



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

November 1, 2016

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

**SUBJECT: BRAIDWOOD STATION, UNITS 1 AND 2 – FLOOD HAZARD EVALUATION OF  
LIMITED INTEGRATED ASSESSMENT (CAC NOS. MF3895 AND MF3896)**

Dear Mr. Hanson:

The purpose of this letter is to provide the U.S. Nuclear Regulatory Commission's (NRC's) evaluation of the limited integrated assessment, as described in the March 12, 2014, flood hazard reevaluation report (FHRR) (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14079A418), submitted by Exelon Generation Company, LLC (Exelon, the licensee) for Braidwood Station, Units 1 and 2 (Braidwood). The NRC staff reviewed the information provided in the FHRR and determined that sufficient information was provided to be responsive to Enclosure 2 of the Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f), "Conditions of Licenses" letter (hereafter referred to as the "50.54(f) letter"). The NRC staff concludes that the licensee will not need to submit an integrated assessment or focused evaluation for any of the flooding hazards as described in the "Closure Plan for the Reevaluation of Flooding Hazards for Operating Nuclear Power Plants" (COMSECY-15-0019). This closes out the NRC's efforts associated with CAC Nos. MF3895 and MF3896.

**BACKGROUND**

By letter dated March 12, 2012 (ADAMS Accession No. ML12053A340), the NRC issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to 10 CFR 50.54(f). The request was issued in connection with implementing lessons-learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant.

Enclosure 2 of the 50.54(f) letter requested that licensees reevaluate flood hazards for their respective sites using present-day methods and regulatory guidance used by the NRC staff when reviewing applications for early site permits and combined licenses. If the reevaluated hazard for any flood-causing mechanism is not "bounded" by the plant's current design-basis (CDB) flood hazard, an additional assessment of plant response would be necessary.

Specifically, the 50.54(f) letter addresses the situation in which an integrated assessment (IA) should be provided and described the information that the IA should contain. According to the NRC guidance, an IA is required for plants where the CDB floods do not bound the reevaluated hazard for all flood causing mechanisms. The NRC provided guidance for performing an IA in Japan Lessons-Learned Project Directorate (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-05, "Guidance for Performing the Integrated Assessment for External Flooding," dated November 30, 2012 (ADAMS Accession No. ML12311A214).

On December 3, 2012, the NRC issued a letter providing additional clarification regarding trigger conditions for performing an IA (ADAMS Accession No. ML12326A912). Often referred to as the "trigger letter," this document identifies four IA approach scenarios that are possible based on the results of the flood hazard reevaluation. The four possible scenarios are:

- Scenario 1 - Reevaluated flood hazard bounded by design basis;
- Scenario 2 - only local intense precipitation (LIP) hazard unbounded;
- Scenario 3 - all permanent and passive flood protection effective for unbounded hazards; and
- Scenario 4 - integrated assessment required.

As described in the trigger letter, an IA is not necessary for Scenario 1. A limited IA that only addresses specific sections of the ISG is required under Scenarios 2 and 3, in which case a limited IA could be submitted with the FHRR. If Scenarios 1 through 3 do not apply, then per Scenario 4, a full IA would be submitted.

The results of the flood hazard reevaluation for Braidwood indicate that the reevaluated flooding hazard is not bounded by the CDB flood for all applicable flood-causing mechanisms. However, since all flood protection features for Braidwood are permanent and passive, Scenario 3 can be used to satisfy the IA requirements in Enclosure 2 of the 50.54(f) letter. Per the trigger letter, under Scenario 3 a licensee needs to demonstrate that all flood protection is permanently installed and passive, as defined in the JLD-ISG-2012-05. A licensee may show that the existing protection is reliable and has margin under reevaluated flood hazard conditions. This limited IA could be performed using Section 6 of the JLD-ISG-2012-05, including appropriate considerations described in Appendix A to the JLD-ISG-2012-05 and present-day codes and standards.

As documented in the interim staff response letter issued by the NRC staff to the licensee, dated September 3, 2015 (ADAMS Accession No. ML15230A523), the reevaluated stream and rivers flood hazard for Braidwood is not bounded by the CDB. As such, the NRC staff has reviewed the portion of the Braidwood FHRR that contains the limited IA for stream and rivers, and documented its evaluation by verifying that the site contains permanent and passive flood protection for this hazard mechanism.

#### LIMITED INTEGRATED ASSESSMENT EVALUATION

The licensee stated that the Braidwood FHRR was developed and the site flood hazard was assessed consistent with the guidance in JLD-ISG-2012-05 and that all flood protection is permanently installed and passive.

The licensee's limited IA was performed using guidance from NUREG/CR-7046, "Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United States of America," Appendix H, Section H.1, "Floods Caused by Precipitation Events," for the following flood hazard events that are not bound by the CDB:

- Combined-effect flood (with hydrologic dam failure) for the Mazon River
- Combined-effect flood for the cooling pond

Using Section H.1 of NUREG/CR-7046 as guidance for the assessment of the Mazon River (with hydrologic dam failure) flood hazard, the limited IA indicated that the maximum stillwater elevation and maximum wind-wave runup elevation are not bounded. The licensee explained that site topography is the only flood protection feature (system) associated with this hazard. The NRC staff noted that the site topography protects safety-related structures, systems, and components (SSCs) to an elevation of 600-ft mean sea level (MSL) and provides 3.49 feet (ft) of reliable, available margin above the bounding water elevation of 596.51-ft MSL.

The licensee identified and assessed two potential failure modes (groundwater ingress and settlement) and determined they were not credible. Per the Braidwood updated final safety analysis report (UFSAR) (ADAMS Accession No. ML14363A393), the design of safety-related plant structures and all subsurface and foundations are designed to withstand full hydrostatic loads from groundwater assumed to be at plant grade. Additionally, the natural soil strata between the Mazon River and the plant and a slurry trench would restrict potential seepage into the main plant area from flooding. Furthermore, the Braidwood UFSAR indicates that the predicted settlement of the plant is considered negligible and that settlement has stabilized. The licensee discussed the conservatism in its hydrologic analysis for the Mazon River and indicated that the available margin exceeds established criteria for uncertainties in the hydraulic model used to estimate flood level (Title 44 of the CFR, Section 65.10, related to accreditation of levee systems in the National Flood Insurance Program).

Based on the site topography and the design at Braidwood site (e.g., slurry trench and safety-related plant structures), including the reliable and available margin used in the hydraulic model to estimate the flood level above the reevaluated hazard, the NRC staff finds the licensee has adequately assessed the reevaluated flood hazard for the Mazon River (with hydrologic dam failure) in its limited IA consistent with Section 6 of JLD-ISG- 2012-05.

Using Section H.1 of NUREG/CR-7046 as guidance for the assessment of the cooling pond flood hazard, the maximum stillwater elevation was determined not to be bounded by the CDB flood. The flood protection features (systems) associated with this hazard include the following: site topography, grading, and slurry trench; northern dike system; and protection against ingress through the essential service water discharge and circulating water discharge pipe and pumping systems.

The licensee explained that site topography provides a natural barrier that protects safety-related SSCs to an elevation of 600-ft MSL compared to the reevaluated maximum stillwater elevation of 599.36 ft MSL. Furthermore, the design of the cooling pond includes a slurry trench that limits seepage from the cooling pond and reduces the potential for groundwater ingress. The NRC staff noted that even with the higher stillwater elevation, per the Braidwood UFSAR, the design of safety-related plant structures and all subsurface and foundations were designed to withstand full hydrostatic loads from groundwater assumed to be at plant grade.

The licensee explained that the northern dike system (top elevation of 602.5-ft MSL) provides 3.14 feet and 0.35 foot of margin above the stillwater and wind-wave runup elevations, respectively. The licensee assessed the potential failure modes of the northern dike system (e.g., dike sloughing and erosion from wind waves) and determined that through slope design and construction, slope armoring, and a quarterly and annual monitoring and inspection program, the northern dike system is reliable and provides adequate margin above the reevaluated hazard.

The licensee also explained that the safety-related classification of the essential service water discharge and circulating water discharge pipe and pumping systems provide adequate flood protection reliability and margin against potential flood water infiltration through these pipes and pumping systems given the insignificant increase in pressure (0.52 per square inch) created by the reevaluated stillwater elevation.

Based on the Braidwood flood protection features discussed above and the design of the plant, including the reliable and available margin above the reevaluated hazard, the NRC staff finds the licensee has adequately assessed the reevaluated flood hazard for the cooling pond in its limited IA, consistent with Section 6 of JLD-ISG- 2012-05.

#### CONCLUSION

Based on the information provided in the Braidwood FHRR for the limited IA, the NRC staff confirmed that the licensee responded appropriately to Enclosure 2, Required Response 2, of the 50.54(f) letter. In reaching this determination, NRC staff confirmed the licensee's conclusions that Braidwood has adequate protection, reliability, and margin against potential flood water infiltration. 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 early site permit and combined operating license reviews.

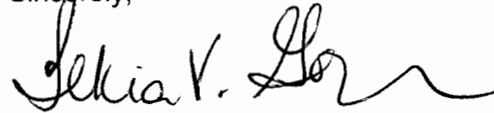
B. Hanson

- 5 -

The NRC staff has no additional information needs at this time with respect to the Exelon's 50.54(f) response for Braidwood.

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

Sincerely,

A handwritten signature in black ink, appearing to read "Tekia V. Govan", with a stylized flourish at the end.

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

Docket Nos.: 50-456 and 50-457

cc: Distribution via Listserv

B. Hanson

- 5 -

The NRC staff has no additional information needs at this time with respect to the Exelon's 50.54(f) response for Braidwood.

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

Sincerely,

**/RA/**

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

Docket Nos.: 50-456 and 50-457

cc: Distribution via Listserv

**DISTRIBUTION:**

**PUBLIC**

RidsNrrDorlpl3-2 Resource  
RidsRgn3MailCenter Resource  
RidsOpaMail Resource

TGovan, NRR  
MShams, NRR  
ARivera-Varona, NRO

**JLD R/F**

RidsNrrDorl Resource  
RidsNrrLaSLent Resource  
RidsAcraAcnw\_MailCtr  
Resource

OYee, NRR  
SBailey, NRR

RidsNRRJLD Resource  
RidsNrrPMClinton Resource  
RidsOgcMailCenter Resource  
RidsNroDsea Resource

CCook, NRO  
JQuichocho, NRR

**ADAMS Accession No.: ML16265A214**

**\*via email**

OFFICE	NRR/JLD/JHMB/PM	NRR/JLD/LA	NRR/JLD/JCBB	NRR/JLD/JCBB/BC
NAME	TGovan	SLent	OYee	JQuichocho
DATE	9/21/2016		9/27/2016	9/28/2016
OFFICE	NRR/JLD/JHMB/BC(A)	OGC *	NRR/JLD/JHMB/PM	
NAME	GBowman	NLO	TGovan	
DATE	10/18/2016	10/28/2016	11/1/2016	

**OFFICIAL RECORD COPY**