



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

February 6, 2017

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: LIMERICK GENERATING STATION, UNITS 1 AND 2 – STAFF REVIEW OF
HIGH FREQUENCY CONFIRMATION ASSOCIATED WITH REEVALUATED
SEISMIC HAZARD IMPLEMENTING NEAR-TERM TASK FORCE
RECOMMENDATION 2.1**

Dear Mr. Hanson:

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information pursuant to Title 10 of the *Code of Federal Regulations* Part 50, Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The request was issued as part of implementing lessons learned from the accident at the Fukushima Dai-ichi nuclear power plant.

Enclosure 1 to the 50.54(f) letter requested that licensees reevaluate seismic hazards at their sites using present-day methodologies and guidance. Enclosure 1, Item 4, of the 50.54(f) letter stated that "if the GMRS [ground motion response spectrum] exceeds the SSE [safe shutdown earthquake] only at higher frequencies information related to the functionality of high frequency sensitive SSCs [structures, systems, and components] is requested." The NRC-endorsed guidance for performing these high frequency confirmations is found in Section 3.4 of Electric Power Research Institute (EPRI) Report 1025287, "Seismic Evaluation Guidance" (ADAMS Accession No. ML12333A170), with further guidance provided in EPRI Report 3002004396, "High Frequency Program: Application Guidance for Functional Confirmation and Fragility Evaluation" (ADAMS Accession No. ML15223A102).

By letter dated November 28, 2016 (ADAMS Accession No. ML16333A084), Exelon Generation Company, LLC (the licensee), provided its high frequency report in response to Enclosure 1, Item 4 of the 50.54(f) letter, for Limerick Generating Station, Units 1 and 2 (Limerick). The NRC staff assessed the licensee's implementation of the high frequency guidance through the completion of the enclosed reviewer checklist. Based on its review of the high frequency confirmation report, the NRC staff concludes that the licensee appropriately implemented the high frequency confirmation guidance and identified and evaluated the high frequency seismic capacity of certain key installed plant equipment to ensure critical functions will be maintained following a seismic event up to the GMRS described in the Seismic Hazard and Screening

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responded appropriately to Enclosure 1, Item 4 of the 50.54(f) letter. Application of this review is limited to the high frequency confirmation as part of the 50.54(f) letter.

CLOSURE OF PHASE TWO EVALUATION

As noted in an NRC letter dated October 27, 2015 (ADAMS Accession No. ML15194A015), Limerick screened in to perform only the high frequency limited-scope evaluation. Based on the completion of the high frequency confirmation, the NRC staff concludes that no further response or regulatory action for the seismic reevaluation associated with the 50.54(f) letter is required for Limerick. Therefore, this letter closes out the NRC's efforts associated with Phases 1 and 2 of the seismic reevaluation portion of the 50.54(f) letter.

If you have any questions, please contact me at (301) 415-3041 or via e-mail at Stephen.Wyman@nrc.gov.

Sincerely,

A handwritten signature in black ink, appearing to be 'S. Wyman', with a long horizontal stroke extending to the right.

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

Docket Nos. 50-352 and 50-353

Enclosure:
Technical Review Checklist

cc w/encl: Distribution via Listserv

TECHNICAL REVIEW CHECKLIST
BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO HIGH FREQUENCY CONFIRMATION
IMPLEMENTING NEAR-TERM TASK FORCE RECOMMENDATION 2.1 SEISMIC
LIMERICK GENERATING STATION, UNITS 1 AND 2
DOCKET NOS. 50-352 AND 353

By letter dated March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), 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) (hereafter referred to as the 50.54(f) letter). Enclosure 1 of the 50.54(f) letter requests addressees to reevaluate the seismic hazard at their site using present-day methods and guidance for licensing new nuclear power plants. Item 4 in Enclosure 1 to the 50.54(f) letter requests addressees to provide information related to high frequency sensitive structures, systems, and components (SSCs) for plants whose ground motion response spectra (GMRS) exceeds the safe shutdown earthquake (SSE) only at higher frequencies.

Additionally, by letter dated July 30, 2015 (ADAMS Accession No. ML15223A095), the Nuclear Energy Institute (NEI) submitted Electric Power Research Institute (EPRI) report EPRI 3002004396, "High Frequency Program: Application Guidance for Functional Confirmation and Fragility Evaluation" (hereafter referred to as the high frequency (HF) guidance). The HF guidance proposes methods for applying HF seismic testing results to support plant-specific analyses of potential HF effects. Specific guidance is given for plants performing a limited-scope high HF confirmation to address the information requested in Item 4 in Enclosure 1 of the 50.54(f) letter. The limited-scope HF confirmation is a simplified seismic capacity evaluation focusing on the potential impacts of HF motion on key plant functions following a seismic event. By letter dated September 17, 2015 (ADAMS Accession No. ML15218A569), the NRC staff endorsed the HF guidance. Licensees with a reevaluated seismic hazard exceeding the SSE above 10 Hertz (Hz) and not performing a seismic probabilistic risk assessment were to submit a HF confirmation report in accordance with the schedule in an NRC letter dated October 27, 2015 (ADAMS Accession No. ML15194A015).

By letter dated November 28, 2016 (ADAMS Accession No. ML16333A084), Exelon Generation Company, LLC (the licensee), provided its HF report in response to Enclosure 1, Item 4 of the 50.54(f) letter, for Limerick Generating Station, Units 1 and 2 (Limerick). The NRC staff assessed the licensee's implementation of the HF guidance through the completion of a reviewer checklist, which is provided below, and confirmed that the licensee's HF confirmation met the guidance. The application of this staff review is limited to the HF confirmation as part of the 50.54(f) letter.

Enclosure

I. Component Selection (EPRI 3002004396 Section 4.2)

<p>The objective of the HF confirmation is to determine if the high frequency ground motion resulting from a seismic event could impact key plant safety functions that are critical following a plant trip/scram. Section 2 of the guidance summarizes EPRI's research on the impact of HF seismic activity which concludes that bi-stables (relays) in seal-in or lock-out (SILO) circuits could impact plant response. Component selection should identify any SILO-related relays that could directly impact critical functions following a trip. Licensees should provide sufficient description to clarify the potential impact in each of five major areas that encompass plant response: reactor (Rx) trip/scram, Rx vessel inventory control, Rx vessel pressure control, core cooling and alternating current/direct current (ac/dc) power systems.</p> <p>The licensee provided adequate description of the function with reasonable justification to support component selection in each of the following five functional areas:</p> <ul style="list-style-type: none"> • Rx trip/scram • Rx vessel inventory control • Rx vessel pressure control • core cooling • ac/dc power systems <p>The licensee identified-SILO related circuits within the equipment scope.</p> <p>The licensee identified the applicable contact configurations for SILO related circuits</p> <p>The licensee identified the locations of components (i.e., buildings and cabinets)</p>	<p>Yes / No / NA</p> <p>Yes / No / NA</p> <p>Yes / No / NA</p> <p>Yes / No / NA</p> <p>Yes / No / NA</p> <p>Yes / No / NA</p> <p>Yes / No / NA</p> <p>Yes / No / NA</p>
<p>Notes from staff reviewer: Licensee identified 528 components for confirmation.</p>	

Deviation(s) or deficiency(ies) and Resolution: None	
The NRC staff concludes: <ul style="list-style-type: none">• The licensee's definition of the equipment list meets the HF guidance.	Yes / No

II. Horizontal Seismic Demand (EPRI 3002004396 Sections 3.2 and 3.3)

For each equipment location, the licensee: <ul style="list-style-type: none">• used the GMRS from the Seismic Hazard and Screening Report (SHSR).• developed a FIRS.• provided justification for not providing FIRS.	Yes / No Yes / No Yes / No / NA
Notes from staff reviewer: Licensee noted that applicable locations founded on rock and GMRS at control point is representative. Deviation(s) or deficiency(ies) and Resolution: None.	
The NRC staff concludes: <ul style="list-style-type: none">• The licensee's definition of the horizontal seismic demand is acceptable for use in the HF confirmation.	Yes / No

III. Component Horizontal Seismic Demand (EPRI 3002004396 Sections 4.3, 4.4, and 4.5)

For each component location, the licensee must apply amplification factors to the peak horizontal GMRS between 15 Hz and 40 Hz to determine the horizontal demand for each component. The structural amplification factor (AF) is given by Figure 4-3 in the guidance based on height above foundation. The cabinet AF is based on cabinet construction per EPRI NP-7148.	
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<p>The licensee:</p> <ul style="list-style-type: none"> • identified the peak horizontal acceleration. • used structural amplification factors based on height above foundation from Figure 4-3 in the HF guidance (Section 4.3.2). • provided justification for selection of low, medium or high cabinet amplification factor based on cabinet construction consistent with EPRI NP-7148. • Estimated the conservative deterministic failure margin mounting point demand in accordance with Section 4.5.1 	<p>Yes / No</p> <p>Yes / No</p> <p>Yes / No</p> <p>Yes / No</p>
<p>Notes from staff reviewer: None.</p> <p>Deviation(s) or deficiency(ies) and Resolution: None</p>	
<p>The NRC staff concludes:</p> <ul style="list-style-type: none"> • The licensee's development of component horizontal demand for the items on the equipment list met the HF guidance. 	<p>Yes / No</p>

IV. Vertical Ground Motion Response Spectrum (EPRI 3002004396 Section 3.2)

<p>The HF guidance Section 3.2 describes the method for developing the vertical GMRS (VGMRS) from the horizontal GMRS and site soil conditions.</p> <p>The licensee:</p> <ul style="list-style-type: none"> • used the horizontal GMRS and soil mean shear wave velocity vs. depth profile as given in the SHSR. • calculated the 30m shear wave velocity (Vs30) per the methodology in Section 3.5 of the HF guidance. • selected soil class from Table 3-1 in the HF guidance based on PGA and Vs30. 	
<p>Yes / No</p> <p>Yes / No</p> <p>Yes / No</p>	

<ul style="list-style-type: none"> used correct V/H ratios from Table 3-2 in the HF guidance based on soil class. 	Yes / No
<ul style="list-style-type: none"> provided a table and plot of the VGMRS. 	Yes / No
<p>Notes from staff reviewer: The licensee identified soil class B-hard. The staff notes that page 18 of the submittal states the V/H ratio value for B-Hard at 20 Hz is a typographical error. The correct value should be 0.68. The staff confirmed in Table 3-2 of the submittal that the vertical calculation was carried out correctly using a 0.68 value for 20 Hz.</p> <p>Deviation(s) or deficiency(ies) and Resolution: None</p>	
<p>The NRC staff concludes:</p> <ul style="list-style-type: none"> The licensee followed the HF guidance in calculating VGMRS for use in HF confirmation. 	Yes / No

V. Component Vertical Seismic Demand (EPRI 3002004396 Sections 4.3 and 4.4)

<p>For each component location, the licensee must apply amplification factors to the peak vertical GMRS between 15 Hz and 40 Hz to determine the vertical demand for each component. The structural AF is given by Figure 4-4 in the guidance based on height above foundation. The cabinet AF is 4.7 for all cabinets based on the calculation in Appendix C of the HF guidance.</p> <p>The licensee:</p> <ul style="list-style-type: none"> identified the peak vertical acceleration. 	Yes / No
<ul style="list-style-type: none"> used Figure 4-4 from the guidance to determine the structural amplification factor. 	Yes / No
<ul style="list-style-type: none"> used the cabinet amplification factor of 4.7 per Appendix C of the HF guidance. 	Yes / No
<p>Notes from staff reviewer: None</p>	

Deviation(s) or deficiency(ies) and Resolution: None	
The NRC staff concludes: <ul style="list-style-type: none"> The licensee's development of the vertical demand for the items on the equipment list met the guidance. 	Yes / No

VI. Component Capacity Evaluation and Comparison with Demand (EPRI 3002004396 Sections 4.5 and 4.6)

The licensee: <ul style="list-style-type: none"> used the maximum of the pair of demand values for the mounting point demand as described in Section 4.5.1 of the HF guidance. selected the correct knockdown factor per Section 4.5.2 of the guidance and Table 4-2. selected/justified the correct single axis correction factor. clearly indicated component capacity demand ratio for each component (in the sample evaluations) Results of demand vs. capacity are provided with identification of potential resolutions as needed. 	Yes / No / NA Yes / No / NA Yes / No / NA Yes / No / NA Yes / No / NA
Notes from staff reviewer: Knockdown factor and single axis correction factor reviewed as part of the sample calculation. Deviation(s) or deficiency(ies) and Resolution: None	
The NRC staff concludes: <ul style="list-style-type: none"> The licensee's component capacity evaluation met the HF guidance. 	Yes / No

VII. Resolution Options and High Frequency Report Requirements (EPRI 3002004396 Sections 4.6 and 4.7)

<p>To resolve any relays not meeting the component capacity screening criteria, the licensee:</p> <ul style="list-style-type: none"> proposed an adequate resolution for each item on the component list that has a capacity vs. demand ratio less than one (outliers). <p>For plants that identified relays not meeting the component capacity screening criteria, the licensee used one or more of the following resolutions outlined in the guidance:</p> <ul style="list-style-type: none"> identified additional component testing as a resolution. identified refined mounting point seismic demand estimates as a resolution. identified operator actions as a resolution. identified plant modifications as a resolution. <p>The HF confirmation report included these required elements not previously identified in this checklist:</p> <ul style="list-style-type: none"> provided a component resolutions schedule. Provided representative calculations 	<p>Yes / No / NA</p> <p>Yes / No / NA</p> <p>Yes / No / NA</p> <p>Yes / No / NA</p> <p>Yes / No / NA</p> <p>Yes / No / NA</p> <p>Yes / No / NA</p>
<p>Notes from staff reviewer: All components evaluated had capacity greater than demand.</p> <p>Deviation(s) or deficiency(ies) and Resolution: None</p>	
<p>The NRC staff concludes:</p> <ul style="list-style-type: none"> The licensee's proposed component resolution and report content met the HF guidance. 	<p>Yes / No</p>

VIII. Conclusions:

The NRC staff concludes that through the implementation of the HF guidance, the licensee identified and evaluated the HF seismic capacity of certain key installed plant equipment to ensure critical functions will be maintained following a seismic event up to the GMRS. As noted in the review checklist, the staff did not identify deviations or exceptions taken from the guidance and the licensee did not identify any necessary equipment modifications. The NRC staff further concludes that the licensee responded appropriately to Enclosure 1, Item 4 of the 50.54(f) letter, dated March 12, 2012, for Limerick. The application of this staff review is limited to the HF confirmation as part of 50.54(f) letter.

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LIMERICK GENERATING STATION, UNITS 1 AND 2 – STAFF REVIEW OF HIGH
FREQUENCY CONFIRMATION ASSOCIATED WITH REEVALUATED SEISMIC HAZARD
IMPLEMENTING NEAR-TERM TASK FORCE RECOMMENDATION 2.1
DATED FEBRUARY 6, 2017

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