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

October 27, 2015

Mr. Bryan Hanson
Senior Vice President
Exelon Generation Company, LLC
President and Chief Nuclear Office
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: CLINTON POWER STATION, UNIT NO.1 – STAFF ASSESSMENT OF RESPONSE TO REQUEST FOR INFORMATION PURSUANT TO10 CFR 50.54(f) – FLOOD-CAUSING MECHANISMS REEVALUATION (TAC NO. MF3654)

Dear Mr. Hanson:

The purpose of this letter is to transmit the U.S. Nuclear Regulatory Commission's (NRC's) staff assessment of the re-evaluated flood-causing mechanisms described in the March 12, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14079A415), flood hazard reevaluation report (FHRR) submitted by Exelon Generation Company, LLC (Exelon, the licensee) for Clinton Power Station, Unit No. 1 (Clinton).

By letter dated March 12, 2012, the NRC issued a request for information pursuant to Title 10 of the *Code of Federal Regulations*, Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The request was issued as part of implementing lessons-learned from the accident at the Fukushima Dai-ichi nuclear power plant. Enclosure 2 to the 50.54(f) letter requested licensees to reevaluate flood-causing mechanisms using present-day methodologies and guidance.

By letter dated September 3, 2015[1], the NRC staff transmitted to Exelon a summary of the staff's review of the licensee's reevaluated flood-causing mechanisms. The enclosed staff assessment provides the documentation supporting the NRC staff's conclusions summarized the letter[1]. As stated in the letter[1], because the reevaluted flood hazard mechanisms at Clinton are bounded by the current design-basis, it is unnecessary for the licensee to perform an integrated assessment or focused evaluation. Therefore, the NRC staff confirms that the licensee responded appropriately to Enclosure 2 of the 50.54(f) letter. This closes out the NRC's efforts associated with TAC No. MF3654.

---

[1] ADAMS Accession No. ML15230A012

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

Sincerely,

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

Docket No. 50-461

Enclosure:
Staff Assessment of Flood Hazard
Reevaluation Report

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO FLOODING HAZARD REEVALUATION REPORT

NEAR-TERM TASK FORCE RECOMMENDATION 2.1

RELATED TO THE FUKUSHIMA DAI-ICHI NUCLEAR POWER PLANT ACCIDENT

CLINTON POWER STATION, UNIT NO. 1

DOCKET NO. 50-461

1.0 INTRODUCTION

By letter dated March 12, 2012 (NRC, 2012a), 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 (NRC, 2011b).

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[2]. Subsequent Staff Requirements Memoranda associated with Commission Papers SECY-11-0124 (NRC, 2011c) and SECY-11-0137 (NRC, 2011d), directed the NRC staff to issue requests for information to licensees pursuant to 10 CFR 50.54(f).

Enclosure 2 to the 50.54(f) letter (NRC, 2012a) requested that licensees reevaluate flood hazards for their respective sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits (ESPs) and combined licenses (COLs). The required response section of enclosure 2 specified that NRC staff would provide a prioritization plan indicating Flooding Hazard Reevaluation Report (FHRR) deadlines for each plant. On May 11, 2012, the NRC staff issued its prioritization of the FHRRs (NRC, 2012c).

If the reevaluated hazard for any flood-causing mechanisms is not "bounded" by the plant's current design-basis (CDB) flood hazard, an additional assessment of plant response is necessary, as described in the 50.54(f) letter (NRC, 2012a) and COMSECY-15-0019, "Closure Plan for the Reevaluation of Flooding Hazards at Operating Nuclear Power Plants" (NRC, 2015b). The FHRR and the responses to the associated Requests for Additional Information (RAIs) provide the hazard input necessary to complete this additional assessment consistent with the process outlined in COMSECY-15-0019 (NRC, 2015b) and the associated guidance that will be subsequently issued.

---

[2] Issued as an enclosure to Commission Paper SECY-11-0093 (NRC, 2011a).

By letter dated March 12, 2014 (Gaston, 2014), Exelon Generation Company, LLC (Exelon, the licensee), provided its FHRR for Clinton Power Station (Clinton), Unit No. 1 (Exelon, 2014). The NRC staff issued RAIs to the licensee by emails dated June 18, 2014 (NRC, 2014a), and March 16, 2015 (NRC, 2015a). The licensee responded to the RAIs by letters dated July 14, 2014 (Kaegi, 2014), and by letter dated May 5, 2015 (Kaegi, 2015). The licensee did not identify any interim actions.

On September 3, 2015, the NRC issued an Interim Staff Response (ISR) letter to the licensee NRC, 2015c). The purpose of the ISR letter is to provide flood hazard information suitable for the assessment of mitigating strategies developed in response to Order EA-12-049 (NRC, 2012b). The ISR letter also made reference to this staff assessment (SA), which documents the NRC staff's basis and conclusions. The flood hazard mechanism values presented in the letter's enclosures match the values in this SA without change or alteration. The reevaluated flood hazard results for all flood-causing mechanisms for Clinton, Unit No.1, were bounded by their respective CDB flood hazard. Therefore, the NRC staff does not anticipate that the licensee will submit any additional assessment for any flood-causing mechanisms, as discussed in COMSECY-15-0019 (NRC, 2015b).

2.0 REGULATORY BACKGROUND

2.1 Applicable Regulatory Requirements

As stated above, Enclosure 2 to the 50.54(f) letter (NRC, 2012a) requested that licensees reevaluate flood hazards for their respective sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for ESPs and COLs. This section of the SA describes present-day regulatory requirements that are applicable to the FHRR.

Section 50.34(a)(1), (a)(3), (a)(4), (b)(1), (b)(2), and (b)(4), of 10 CFR, describes the required content of the preliminary and final safety analysis reports, including a discussion of the facility site with a particular emphasis on the site evaluation factors identified in 10 CFR Part 100. The licensee should provide any pertinent information identified or developed since the submittal of the preliminary safety analysis report in the final safety analysis report.

Section 50.54(f) of 10 CFR states that a licensee shall at any time before expiration of its license, upon request of the Commission, submit written statements, signed under oath or affirmation, to enable the Commission to determine whether or not the license should be modified, suspended, or revoked.

General Design Criterion 2 in Appendix A of Part 50 states that structures, systems, and components (SSCs) important to safety at nuclear power plants must be designed to withstand the effects of natural phenomena such as earthquakes, tornados, hurricanes, floods, tsunamis, and seiches without loss of capability to perform their intended safety functions. The design bases for these SSCs are to reflect appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area. The design bases are also to have sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

Section 50.2 of 10 CFR defines the design-basis as the information that identifies the specific functions that an SSC of a facility must perform, and the specific values or ranges of values chosen for controlling parameters as reference bounds for design which each licensee is required to develop and maintain. These values may be (a) restraints derived from generally accepted "state of the art" practices for achieving functional goals, or (b) requirements derived from an analysis (based on calculation, experiments, or both) of the effects of a postulated accident for which an SSC must meet its functional goals.

Section 54.3 of 10 CFR defines the "current licensing basis" (CLB) as: "the set of NRC requirements applicable to a specific plant and a licensee's written commitments for ensuring compliance with and operation within applicable NRC requirements and the plant-specific design basis (including all modifications and additions to such commitments over the life of the license) that are docketed and in effect." This includes 10 CFR Parts 2, 19, 20, 21, 26, 30, 40, 50, 51, 52, 54, 55, 70, 72, 73, 100 and appendices thereto; orders; license conditions; exemptions; and technical specifications as well as the plant-specific design-basis information as documented in the most recent final safety analysis report. The licensee's commitments made in docketed licensing correspondence, which remain in effect, are also considered part of the CLB.

Present-day regulations for reactor site criteria (Subpart B to 10 CFR Part 100 for applications on or after January 10, 1997), state, in part, that the physical characteristics of the site must be evaluated and site parameters established such that potential threats from such physical characteristics will pose no undue risk to the type of facility proposed to be located at the site. Factors to be considered when evaluating sites include the nature and proximity of dams and other man-related hazards (10 CFR 100.20(b)) and the physical characteristics of the site, including the hydrology (10 CFR 100.21(d)).

2.2 Enclosure 2 to the 50.54(f) Letter

The 50.54(f) letter requests all power reactor licensees and construction permit holders reevaluate all external flooding-causing mechanisms at each site (NRC, 2012a). This includes current techniques, software, and methods used in present-day standard engineering practice.

2.2.1 Flood-Causing Mechanisms

Attachment 1 to Recommendation 2.1, Flooding (Enclosure 2 of the 50.54(f) letter) discusses flood-causing mechanisms for the licensee to address in the FHRR (NRC, 2012a). Table 2.2-1 lists the flood-causing mechanisms the licensee should consider, and the corresponding Standard Review Plan (SRP) (NRC, 2007) section(s) and applicable interim staff guidance (ISG) documents containing acceptance criteria and review procedures. The licensee should incorporate and report associated effects per Japan Lessons-Learned Directorate (JLD) JLD-ISG-2012-05 (NRC, 2012d) in addition to the maximum water level associated with each flood-causing mechanism.

2.2.2 Associated Effects

In reevaluating the flood-causing mechanisms, the "flood height and associated effects" should be considered. The ISG for performing the Integrated Assessment for external flooding, JLD-ISG-2012-05 (NRC, 2012d), defines "flood height and associated effects" as the maximum stillwater surface elevation plus:

- wind waves and run-up effects
- hydrodynamic loading, including debris
- effects caused by sediment deposition and erosion
- concurrent site conditions, including adverse weather conditions
- groundwater ingress
- other pertinent factors

2.2.3 Combined Effects Flood

The worst flooding at a site that may result from a reasonable combination of individual flooding mechanisms is sometimes referred to as a "Combined Effects Flood." Even if some or all of these individual flood-causing mechanisms are less severe than their worst-case occurrence, their combination may still exceed the most severe flooding effects from the worst-case occurrence of any single mechanism described in the 50.54(f) letter (See SRP Section 2.4.2, Areas of Review (NRC, 2007)). Attachment 1 of the 50.54(f) letter describes the "Combined Effect Flood"[3] as defined in American National Standards Institute/American Nuclear Society (ANSI/ANS) 2.8-1992 (ANSI/ANS, 1992) as follows:

> *For flood hazard associated with combined events, American Nuclear Society (ANS) 2.8-1992 provides guidance for combination of flood causing mechanisms for flood hazard at nuclear power reactor sites. In addition to those listed in the ANS guidance, additional plausible combined events should be considered on a site specific basis and should be based on the impacts of other flood causing mechanisms and the location of the site.*

If two less severe mechanisms are plausibly combined per ANSI/ANS-2.8-1992 (ANSI/ANS, 1992), then the NRC staff will document and report the result as part of one of the hazard sections. An example of a situation where this may occur is flooding at a riverine site located where the river enters the ocean. For this site, storm surge and river flooding should be plausibly combined.

2.2.4 Flood Event Duration

Flood event duration was defined in the ISG for the Integrated Assessment for external flooding, JLD-ISG-2012-05 (NRC, 2012d), as the length of time during which the flood event affects the site. It begins when conditions are met for entry into a flood procedure, or with notification of an impending flood (e.g., a flood forecast or notification of dam failure), and includes preparation for the flood. It continues during the period of inundation, and ends when water recedes from

---

[3] For the purposes of this SA, the terms "combined effects" and "combined events" are synonyms.

the site and the plant reaches a safe and stable state that can be maintained indefinitely. Figure 2.2-1 illustrates flood event duration.

2.2.5 Actions Following the FHRR

For the sites where the reevaluated flood hazard is not bounded by the CDB flood hazard for any flood-causing mechanisms, the 50.54(f) letter (NRC, 2012a) requests licensees and construction permit holders to:

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

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

If the reevaluated flood hazard is bounded by the CDB flood hazard for all flood-causing mechanisms at the site, licensees are not required to perform an Integrated Assessment (NRC, 2012a).

COMSECY-15-0019 (NRC, 2015b) outlines a revised process for addressing cases in which the reevaluated flood hazard is not bounded by the plant's CDB. The revised process describes an approach in which licensees with local intense precipitation (LIP) hazards exceeding their CDB flood will not be required to complete an Integrated Assessment. These licensees will instead assess the impact of the LIP hazard on their sites and then evaluate and implement any necessary programmatic, procedural or plant modifications to address this hazard exceedance. In addition, for all mechanisms exceeding the CDB, licensees can assess the impact of the reevaluated hazard on their sites and confirm the capability of existing or proposed flood protection to address the hazard exceedance in lieu of performing a revised Integrated Assessment. Sites with flooding hazards other than LIP exceeding the design-basis flood and where the exceedance could not be addressed through existing or proposed flood protection will proceed to performing a revised Integrated Assessment.

3.0 TECHNICAL EVALUATION

The NRC staff reviewed the information provided for the flood hazard reevaluation of Clinton, Unit No. 1. The licensee conducted the hazard reevaluation using present-day methodologies and regulatory guidance used by the NRC staff in connection with ESP and COL reviews.

The NRC staff requested additional information from the licensee to supplement the FHRR and the licensee responded by letters dated July 14, 2014 (Kaegi, 2014), and May 5, 2015 (Kaegi, 2015). To provide additional information in support of the summaries and conclusions in the Clinton, Unit No. 1 FHRR, the licensee made several calculation packages available to the NRC staff via an electronic reading room. When the NRC staff relied directly on any of these calculation packages in its review, they or portions thereof were docketed. Certain other calculation packages were found only to expand upon and clarify the information provided on the docket, and so are not docketed or cited. The NRC staff's review and evaluation is provided below.

3.1 Site Information

The 50.54(f) letter (NRC, 2012a) included the SSCs important to safety (e.g. the Ultimate Heat Sink), in the scope of the hazard reevaluation, specifically enclosure 2 of the 50.54(f) letter describes site information to be contained in the FHRR. The licensee included this pertinent data concerning the SSCs in the FHRR (Exelon, 2014). The NRC staff reviewed and summarized this information in the sections below.

3.1.1 Detailed Site Information

The Clinton FHRR, described the site specific information related to the flood hazard reevaluation. All elevations in this SA are given with respect to the National Geodetic Vertical Datum 1929 (NGVD29). The FHRR references the mean sea level datum, which the licensee determined is the same as the NGVD29 datum. The following is a summary of the site specific information.

The Clinton site is located 6 miles (mi; 9.6 kilometers (km)) east of the city of Clinton (DeWitt County) in central Illinois. The site includes a cooling pond (Clinton Lake), which was formed by constructing an earth dam (Clinton Dam) across Salt Creek (Figure 3.1-1). The dam is approximately 1,200 feet (ft; 366 meters (m)) downstream from the confluence of Salt Creek with North Fork, and 3,300 ft (1,000 m) upstream from Illinois State Route 10. The Salt Creek and North Fork fingers of the U-shaped lake extend 14 mi and 8 mi (22.5 km and 12.9 km), respectively, upstream from the dam. The drainage area of the lake is 296 square miles (mi^2; 767 square kilometers (km^2)). The surface area of the lake is 7.65 mi^2 (20 km^2)) and the storage capacity is 74,200 acre-feet (91.5 million cubic meters) at a normal pool elevation of 690.0 ft (210.3 m) NGVD29. Clinton is located between the two fingers of the lake with a power block elevation (site grade) of 736.0 ft (224.3 m) and plant floor elevation of 737.0 ft (224.6 m) NGVD29 (Exelon, 2014) (Figure 3.1-2). Table 3.1-1 provides the summary of controlling reevaluated flood-causing mechanisms, including associated effects, the licensee computed to be higher than the powerblock elevation.

3.1.2 Design-Basis Flood Hazards

In its FHRR, the licensee discussed the CDB flood hazards for Clinton, which includes LIP, riverine flooding, upstream dam failure, probable maximum flooding (PMF) of cooling pond (wind-induced surge), and ice-induced flooding. The CDB flood elevations for LIP is 736.8 ft (224.6 m) NGVD29, and for PMF on the cooling pond is 713.8 ft (217.6 m) NGVD29. Riverine flooding, upstream dam failure, and ice-induced flooding were evaluated and determined to produce floods below the site grade of 736.0 ft (224.3 m) NGVD29 (Exelon, 2014), however detailed flood elevations were not provided in the design-basis. The CDB flood levels are summarized by flood-causing mechanism in Table 3.1-2.

3.1.3 Flood-Related Changes to the Licensing Basis

The licensee stated in its FHRR, that there are no flood related changes to the CLB.

3.1.4 Changes to the Watershed and Local Area

In its FHRR, the licensee discussed two watershed changes that could impact the flooding at the site. First, the licensee identified and analyzed four dams in the upstream watershed that were not analyzed under the CDB, which is described in more detail in section 3.3 of this SA. Second, the licensee reviewed aerial imagery and noted commercial development upstream of the site. The licensee analyzed the effect of the commercial development on riverine flooding, which is described in more detail in section 3.3. of this SA.

3.1.5 CLB Flood Protection and Pertinent Flood Mitigation Features

In its FHRR, the licensee stated that the Clinton site is a "dry site", meaning only the LIP flooding exceeds site grade. The CDB LIP flood elevation is 736.8 ft (224.6 m) NGVD29, which is below the station first floor elevation of 737.0 ft (224.6 m) NGVD29. The CDB provides flood protection of the circulating water screen house up to an elevation of 714.0 ft (217.6 m) NGVD29, which would protect the screen house from the CDB flood of 713.8 ft (217.6 m) NGVD29. The flood protection measures at the screen house include water stops, penetration seals, and watertight doors. The licensee stated that periodic inspections are performed during flood events through a roof hatch on the screen house.

3.1.6 Additional Site Details to Assess the Flood Hazard

The licensee submitted other site details, as either part of its FHRR submittal or in response to RAIs. These included electronic topographic information as an enclosure to the FHRR (Exelon, 2014) and electronic versions of hydrologic and hydraulic computer models (Kaegi, 2014).

3.1.7 Plant Walkdown Activities

The 50.54(f) letter[4] (NRC, 2012a) requested that licensees plan and perform plant walkdown activities to verify that current flood protection systems are available, functional, and implementable. Other parts of the 50.54(f) letter[5] asked the licensee to report any relevant information from the results of the plant walkdown activities (NRC, 2012a).
By letter dated November 27, 2012 (Kaegi, 2012), Exelon, provided the flood Walkdown Report for the Clinton site (Exelon, 2012). The Walkdown Report was supplemented by letter, including RAI responses, dated June 19, 2013 (Kaegi, 2013).

The NRC staff issued an SA on June 26, 2014 (NRC, 2014b), which documented its review of the Walkdown Report and concluded that the licensee's implementation of the flooding walkdown methodology met the intent of the walkdown guidance.

---

[4] Enclosure 4, Requested Actions, Item 1 and Enclosure 4, Requested Information, Item 2.

[5] Enclosure 2, Requested Information, Items 1.a.vi and 1.c; Enclosure 2, Attachment 1, Steps 1 and 6; Enclosure 4, Requested Actions, Item 5; Enclosure 4, Requested Information, Items 1.c and 2; and Enclosure 4, Required Response, Item 2.

3.2 LIP and Associated Site Drainage

The licensee started in its FHRR,, that the reevaluated flood hazard, including associated effects, for LIP and associated site drainage is water-surface elevation of 736.8 ft (224.6 m) NGVD29. This flood-causing mechanism is discussed in the licensee's CDB. The CDB probable maximum flood elevation for LIP and associated site drainage is based on a stillwater-surface elevation of 736.8 ft (224.6 m) NGVD29.

The licensee's analysis used a two-dimensional (2D) hydrodynamic model, FLO-2D, Build 2009.006 (FLO-2D, 2009), with the following parameters:

- the 1-hour (h) probable maximum precipitation (PMP) event;
- Site topography including grading, drainage divides, buildings, and other site drainage features;
- Manning's Roughness Coefficients (Manning's n-values) to characterize the land cover of the site.

In response to the NRC RAI (NRC, 2014a), the licensee submitted the FLO-2D model inputs and outputs (Kaegi, 2014). The FLO-2D model uses a grid input to represent the site topography. The licensee performed a sensitivity analysis of the grid size which optimized the grid spacing to reduce computing time without sacrificing precision and a grid size of 10-ft (3-m) by 10-ft (3-m) spacing was selected. The NRC staff performed sensitivity testing of the parameters and examined licensee's sensitivity of grid sizing. The NRC staff reviewed publically available aerial photography to verify that the licensee incorporated site features (e.g. buildings, observable drainage) appropriately. The NRC staff considers the parameters and grid size appropriate based on the sensitivity tests and examinations.

The licensee's analysis developed the 1-h, 1- mi^2 PMP event distribution using Hydrometerological Reports (HMRs) 51 and 52 (National Oceanic and Atmospheric Administration (NOAA), 1978 and 1982). The licensee stated that the LIP event is defined by NUREG/CR-7046 (NRC, 2011e) as the 1-h, 1-mi^2 PMP event. The licensee extrapolated from the PMP depth contour map provided in HMR 52. The licensee developed the distribution of the 1-h PMP from the 5-, 15-, 30- and 60-minute time intervals from HMR 52. The licensee computed a cumulative depth of the 1-h, 1- mi^2 PMP of 17.97 inches (45.28 centimeters). The NRC staff verified the HMR 51 and HMR 52 computations based on the location of the Clinton site, and concluded the PMP depths are appropriate.

Based on the NRC staff's reviews of FHRRs to date, the staff observed that, when using transient rainfall runoff models, PMP events having longer than 1-h durations may result in higher LIP flood elevations and longer periods of inundation than the 1-h event. The NRC staff also noted that LIP events deriving from PMPs having relatively short durations may result in limiting warning time and may likewise result in a consequential LIP flood elevation (e.g., flood elevations above the openings to plant structures).

The NRC staff requested in an RAI that the licensee evaluate the plant response time considering a range of precipitation durations associated with the LIP flood hazard (e.g., 1-, 6-, 12-, 24-, 48-, 72-h PMPs) (NRC, 2015a); the licensee responded to the RAI by letter dated May 5, 2015 (Kaegi, 2015). The licensee determined that the 1-h duration precipitation event results in the highest LIP flood elevation. The licensee also stated that warning time and flood duration are not an issue due to the permanent/passive flood protection features used for LIP. The NRC staff reviewed the licensee's response, and concurred that the 1-h flood elevation is the most conservative, and that permanent/passive features make warning time a non-issue.

The NRC staff confirmed the licensee's conclusion that the reevaluated flood hazard for LIP and associated site drainage is bounded by the CDB flood hazard. Therefore, the NRC staff does not expect that the licensee will submit a focused evaluation or a revised integrated assessment consistent with the process and guidance discussed in COMSECY-15-0019 (NRC, 2015b).

3.3 Streams and Rivers

The licensee stated in its FHRR, that the reevaluated flood hazard, including associated effects, for streams and rivers is based on a stillwater-surface elevation of 708.0 ft (215.8 m) NGVD29. This flood-causing mechanism is discussed in the licensee's CDB, however in a limited scope. The license stated this mechanism is bounded by the probable maximum surge on the cooling pond (Clinton Lake).

The licensee described an error/uncertainty in Section 3.9 of its FHRR, but stated that existing conservatism in the riverine PMF calculation are sufficient to bound uncertainties in the inputs. The NRC staff reviewed the uncertainties and compared the values to the riverine flooding elevations versus site grade. The NRC staff concluded that the uncertainties would not cause the flooding to exceed site grade. Therefore, the NRC staff concurred with the licensee's analysis.

The licensee used the following software in the riverine flooding analysis. The NRC staff considers all three of them to be suitable software packages for such analyses.

- U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC)-Hydrologic Modeling System (HMS) (USACE, 2010b) was the primary software used to analyze riverine flooding.

- USACE HEC-River Analysis System (RAS) (USACE, 2010a) was used to estimate the backwater elevation rise between the Clinton site and the Clinton Dam.

- Wind-wave height and wave runup were analyzed using Coastal Engineering and Design Analysis System-Automated Coastal Engineering System Version 4.03, distributed by Veri-Tech, Inc., as authorized by USACE (Veri-Tech, 2006).

The NRC staff reviewed the 2006 Safety Evaluation Report (SER) for the Exelon site ESP application, as documented in NUREG-1844 (NRC, 2006). The Exelon ESP site is adjacent to Clinton, Unit No. 1. The grade of the Exelon ESP site was 735.0 ft (224.0 m) NGVD29 (NRC, 2006). In its FHRR, the licensee provided building grade floors for all Clinton, Unit No.1 safety-related buildings (except the Circulating Water Screen House) of 737.0 ft (224.6 m) NGVD29. Water-surface elevations at structures other than the nuclear island were not within the scope of the NRC staff's review of the FHRR discussed herein. In the Exelon ESP SER (NRC, 2006), the NRC staff determined that the grade of the ESP site was above the elevation attained by the PMF (with coincident wind waves). In the Exelon ESP SER, the NRC staff independently evaluated PMF water-surface elevations using a variety of assumptions. Even using implausible conservative assumptions (e.g., no time delay between precipitation landing on the watershed and entering the lake, no infiltration losses), the NRC staff was unable to estimate a water-surface elevation in excess of 712.2 ft (217.1 m) NGVD29. While NUREG/CR-7046 (NRC, 2011e) was not published at the time of the Exelon ESP SER analysis, HMRs 51 and 52 (NOAA, 1978, 1982) were used as the basis of the NRC staff's review.

In accordance with guidance in ANSI/ANS-2.8-1992 (ANSI/ANS, 1992) (explicitly incorporated in Regulatory Guide 1.59) and in NUREG/CR-7046 (NRC, 2011e), the licensee considered three alternative river and stream flooding events. The licensee determined that the all-season PMP with no snowmelt runoff produces the greatest runoff (Exelon, 2014). In its FHRR, the licensee estimated the all-season PMP following the standard methods described in HMR 51 and HMR 52. The NRC staff reviewed the analyses of the runoff-generating events and determined that they were performed consistent with guidance and current standard practice. The NRC staff agreed with the licensee's determination that the all-season PMP with no snow melt produces the maximum runoff.

In its FHRR, the licensee analyzed the hydrologic routing for the runoff using the HEC-HMS software. The Clinton Dam service spillway and auxiliary spillway were the downstream controls of the level-pool analysis using HEC-HMS (Exelon, 2014). The licensee relied on information from the Illinois Institute of Natural Resources to develop preliminary synthetic unit hydrographs (Singh, 1981), which the NRC staff reviewed and found acceptable. These initial unit hydrographs were calibrated using observed records and then modified per NUREG/CR-7046 for nonlinear hydrologic responses for events significantly larger than the calibration events (e.g., PMP). The FHRR states that the maximum level-pool elevation was 707.9 ft (215.8 m) NGVD29. The NRC staff reviewed the HEC-HMS analyses and determined that they were consistent with current guidance.

Because the hydrologic routing was done with a level-pool assumption for Clinton Lake, the licensee performed a backwater calculation with HEC-RAS to estimate the increase in the water-surface elevation between the dam and the Clinton Unit 1 location (Exelon, 2014). Cross sections of segments of Salt Creek, Salt Creek upstream of Clinton Dam, and Salt Creek downstream of Clinton Dam were derived from digital data and simulated using the results of the prior HEC-HMS analysis. In its FHRR, the licensee stated that the backwater increase was 0.1 ft (0.03 m). Combined with the level-pool elevation from the HEC-HMS analysis, the maximum stillwater elevation was 708.0 ft (215.8 m) NGVD29 at the Clinton site. In its FHRR, the licensee discussed the wind waves and wave runup in Section 3.5, Combined Events. The NRC staff reviewed the assumptions and methods used and determined they were consistent with current guidance.

The NRC staff confirmed the licensee's conclusion that the reevaluated hazard for flooding from streams and rivers is bounded by the CDB flood hazard. Therefore, the NRC staff does not expect that the licensee will submit a focused evaluation or a revised integrated assessment consistent with the process and guidance discussed in COMSECY-15-0019 (NRC, 2015b).

3.4 Failure of Dams and Onsite Water Control/Storage Structures

The licensee reported in its FHRR, that the reevaluated flood hazard, including associated effects, for failure of dams and onsite water control or storage structures results in a stillwater-surface elevation of 708.5 ft (216 m) NGVD29, including wind waves and runup results in an elevation of 710.9 ft (216.7 m) NGVD29. This flood-causing mechanism is discussed in the licensee's CDB. The CDB states that no upstream dams exist, therefore no flood hazard exist from any upstream dam failure.

In accordance with JLD-ISG-2013-01 (NRC, 2013b), the licensee applied the Volume Method (complete and instantaneous displacement of the combined volumes of the upstream reservoirs) to compute the rise in Clinton Lake due to failure of upstream dams within the Clinton Lake drainage area. The licensee conservatively assumed the area of Clinton Lake remains constant above 708.0 ft (215.8 m) NGVD29 and estimated a 0.5 ft (0.15 m) rise using the Volume Method (Exelon, 2014).

The NRC staff reviewed the Clinton SER for the Exelon ESP application, as documented in NUREG-1844 (NRC, 2006). In the Exelon ESP SER, the NRC staff determined that the grade of the ESP site is well above the elevation attained by the PMF combined with complete and instantaneous displacement of the combined volumes of the upstream reservoirs into Clinton Lake. In the Exelon ESP SER, the NRC staff independently estimated a 3.1 ft (0.94 m) rise. The differences in the assumed upstream reservoir volumes between the Exelon ESP SER and the FHRR were insignificant. The discrepancy is the result of the fact that in the Exelon ESP SER the NRC staff assumed a base elevation of 690 ft (210.3 m) (NRC, 2006), whereas in the reevaluation the licensee assumed a base elevation of 708.0 ft (215.8 m) (consistent with the PMF) (Exelon, 2014). The higher base elevation resulted in a larger surface area and hence a smaller rise. The NRC staff concluded that the licensee's dam failure flood reevaluation was performed consistent with present-day guidance and methodology.

The NRC staff confirmed the licensee's conclusion that the reevaluated flood hazard for failure of dams and onsite water control or storage structures is bounded by the CDB flood hazard. Therefore, the NRC staff does not expect that the licensee will submit a focused evaluation or a revised integrated assessment consistent with the process and guidance discussed in COMSECY-15-0019 (NRC, 2015b).

3.5 Cooling Pond Surge

The licensee reported in its FHRR , that the reevaluated flood hazard, including associated effects, for cooling pond (Clinton Lake) surge results in a stillwater-surface elevation of 701.2 ft (213.7 m) NGVD29. The licensee also analyzed wind waves and runup resulting in an elevation of 713.3 ft (217.4 m) NGVD29. This flood-causing mechanism is discussed in the licensee's CDB. The maximum water-surface elevation from storm surge is bounded by a PMF stillwater-surface elevation of 708.9 ft (216.1 m) NGVD29, including wind waves and runup results in an elevation of less than 713.8 ft (217.6 m) NGVD29.

In its FHRR, the licensee calculated the largest surge of 1.7 ft (0.52 m) and the maximum wave height of 5.87 ft (1.79 m) based on Delft3D model results in accordance with NRC guidance for performing surge hazard assessments (NRC, 2013a). These values were consistent with the wind direction with the longest fetch to the site. The NRC staff reviewed the input and output files of the licensee's Delft3D model and determined the model had been properly implemented.

The NRC staff reviewed the SER for the Exelon ESP application, as documented in NUREG-1844 (NRC, 2006). In the Exelon ESP SER the NRC staff independently evaluated surge and determined that the grade of the ESP site is well above the elevation attained by the PMF combined with surge.

The NRC staff confirmed the licensee's conclusion that the reevaluated hazard for flooding from storm surge is bounded by the CDB flood hazard. Therefore, the NRC staff does not expect that the licensee will submit a focused evaluation or a revised integrated assessment consistent with the process and guidance discussed in COMSECY-15-0019 (NRC, 2015b).

3.6 Cooling Pond Seiche

The licensee reported in its FHRR, that the reevaluated flood hazard, including associated effects, for seiche is 708.5 ft (216 m) NGVD29, including wind waves and runup results in an elevation of 712.0 ft (217 m) NGVD29. This flood-causing mechanism is not discussed in the licensee's CDB.

The licensee used Fast Fourier Transform on the observed historical wind data and stated that an application of Delft3D to Clinton Lake showed no observable seiche-like oscillations (Exelon, 2014). This determination is consistent with the NRC staff's expectation that seiche phenomena either from meteorological or seismic phenomena are unlikely on Clinton Lake because of the difference in resonant frequencies. The NRC staff reviewed the input and output files of the licensee's Delft3D model and determined the model had been properly implemented.

The NRC staff reviewed the Clinton SER for the Exelon ESP application, as documented in NUREG-1844 (NRC, 2006). In the Exelon ESP SER, the NRC staff independently evaluated seiche and determined that the grade of the ESP site is well above the elevation attained by the PMF combined with seiche.

The NRC staff confirmed the licensee's conclusion that the reevaluated hazard for flooding from seiche is bounded by the CDB flood hazard. Therefore, the NRC staff does not expect that the licensee will submit a focused evaluation or a revised integrated assessment consistent with the process and guidance discussed in COMSECY-15-0019 (NRC, 2015b).

3.7 Tsunami

The licensee reported in its FHRR, that the reevaluated hazard, including associated effects, for tsunami does not inundate the plant site. This flood-causing mechanism is discussed in the licensee's CDB, but was considered not plausible due to the inland location of Clinton, Unit 1, which does not connect directly with any bodies of water capable of producing a tsunami.
The NRC staff examined the location of the Clinton site and determined that the Clinton site exists approximately 125 mi (201 km) from Lake Michigan, the closest tsunami producing body of water. The NRC staff agrees that flooding as a result of tsunami would not be a mechanism of concern for the site.

The NRC staff confirmed the licensee's conclusion that the reevaluated hazard for flooding from tsunami is bounded by the CDB. Therefore, the NRC staff does not expect that the licensee will submit a focused evaluation or a revised integrated assessment consistent with the process and guidance discussed in COMSECY-15-0019 (NRC, 2015b).

3.8 Ice-Induced Flooding

The licensee reported in its FHRR,that the reevaluated flood hazard, including associated effects, for ice-induced flooding from an upstream flood wave produced by a collapse of an ice jam results in an elevation of 704.0 ft (214.6 m) NGVD29, and ice-induced flooding from a downstream ice jam results in an elevation of 702.4 ft (214.1 m) NGVD29. Wind waves were not analyzed for either ice-induced flooding mechanism. This flood-causing mechanism is discussed in the licensee's CDB. The CDB discusses historical ice-induced flooding which is bounded by the probable maximum surge on the cooling pond (Clinton Lake).

According to the FHRR, the licensee used the USACE National Ice Jam Database (USACE, 2012) to determine the most severe historical ice flooding events for both a downstream ice jam and an upstream ice collapse with resulting wave. The peak elevation of the historic ice jam flooding was assumed to represent the full height of the ice jam relative to the normal water surface elevation at the recorded location (Exelon, 2014).

The maximum downstream ice jam on the Clinton Dam was determined to block the service spillway entirely, with a coincident 100-year flood discharge at the dam (Exelon, 2014). The NRC staff reviewed the analysis, including the USACE National Ice Jam Database (USACE, 2012) and determined that the analysis was consistent with present-day methodologies.

For upstream flooding produced by a collapse of an upstream ice jam with a resulting wave, the licensee used the 100-year flood elevation and translated to the Clinton site without attenuation the maximum flood wave from an ice-jam collapse (Exelon, 2014). The NRC staff reviewed the analysis and concluded the analysis was reasonable and appropriate for an upstream ice jam collapse induced wave.

The NRC staff confirmed the licensee's conclusion that the reevaluated hazard from flooding from ice-induced flooding is not bounded by the CDB flood hazard. However, the NRC staff also confirmed the licensee's conclusion that the flood hazard from ice-induced flooding alone would not inundate the site. Therefore, the NRC staff deemed that ice-induced flooding does not need to be analyzed in a focused evaluation or a revised integrated assessment consistent with the process and guidance discussed in COMSECY-15-0019 (NRC, 2015b).

3.9 Channel Migrations or Diversions

The licensee reported in its FHRR, that the reevaluated hazard, including associated effects, for channel migrations or diversions is bounded by other flood causing mechanisms. The licensee provided historical topographic discussions of the historical channel diversions of the North Fork channel adjacent to the Clinton site. In addition, the licensee discussed the potential for local landslides, which could influence channel migration. The licensee determined that available historical information suggested that no significant migrations or diversions have occurred, and therefore the changes to the channels would not significantly increase water surface elevations at the site. The NRC staff reviewed the information provided and concluded that it was reasonable based on the available historical data.

The NRC staff confirmed the licensee's conclusion that the reevaluated hazard from flooding from channel migrations or diversions is not bounded by the CDB flood hazard. However, the NRC staff also confirmed the licensee's conclusion that the flood hazard from channel migrations or diversions alone would not inundate the site. Therefore, the NRC staff deemed that channel migrations or diversions do not need to be analyzed in in a focused evaluation or a revised integrated assessment consistent with the process and guidance discussed in COMSECY-15-0019 (NRC, 2015b).

4.0 REEVALUATED FLOOD HEIGHT, EVENT DURATION AND ASSOCAITED EFFECTS FOR HAZARDS NOT BOUNDED BY THE CBD

The NRC staff confirmed that the reevaluated hazard results for all reevaluated hazard mechanisms are bounded by the CDB flood hazard. Therefore, the NRC staff concludes that the licensee will not need to submit any additional assessment (including reevaluated flood heights, event durations, and associated effects) as discussed in COMSECY-15-0019 (NRC, 2015b) for any flood-causing mechanisms.

5.0 CONCLUSION

The NRC staff has reviewed the information provided for the reevaluated flood-causing mechanisms of Clinton, Unit 1. Based on its review, the NRC staff concludes that the licensee conducted the hazard reevaluation using present-day methodologies and regulatory guidance used by the NRC staff in connection with ESP and COL reviews.

Based upon the preceding analysis, the NRC staff confirmed that the licensee responded appropriately to Enclosure 2, of the 50.54(f) letter, dated March 12, 2012. In reaching this determination, the NRC staff confirmed the licensee's conclusions that (a) the reevaluated hazard results for each reevaluated flood-causing mechanism are bounded by the CDB flood hazard, and (b) an integrated assessment or focused evaluation as outlined in COMSECY-15-0019 (NRC, 2015b) are not necessary. The NRC staff has no additional information needs at this time with respect to FHRR.

REFERENCES

Notes: (1) ADAMS Accession Nos. refers to documents available through NRC's Agencywide Documents Access and Management System (ADAMS). Publicly-available ADAMS documents may be accessed through http://www.nrc.gov/reading-rm/adams.html. (2) "n.d." indicates no date is available or relevant, for example for sources that are updated by parts. "n.d.-a", "n.d.-b" indicate multiple undated references from the same source.

U.S. Nuclear Regulatory Commission Documents and Publications

NRC (U. S. Nuclear Regulatory Commission), 2006, NUREG-1844 "Safety Evaluation Report for an Early Site Permit (ESP) at the Exelon Generation Company, LLC (EGC) ESP Site," NUREG-1844, May 2006, ADAMS Accession No. ML061210203.

NRC (U.S. Nuclear Regulatory Commission), 2007, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition", NUREG-0800, 2007. ADAMS stores the Standard Review Plan as multiple ADAMS documents, which are accessed through NRC's public web site at http://www.nrc.gov/reading-rm/basic-ref/srp-review-standards.html.

NRC (U.S. Nuclear Regulatory Commission), 2011a, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," Commission Paper SECY-11-0093, July 12, 2011, ADAMS Accession No. ML11186A950.

NRC (U.S. Nuclear Regulatory Commission), 2011b, "Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident," Enclosure to Commission Paper SECY-11-0093, July 12, 2011, ADAMS Accession No. ML111861807.

NRC (U.S. Nuclear Regulatory Commission), 2011c, "Recommended Actions to be Taken Without Delay from the Near-Term Task Force Report," Commission Paper SECY-11-0124, September 9, 2011, ADAMS Accession No. ML11245A158.

NRC (U.S. Nuclear Regulatory Commission), 2011d, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned," Commission Paper SECY-11-0137, October 3, 2011, ADAMS Accession No. ML11272A111.

NRC (U.S. Nuclear Regulatory Commission), 2011e, "Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United State of America," NUREG/CR-7046, November 2011, ADAMS Accession No. ML11321A195.

NRC (U.S. Nuclear Regulatory Commission), 2012a, letter from Eric J. Leeds, Director, Office of Nuclear Reactor Regulation and Michael R. Johnson, Director, Office of New Reactors, to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, "Request for Information Pursuant to Title 10 of the *Code of Federal Regulations* 50.54(f) Regarding the Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident", March 12, 2012, ADAMS Accession No. ML12056A046.

NRC (U.S. Nuclear Regulatory Commission), 2012b, letter from Eric J. Leeds, Director, Office of Nuclear Reactor Regulation and Michael R. Johnson, Director, Office of New Reactors, to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events", March 12, 2012, ADAMS Accession No. ML12054A736.

NRC (U.S. Nuclear Regulatory Commission), 2012c, letter from Eric J. Leeds, Director, Office of Nuclear Reactor Regulation, to All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status, "Prioritization of Response Due Dates for Request for Information Pursuant to Title 10 of the *Code of Federal Regulations* 50.54(f) Regarding Flooding Hazard Reevaluations for Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident", May 11, 2012, ADAMS Accession No. ML12097A510.

NRC (U.S. Nuclear Regulatory Commission), 2012d, "Guidance for Performing the Integrated Assessment for External Flooding," Japan Lessons-Learned Project Directorate, Interim Staff Guidance JLD-ISG-2012-05, Revision 0, November 30, 2012, ADAMS Accession No. ML12311A214.

NRC (U.S. Nuclear Regulatory Commission), 2013a, "Guidance for Performing a Tsunami, Surge, or Seiche Hazard Assessment," Japan Lessons-Learned Project Directorate, Interim Staff Guidance JLD-ISG-2012-06, Revision 0, January 4, 2013, (2013a), ADAMS Accession No. ML12314A412.

NRC (U.S. Nuclear Regulatory Commission), 2013b, "Guidance For Assessment of Flooding Hazards Due to Dam Failure," Japan Lessons-Learned Project Directorate, Interim Staff Guidance JLD-ISG-2013-01, Revision 0, July 29, 2013, ADAMS Accession No. ML13151A153.

NRC, (U.S. Nuclear Regulatory Commission). 2014a. "2014/6/18 NRR E-mail Capture – RAIs for Braidwood, Byron, Clinton and LaSalle Flood Hazard Reevaluation," June 18, 2014. ADAMS Accession No. ML14169A545.

NRC (U.S. Nuclear Regulatory Commission), 2014b, "Clinton Power Station, Unit 1 - Staff Assessment of the Flooding Walkdown Report Supporting Implementation of Near-Term Task Force Recommendation 2.3 Related to the Fukushima Dai-Ichi Nuclear Power Plant Accident (TAC NO. MF0212)," Japan Lessons-Learned Project Directorate, June 26, 2014, ADAMS Accession No. ML14164A298.

NRC, (U.S. Nuclear Regulatory Commission), 2015a, "2015/3/16 NRR E-mail Capture – Request for Additional Information: Clinton Flooding Hazard Reevaluation Report (TAC No. MF3654)," March 16, 2015, ADAMS Accession No. ML15093A311.

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

NRC (U.S. Nuclear Regulatory Commission), 2015c,"Clinton Nuclear Generating Station, Unit No. 1 - Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation." September 3, 2015. ADAMS Accession No. ML15230A012.

Codes and Standards

ANSI/ANS (American National Standards Institute/American Nuclear Society), 1992, ANSI/ANS-2.8-1992, "Determining Design Basis Flooding at Power Reactor Sites," American Nuclear Society, LaGrange Park, IL, July 1992.

Other References

Exelon, 2012, ""Flooding Walkdown Report in Response to the 50.54(f) Information Request Regarding Near-Term Task Force Recommendation 2.3: Flooding for Clinton Power Station", Revision 1, November 27, 2012, (Attachment to Letter Kaegi, 2012) ADAMS Accession No. ML12332A304.

Exelon, 2014, "Flood Hazard Reevaluation Report in Response to the 50.54(f) Information Request Regarding Near-Term Task Force Recommendation 2.1: Flooding for the Clinton Power Station", Revision 0, February 25, 2014, (Enclosure to Letter Gaston, 2014) ADAMS Accession No. ML14079A420.

FLO-2D Software Inc., 2009, FLO-2D® V. 2009 Reference Manual, FLO-2D Software, Inc., Nutrioso, Arizona FLO-2D, 2009, Build 2009.06, FLO-2D Software, Inc..

Gaston, Ronald W., 2014, "Exelon Generation Company, LLC Response to March 12, 2012, Request for Information Enclosure 2, Recommendation 2.1, Flooding, Required Response 2, Flood Hazard Reevaluation Report (FHRR)", Exelon Nuclear Generation Company, LLC, March 12, 2014, ADAMS Accession No. ML14079A419.

Google, n.d., "Google Maps" (Web site), https://www.google.com/maps, accessed September 28, 2015.

Kaegi, Glen T., 2012, "Clinton Power Station, Unit 1, Exelon Generation Company, LLC's 180-day Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Flooding Aspects of Recommendation 2.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," Exelon Generation Company, LLC, November 27, 2012, ADAMS Accession No. ML12332A304.

Kaegi, Glen T., 2013, "Supplemental Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Flooding Aspects of Recommendation 2.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident", Exelon Nuclear Generation Company, LLC, June 19, 2014, ADAMS Accession No. ML13171A273.

Kaegi, Glen T., 2014, "Response to Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report", Exelon Nuclear Generation Company, LLC, July 14, 2014, ADAMS Accession No. ML14293A599.

Kaegi, Glen T., 2015, "Response to Request for Additional Information Regarding Fukushima Lessons Learned – Flood Hazard Reevaluation Report", Exelon Nuclear Generation Company, LLC, May 5, 2015, ADAMS Accession No. ML15133A163.

NOAA (National Oceanic and Atmospheric Administration), 1978, "Probable Maximum Precipitation Estimates, United States, East of the 105th Meridian," NOAA Hydrometeorological Report No. 51, June 1978.

NOAA (National Oceanic and Atmospheric Administration), 1982, "Application of Probable Maximum Precipitation Estimates, United States, East of the 105th Meridian," NOAA Hydrometeorological Report No. 52, August 1982.

Singh, K. P., 1981, "Derivation and Regionalization of Unit Hydrograph Parameters for Illinois (Dam Safety Program)", Illinois Institute of Natural Resources, SWS Contract Report 258, 1981.
USACE (U.S. Army Corps of Engineers), 1994, "Engineering and Design - Flood Runoff Analysis," Engineer Manual EM 1110-2-1417, August 1994.

Veri-Tech, Incorporated, 2006, "Coastal Engineering Design and Analysis System – Automated Coastal Engineering System, Version 4.03," Veri-Tech for Hydrologic Engineering Center, U.S. Army Corps of Engineers, http://www.veritechinc.com/products/cedas/index.php, date updated September 27, 2006, date accessed January 22, 2015.

USACE (U.S. Army Corps of Engineers), 2010a, "River Analysis System (HEC-RAS), Version 4.1.0," Hydrologic Engineering Center, U.S. Army Corps of Engineers, January 2010 (2010a).

USACE (U.S. Army Corps of Engineers), 2010b, "Hydrologic Modeling System (HEC-HMS), Version 3.5.0," Hydrologic Engineering Center, U.S. Army Corps of Engineer, August 2010 (2010b).

USACE (U.S. Army Corps of Engineers), 2012, "Ice Jam Database", U.S. Army Corps of Engineers, Cold Region Research and Engineering Laboratory (CRREL), available at: http://icejams.crrel.usace.army.mil/, accessed October 8, 2014.

Veri-Tech, Incorporated, 2006, "Coastal Engineering Design and Analysis System – Automated Coastal Engineering System, Version 4.03," Veri-Tech for Hydrologic Engineering Center, U.S. Army Corps of Engineers, http://www.veritechinc.com/products/cedas/index.php, date updated September 27, 2006, date accessed January 22, 2015.

Table 2.2-1. Flood-Causing Mechanisms and Corresponding Guidance

Flood-Causing Mechanism	SRP Section(s) and JLD-ISG
Local Intense Precipitation and Associated Drainage	SRP 2.4.2 SRP 2.4.3
Streams and Rivers	SRP 2.4.2 SRP 2.4.3
Failure of Dams and Onsite Water Control/Storage Structures	SRP 2.4.4 JLD-ISG-2013-01
Storm Surge	SRP 2.4.5 JLD-ISG-2012-06
Seiche	SRP 2.4.5 JLD-ISG-2012-06
Tsunami	SRP 2.4.6 JLD-ISG-2012-06
Ice-Induced	SRP 2.4.7
Channel Migrations or Diversions	SRP 2.4.9

Note: SRP is the Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition (NRC, 2007)

JLD-ISG-2012-06 is the "Guidance for Performing a Tsunami, Surge, or Seiche Hazard Assessment" (NRC, 2013a)

JLD-ISFG-2013-01 is the "Guidance for Assessment of Flooding Hazards Due to Dam Failure" (NRC, 2013b)

Table 3.1-1. Summary of Controlling Flood-Causing Mechanisms

Reevaluated Flood-Causing Mechanisms and Associated Effects that May Exceed the Powerblock Elevation (736.0 ft (224.3 m) NGVD29)[1]	ELEVATION (NGVD29)
Local Intense Precipitation and Associated Drainage	736.8 ft (224.6 m)

Source: Exelon, 2014

[1]Flood Height and Associated Effects as defined in JLD-ISG-2012-05.

Table 3.1-2. Current Design-Basis Flood Hazards

Flooding Mechanism	Stillwater Level (NGVD29)[1]	Associated Effects	Flood Level[2] NGVD29	Section in FHRR[3] or Other Reference
Local Intense Precipitation and Associated Drainage	736.8 ft (224.6 m)	N/A	736.8 ft (224.6 m)	FHRR 2.2.1 and FHRR Table 4.0.2
Streams and Rivers	Only discusses flow in CDB[4]. Less than site grade.	Not Discussed in CDB	Bounded by CDB	FHRR 2.2.2
Failure of Dams and Onsite Water Control/Storage Structures	Upstream dams and onsite cooling pond failures would produce flood wave below site grade.	Not Discussed in CDB	Bounded by CDB	FHRR 2.2.3
Probably Maximum Flood on Cooling Pond	708.9 ft (216.1 m)	4.9 ft (1.5 m)	713.8 ft (217.6 m)	FHRR 2.2.4
Storm Surge	Considered N/A for site.	N/A[5]	Considered not applicable for site.	FHRR 2.2.5
Seiche	Considered N/A for site.	N/A	Considered not applicable for site.	FHRR 2.2.5
Tsunami	Considered N/A for site.	N/A	Considered not applicable for site.	FHRR 2.2.6
Ice-Induced	No value but less than site grade.	N/A	Bounded by CDB.	FHRR 2.2.7
Channel Migrations or Diversions	Considered unlikely at site.	N/A	Considered unlikely at site.	FHRR 2.2.8

Source: Exelon, 2014
[1] Elevations are provided in feet (ft) and meters (m)
[2] Site grade at elevation 736.0 ft (224.3 m) NGVD29.
[3] FHRR = Flooding Hazard Reevaluation Report
[4] CDB = Current Design Basis

[5] N/A = Not Applicable

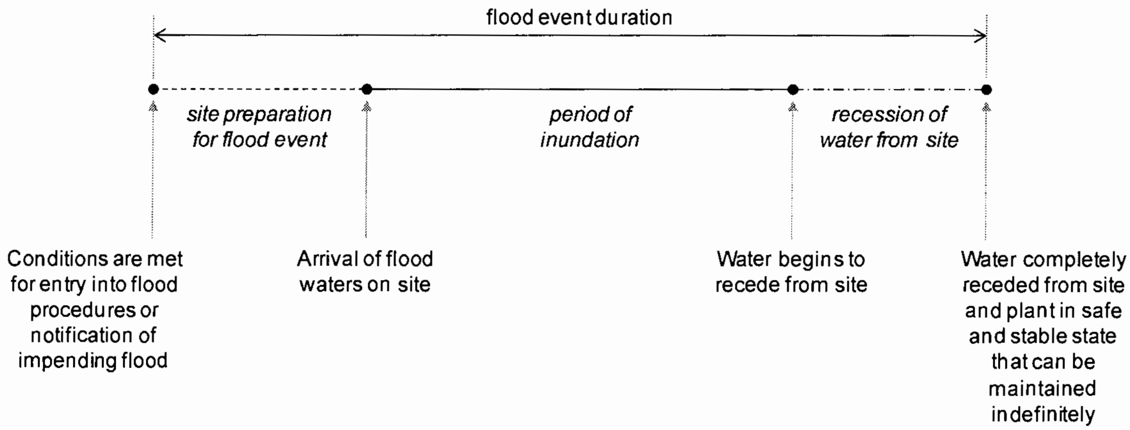

Figure 2.2-1 Flood Event Duration

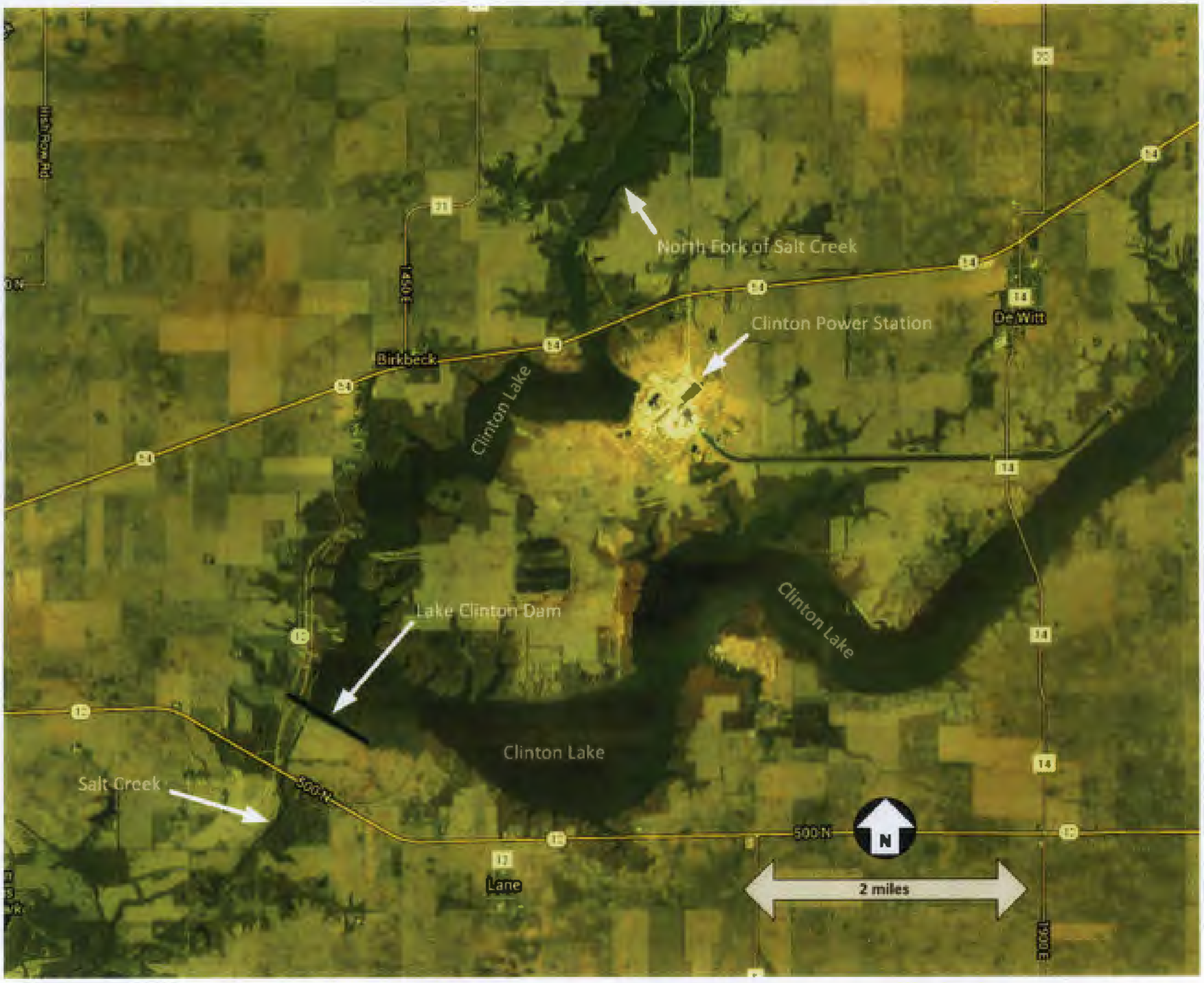

Figure 3.1-1 Clinton Power Station Location and Surrounding Hydrologic Features (Base map from Google Maps (Google, n.d.) and locations of map features from Exelon (2014))

Figure 3.1-2 Clinton Power Station Site Layout (derived from Exelon, 2014)

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

Sincerely,

/RA/

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

Docket No. 50-461

Enclosure:
Staff Assessment of Flood Hazard Reevaluation Report

cc w/encl: Distribution via Listserv

DISTRIBUTION:
PUBLIC
TGovan, NRR
RidsNrrDorlLpl3-2 Resource
RidsRgn3MailCenter Resource
RidsOpaMail Resource
JThompson, NRO
ARivera-Varona, NRO
LQuinn-Willingham, NRO
JLD R/F
MWillingham, NRO
RidsNrrDorl Resource
RidsNrrLASLent
RidsAcrsAcnw_MailCtr Resource
RRivera-Lugo, NRO
KErwin, NRO
RidsNroDsea Resource
RidsNRRJLD Resource
MShams, NRR
RidsNrrPMClinton Resource
RidsOgcMailCenter Resource
PChaput, NRO
CCook, NRO
ACampbell, NRO

ADAMS Accession No.: ML15279A134 ***via email**

OFFICE	NRR/JLD/JHMB/PM	NRR/JLD/LA	NRO/DSEA/RHM1/BC*
NAME	TGovan	SLent	ARivera-Varona
DATE	10/08/15	10/08/15	9/30/15
OFFICE	NRR/JLD/JHMB/BC	NRR/JLD/JHMB/PM	
NAME	MShams	TGovan	
DATE	10/24/15	10/27/15	

OFFICIAL RECORD COPY