information need request was sufficient.
3	**Local Intense Precipitation – Grid Resolution** Evaluation of the effects of flooding of LIP on water surface elevations at the Oyster Creek site is requested in the 50.54 letter. For the purposes of the LIP-based FLO-2D® analysis, the licensee reported that it relied on topographic data that possessed resolution level of 1 square foot and later averaged those data into a single elevation value corresponding to the 10 square foot grid cells that formed the basis of the FLO-2D® computational domain. It is requested that the licensee describe how the 1 square foot level-of-resolution topographic data were mathematically treated (averaged) to defined the elevations of the 10 square foot grid cells used in the FLO-2D®-based LIP model.	In response to this information need, the ERR file document entitled, "OYS FHRR Audit IN Responses 8-14-15.pdf," was submitted. The licensee clarified that the photogrammetric data provided 1-ft contours of the site topography from point measurements of elevation that were horizontally spaced 10- to 100-ft apart, and that the supplemental field survey data were used to capture local topographic grade variations as well as depressions (low points) in the site topography. During the August 18, 2015, audit, the licensee confirmed that the combined photogrammetric and field survey topographic point measurements were averaged when multiple points were co-located within a single 10ft-by-10ft FLO-2D model grid cell, and were interpolated to grid cells between topographic points. The licensee confirmed that the averaging/interpolation was completed as part of the FLO-2D® model development. The NRC staff concluded that the information provided by the licensee in response to this information need request was sufficient.

INFO NEED	INFORMATION NEED DESCRIPTION	ACTION (POST-AUDIT)
4	**Local Intense Precipitation – Treatment of Building Roofs** Evaluation of the effects of flooding of local intense precipitation on water surface elevations at the Oyster Creek site is requested in the 50.54 letter. For the purposes of the LIP analysis, the licensee relied on a FLO-2D® computer model. Buildings were represented in that model by width reduction factor (WRF) values of 1.0 and area reduction factor (ARF) values of 0.94. The WRF values of 1.0 prevent flow to/from building grid cells that would be adjacent to cells that would be used to simulate overland flow within the power block yard. The ARF values reduce by 94 percent the cell area available for water storage on the tops of buildings and other structures. Consistent with American Nuclear Society (ANS) 2.8 Section 11.4, the NRC staff expects that the roof drain contribution to surface runoff would be evaluated to determine a worst case for site surface drainage effects. It is requested that the licensee clarify how the FLO-2D® computer model described in the FHRR handles rainfall occurring on grid cells where the WRF and ARF parameters values were set to 1.0 and 0.94, respectively. It is also requested that the licensee describe how drainage associated with Oyster Creek facility roofs, as represented in FLO-2D® analyses, is consistent with the guidance found in American National Standards Institute (ANSI)/ANS-2.8-1992, Section 11.4.	In response to this information need, the ERR file document entitled, "OYS FHRR Audit IN Responses 8-14-15.pdf," was submitted. The licensee confirmed the use of WRF and ARF values as stated in the information need request description. The licensee stated that the ARF value of 0.94 was used to ensure that precipitation falling on roofs was not removed from the modelling domain. The licensee also stated that some precipitation was allowed to pond on the roofs due to the presence of parapet walls. The licensee noted the presence scuppers on the reactor, turbine building roof, and provided estimated flow rates through the scuppers for a 27-inch, 6-hour probable maximum precipitation event. The licensee stated that flow through the scupper drains would minimally affect the peak flood elevations on the site. During the August 18, 2015, audit, the licensee confirmed that the configuration of the FLO-2D® model used in the LIP flood analysis (described in FHRR Enclosure 1 and ERR file document entitled "LIP-121 OYS LIP Calculation Package-Rev 4") resulted in no drainage from building roofs to the ground surface adjacent to those buildings. The NRC staff determined that the information provided by the licensee regarding water flow off of building roofs was not consistent with ANSI/ANS-2.8 Section 11.4 standard for worst case effect on site drainage. The licensee's modeling resulted in all precipitation being stored on the roofs. Information provided by the licensee on roof design features indicated that the LIP event would result in some flow of water from the roofs to the ground surface. The licensee agreed to address this issue as part of a revision to the FHRR LIP analysis. Following the August 18, 2015, audit the licensee provided detailed drawings of the reactor building roof (within ERR file document entitled: "BR 4502, Sheet 1, Rev 001, REACTOR BLDG ROOF PLAN DETAILS WALL SECTIONS") as well as a ponding calculation on the reactor and turbine building roofs with

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		subsequent flow through the parapet wall scuppers (within ERR file document entitled: "C-1302-576-5320-001, Rev 0, 19841018, PONDING OF REACTOR BUILDING – TURBINE BUILDING ROOF LOADING ANALYSIS"). The NRC staff reviewed these documents. On October 16, 2015, the licensee submitted a revised LIP calculation (ERR file document entitled: "LIP-121.6 OYS LIP Calculation Package-Rev 5_Final") as well as a supplemental response to Information Need 4 on October 21, 2015, as a second ERR file document entitled: "OYS FHRR Audit IN Updated Responses 4 and 6 10-21-15." In its supplemental response, the licensee stated that the FLO-2D® model used in the LIP flood analysis had been revised to raise the elevation of grid cell locations corresponding to building locations to obviate the need to use ARFs. The licensee stated that building roofs were flat and set at 10 ft per story above the ground elevation, with the exception of the reactor and turbine buildings which were given sloped roofs. As a result of this modeling decision, the licensee stated that the revised LIP model now assumed that all runoff from the buildings was conveyed directly to the adjacent ground surface and took no credit for roof storage from parapet walls or runoff diversion from roof drainage systems. The licensee also provided to the NRC staff FLO-2D® model input files corresponding to the revised LIP flood analysis. The NRC staff reviewed the supplemental information and the revised LIP flood calculation provided on the ERR. The staff used the licensee-provided FLO-2D® model input files to confirm that the revised model did not use ARF values for the model grid cells representing building. The NRC staff confirmed that buildings were represented in the model as described in ERR file document entitled "LIP-121.6 OYS LIP Calculation Package-Rev 5_Final," with the exception that model grid elevations for cells corresponding to the turbine and reactor building locations

INFO NEED	INFORMATION NEED DESCRIPTION	ACTION (POST-AUDIT)
		appeared to now represent the building parapet walls on the east and west sides of those buildings. The NRC staff determined that building grid cell elevations were consistent with information in ERR files entitled "BR 4502, Sheet 1, Rev 001, REACTOR BLDG ROOF PLAN DETAILS WALL SECTIONS" and "C-1302-576-5320-001, Rev 0, 19841018, PONDING OF REACTOR BUILDING – TURBINE BUILDING ROOF LOADING ANALYSIS," and that flow off the north and south sides of the buildings would limit water storage on the roofs and provide conservative flood depths adjacent to the buildings. The NRC staff concluded that the supplemental information and revised LIP flood analysis provided by the licensee in response to this information need request was sufficient. However, the NRC staff issued follow-up question numbers 1a, 1b, and 2 (below) to obtain additional information about the revised LIP flood model.
5	**Local Intense Precipitation – Specification of Boundary Conditions** Evaluation of the effects of flooding of local intense precipitation on water surface elevations at the Oyster Creek site is requested in the 50.54 letter. For the purposes of the LIP analysis, the licensee relied on a FLO-2D® computer model. In the matter of how the boundary conditions in that model were treated, the licensee specified an outflow boundary condition for the entire periphery of the modeling domain, including the outer bank of the intake and discharge canal locations. When examining the discharge canals, for example, it would appear that they were modeled as an overland flow surface, since the licensee assigned Manning's n values to a water surface land cover type (Table 1 of the Oyster Creek FHRR Enclosure 1). The effect (and reasoning) of these modeling choices is unclear in the text of the Oyster Creek FHRR.	In response to this information need, the ERR file document entitled, "OYS FHRR Audit IN Responses 8-14-15.pdf," was submitted. The licensee stated that the photogrammetric survey coverage of the intake/discharge canals represents the side slopes and water surface of the canals at the time of the survey. The licensee confirmed that the intake/discharge canals were modeled as an overland flow surface. The licensee also stated that a Manning's n coefficient for a water surface was used for model grid cells representing the intake/discharge canal's bottom and a Manning's n coefficient for asphalt was used for model grid cells representing the side slopes. The licensee stated that any overflow from the discharge canals would be directed toward the outer boundaries of the modeling domain because the powerblock and switch yard areas represent topographic high ground within the modelling domain. The licensee stated that, because of this elevation difference, the modeling choices for the intake/discharge canals and model boundary would have no effect on the estimated LIP flood elevations.

INFO NEED	INFORMATION NEED DESCRIPTION	ACTION (POST-AUDIT)
	It is requested that the licensee describe the use of an outflow boundary around the entire model and for modeling the canals as an overland flow surface, and the possible effect of these modeling decisions on the estimated flood hazard elevation.	The NRC staff concluded that the information provided by the licensee in response to this information need request was sufficient.
6	**Changes to Power Block Site Lay-Out** Evaluation of the effects of flooding on water surface elevations at the Oyster Creek site is requested in the 50.54 letter. In connection with that evaluation, the 50.54 letter requests that the licensee describe any changes to the power block site that might influence current licensing basis flood water elevations. This would include but not be limited to changes to existing site topography (and grading) as well as modifications to the footprint of existing on-site structures or the addition of new site structures (such as vehicle barrier systems – vehicle barrier system (VBS) or other type temporary structures). It is requested that the licensee describe any changes to the site layout that have occurred since the last update to the Safety Analysis Report for the Oyster Creek site consistent with the 50.54 letter.	In response to this information need, the ERR file document entitled, "OYS FHRR Audit IN Responses 8-14-15.pdf," was submitted. The licensee described the photogrammetric and field surveys performed to obtain undated site elevations, and stated that site visits in 2012 verified the locations of buildings, security barriers, and other important site features. The licensee also stated that administrative procedures are in place to control changes to the site layout as well as the evaluation of those changes potentially to estimated flood elevations. During the August 18, 2015, audit, the licensee confirmed that the VBS present at the site was not included in the FLO-2D® LIP flood analysis model (described in FHRR Enclosure 1 and ERR file "LIP-121 OYS LIP Calculation Package-Rev 4"). The licensee stated that an engineering judgement was made initially that the VBS would either not affect the flood hazard, or that its inclusion in the LIP model would not be conservative because it would not allow flow from the east to cross the site. The NRC staff determined that the VBS should be evaluated for possible impacts to the estimated LIP flood hazard elevation. The licensee agreed to address this issue as part of a revision to the FHRR LIP analysis. The licensee provided on October 16, 2015, a revised LIP calculation in the ERR entitled "LIP-121.6 OYS LIP Calculation Package-Rev 5_Final," and a supplemental response to Information Need 6 on October 21, 2015, in the ERR file document entitled, "OYS FHRR Audit IN Updated Responses 4 and 6 10-21-15." In the supplemental responses, the licensee stated that the FLO-2D® LIP flood analysis model had been revised consistent with the NRC staff's earlier request. That revised model now

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		included four different sizes of security barriers ranging from 40 to 48 inches high, 32-inch high Jersey barriers, a landscaping area and rock wall near the Office Building, and a metal security barrier around the Diesel Generator Building (DGB). The licensee stated that these features, which could affect flow patterns during the LIP event, were identified during a September 11, 2015, walkdown of the site conducted in response to the NRC staff's information need request. In the supplemental information, the licensee provided a summary of LIP flood results and reported that the maximum water surface elevations at main door locations across the site had increased by up to 0.60 ft, but remained below the protection elevations at all doors other than Door #9 (of the Reactor Building). The licensee stated that the maximum flood elevation increased by 0.07 ft at Door #9. The licensee also provided to the NRC staff FLO-2D® model input/output (I/O) files corresponding to the revised LIP flood analysis. The NRC staff reviewed the supplemental information and the revised LIP flood calculation provided in the ERR. Using a satellite image of the site, the NRC staff determined that the security and landscaping features were properly located in the model. The NRC staff used the licensee-provided FLO-2D® model input files to confirm the LIP flood results reported in an ERR file document entitled "LIP-121.6 OYS LIP Calculation Package-Rev 5_Final." In reviewing the revised LIP analysis the NRC staff observed that the licensee had revised the DGB door sill elevations. In the ERR file document entitled "LIP-121 OYS LIP Calculation Package-Rev 4," the DGB door sill elevations reported were based on earlier information described in Updated Final Safety Analysis Report (UFSAR) Section 2.4.8. In the revised analysis provided in an ERR file document entitled "LIP-121.6 OYS LIP Calculation Package-Rev 5_Final," the DGB door sill elevations being reported were now based on a document entitled "Exelon Nuclear, Oyster Creek Nuclear Generating Station (2009), Drawing DRC 06-121-203, Rev 0, As-Built Survey Diesel Generator Building Security."

INFO NEED	INFORMATION NEED DESCRIPTION	ACTION (POST-AUDIT)
		The NRC staff noted this difference, but neither verified nor validated the revised DGB door sill elevations because this revision had no effect on the estimated flood water surface elevations. The NRC staff concluded that the supplemental information and revised LIP flood analysis provided by the licensee in response to this information need request was sufficient. However, the NRC staff did issue follow-up questions designated 1a, 1b, and 2 (below) in an effort to obtain additional information about the revised LIP flood model.
FOLLOW-UPS TO ORIGINAL INFORMATION NEED REQUESTS		
1a	**Revised LIP Flood Model, Flow around the Northeast Corner of the Reactor Building (Follow-up Question to Information Need Requests 4 and 6)** In response to earlier Information Needs Requests 4 and 6, the licensee revised its FLO-2D® LIP analysis. The figure shows detail from the licensee's updated grid for the FLO-2D® model construction in the vicinity of the reactor containment building. In connection with its review of the revised LIP analysis, the NRC staff observed that the north corner of the Reactor Building and a building believed to be the old rad waste storage appears to have been "joined" as part of the development of the FLO-2D® computational grid. The northeast corner of the Reactor Building is identified by the yellow circle in the figure. Reactor Building Door #9 is identified by the teal-colored square and was previously identified as location of LIP ingress. The NRC staff would like clarification as to whether these two structures are physically joined or whether there is an open passage way between the two structures that would permit the conveyance of LIP-generated surface water along the east face of the Reactor Building. The model results shown in	The licensee responded to this Information Need Request on December 15, 2015, in the ERR file document entitled, "OYS FHRR Responses to Staff Follow Questions 12-15-15." The licensee stated that the revised FLO-2D model described in a second ERR file document entitled "LIP-121.6 OYS LIP Calculation Package-Rev 5_Final," treated the area along the east side of the Reactor Building as obstructed to water flow. The licensee provided a figure of the buildings in this general area and stated that, although the Reactor and Old Radwaste Buildings do not connect, other structures exist between the two buildings that would constrict flow. Using the revised FLO-2D® model input files provided by the licensee in response to Information Need Requests 4 and 6, the NRC staff evaluated flow at the corner of the Reactor Building and determined that the licensee's initial response to this Information Need Required additional clarification. The NRC staff sent the licensee a request for clarification. In response to the NRC staff's request for clarification, on January 14, 2016, the licensee provided an updated response to this information request in an email to the NRC staff (ADAMS Accession No. ML16015A001) and discussed this updated

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	Appendix A of LIP-121.6 Rev. 5 suggest the absence of a flow path at this location by the absence of model results at building locations (see, for example, Figure A-05b on Sheet 29 of 49 in LIP-121.6). If the licensee chooses to treat this location as an obstruction for the purposes of modeling, the NRC staff believes it might possibly lead to a higher (more conservative) estimated flood elevation at Door #9 compared to modeling treatment as an unobstructed location. If the licensee proposes to treat this location as an obstruction, what is the LIP-related flood elevation at Door #9? The NRC staff seeks clarification as to how the licensee intends to treat this location for the purposes of modeling and ultimately Mitigating Strategies Flood Hazard Information reporting.	response with the NRC staff during a clarification telephone call. In the updated response, the licensee stated that when the FLO-2D® model was revised to remove ARF values, a gap (space) was inadvertently created between the Reactor and Old Radwaste Buildings allowing fluid flow between the two structures. The licensee stated that the FLO-2D® computer model was revised to fill this gap and prevent flow from passing between the structures. The licensee provided a table of revised flood depths and durations at the door locations, and stated that this revision of the LIP analysis increased the maximum flood depth at Door #9 by 0.36 ft, to a maximum water surface elevation of 24.37 ft MSL, which is 0.87 ft above the door sill elevation. The licensee stated that the revision increased the flooding duration at Door #9 by 0.58 hr, to a total duration of 1.52 hr. On January 22, 2016, the licensee provided a revised LIP flood calculation in the ERR file document entitled, "LIP-121_7 OYS LIP Calculation Package-Rev 6_Full Binder." The licensee's updated response and revised LIP calculation were reviewed by the NRC staff and it was determined that the revised LIP flood results were consistent with NRC staff's calculations using FLO-2D® model input files provided by the licensee in response to Information Need Requests 4 and 6. The NRC staff received supplemental information dated April 25, 2016, from the licensee. The supplemental information included a letter stating that responding to the NRC staff's information needs resulted in the addition of a reactor building door to the results of the LIP flood evaluation. Enclosure 1 of the licensee's letter was a revised LIP Evaluation Report (Rev. 8) that incorporated the licensee's responses to all of the NRC staff's information needs discussed in the audit. Enclosure 2 of the letter was a set of FLO-2D® model files for the calculations described in the revised LIP report. The NRC staff received the supplemental information on April 28, 2016. The NRC staff reviewed the revised report and

INFO NEED	INFORMATION NEED DESCRIPTION	ACTION (POST-AUDIT)
		used the licensee's model files to confirm the licensee's calculations of flood elevation and duration. The maximum flood elevation at the additional door in the Reactor Building (Door 14) was 24.38 ft MSL, 0.88 ft above the door sill elevation. Flooding duration at Door #14 was 1.41 hrs. The NRC staff concluded that the supplemental information and revised LIP flood analysis provided by the licensee in response to this information need request was sufficient.
1b	**Revised LIP Flood Model, Apparent Inconsistency in Flood Results (Follow-up Question to Information Need Requests 4 and 6)** As mentioned above, the updated FLO-2D® model construction appears to show the northeast corner of the DGB just touching the corner of the adjacent Old Radwaste Building located immediately to the northeast. In reference to that general area, Figures A-15f and A-15g in LIP-121.6, Rev. 5 do not appear to reflect the margins listed in Table 8-3 (also Table A of the updated audit response to information need requests 4 and 6, dated October 21, 2015). Margins are 0.00 ft at Door #12 and 0.04 ft at Door #13, but appear larger in the Appendix A figures. The NRC staff seeks clarification on what are the appropriate flood elevations to report based on the apparent inconsistency identified.	The licensee responded to this information need request on December 15, 2015, in an ERR file document entitled, "OYS FHRR Responses to Staff Follow Questions 12-15-15." The licensee stated that Table 8-3 of the ERR file document entitled "LIP-121.6 OYS LIP Calculation Package-Rev 5_Final" provides the correct maximum water surface elevations. The licensee stated that the maximum water surface elevations in the Appendix A figures referred to in the information need request may be lower because the figures were generated from FLO-2D® computer code results reported at 6-minute time steps, which may not coincide with the time of maximum water surface elevation. The NRC staff concluded that the information provided by the licensee in response to this information need request was sufficient.
2a	**Revised LIP Flood Model, Manning's n Sensitivity (Follow-up Question to Information Need Requests 4 and 6)** Upon review, the NRC staff found that the licensee apparently did not repeat the Manning's n sensitivity analysis using the updated FLO-2D® computer model. On Sheet 12 of 50 in LIP-121.6, it is stated that the sensitivity analysis performed on Manning's n values used a FLO-2D® model with buildings accounted for using ARF. However, ARFs were not used in the	The licensee responded to this information need request on December 15, 2015, in the ERR file document entitled, "OYS FHRR Responses to Staff Follow Questions 12-15-15." The licensee stated (in the ERR file document entitled "LIP-121 OYS LIP Calculation Package-Rev 4") that the sensitivity of the FLO-2D® LIP results to Manning's n values had been found to be small and that both eliminating the use of ARF values while adding the security and VBS features to the model would not affect the Manning's n sensitivity.

INFO NEED	INFORMATION NEED DESCRIPTION	ACTION (POST-AUDIT)
	updated model. The NRC staff seeks clarification concerning this ambiguity.	Using the revised FLO-2D® model input files provided by the licensee in response to Information Need Requests 4 and 6, the NRC staff evaluated the sensitivity to Manning's n value of the revised LIP model results, as described in the ERR file document entitled "LIP-121.6 OYS LIP Calculation Package-Rev 5_Final." The NRC staff determined that the revised model was not sensitive to the magnitude of the Manning's n value. The NRC staff concluded that the information provided by the licensee in response to this information need request was sufficient.

ATTACHMENT 1
Oyster Creek Audit Document List

1. Exelon, Calculation Number LIP-OYS-001: Oyster Creek Local Intense Precipitation Evaluation, Revision 4, 2013.

2. Exelon, Calculation Number LIP-OYS-001: Oyster Creek Local Intense Precipitation Evaluation, Revision 5, 2015.

3. Exelon, Calculation Number LIP-OYS-001: Oyster Creek Local Intense Precipitation Evaluation, Revision 6, 2016.

4. GPU Nuclear, Calculation Number 1302-576-5320-001: Ponding of Reactor Building and Turbine Building Roof Loading Analysis, Oyster Creek, Revision 0, 1984.

ATTACHMENT 2

List of Oyster Creek Audit Participants

Name	Organization
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2. Vinod Aggarwal	Exelon
3. Joseph Bellini	Exelon
4. David Distel	Exelon
5. George Wrobel	Exelon
6. John Traynor	Exelon
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8. Dan Brown	AREVA
9. David Leone	GZA GeoEnvironmental, Inc. (GZA)
10. Ken Hunu	GZA

If you have any questions, please contact me at (301) 415-6197 or by e-mail at Tekia.Govan@nrc.gov.

Sincerely,

/RA/

Tekia V. Govan, Project Manager
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Japan Lessons-Learned Division
Hazards Management Branch

Docket No. 50-219

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