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September 19, 2016

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Limerick Generating Station, Units 1 and 2
Renewed Facility Operating License Nos. NPF-39 and NPF-85
NRC Docket Nos. 50-352 and 50-353

Subject: Response to Request for Additional Information Regarding Proposed Relief Request I4R-01 for Limerick Generating Station, Units 1 and 2

References:

1) Letter from D. P. Helker (Exelon Generation Company, LLC), to the U.S. Nuclear Regulatory Commission, "Submittal of Relief Requests associated with the Fourth 10-Year Interval Inservice Inspection (ISI) Program," dated April 13, 2016 (ML16104A122).

2) E-mail correspondence from R. Ennis (U.S. Nuclear Regulatory Commission) to S. J. Hanson (Exelon Generation Company, LLC), "Draft Request for Additional Information Regarding Proposed Relief Request I4R-01 for Limerick Generating Station, Units 1 and 2," dated July 27, 2016 (ADAMS Accession No. ML16221A671).

By letter dated April 13, 2016, Exelon Generation Company, LLC (Exelon) submitted relief requests associated with the Fourth 10-Year Inservice Inspection Interval for Limerick Generating Station (LGS), Units 1 and 2. Specifically, Exelon submitted requests I4R-01, I4R-02, I4R-05, I4R-06, I4R-07, I4R-08, I4R-09, I4R-10, I4R-11, I4R-12, and I4R-13.

In the Reference 2 e-mail correspondence, the U.S. Nuclear Regulatory Commission (NRC) requested additional information (RAI) relating to relief request I4R-01. The attached contains Exelon's response to the NRC request for additional information.

On August 8, 2016, Exelon indicated that a clarification call to discuss the RAI was not needed. Exelon agreed to provide a response to the RAI by September 23, 2016.

There are no regulatory commitments in this response.

If you have any questions concerning this response, please contact Stephanie J. Hanson at 610-765-5143.

Respectfully,

James Barstow
Director, Licensing and Regulatory Affairs
Exelon Generation Company, LLC

Attachment: Response to Draft Request for Additional Information Regarding Proposed Relief Request I4R-01 for Limerick Generating Station, Units 1 and 2

cc: USNRC Region I, Regional Administrator
USNRC Senior Resident Inspector, LGS
USNRC Project Manager, LGS
R. R. Janati, Pennsylvania Bureau of Radiation Protection

ATTACHMENT

Limerick Generating Station, Units 1 and 2

Renewed Facility Operating License Nos. NPF-39 and NPF-85

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Response to Draft Request for Additional Information Regarding Proposed Relief Request I4R-01

By letter dated April 13, 2016, Exelon Generation Company, LLC (Exelon) submitted relief requests associated with the Fourth 10-Year Inservice Inspection Interval for Limerick Generating Station (LGS), Units 1 and 2. Specifically, Exelon submitted requests I4R-01, I4R-02, I4R-05, I4R-06, I4R-07, I4R-08, I4R-09, I4R-10, I4R-11, I4R-12, and I4R-13.

With respect to relief request I4R-01, the NRC staff has determined that additional information is needed to complete its review. The specific requests for additional information (RAI) questions are restated below along with Exelon's response.

APLA-RAI-01 (Question 1):

Background

The technical adequacy of the probabilistic risk assessment (PRA) used in developing LGS Units 1 and 2 relief request (RR) I4R-01 is based on Electric Power Research Institute (EPRI) Topical Report (TR) 1021467-A, "Nondestructive Evaluation: Probabilistic Risk Assessment Technical Adequacy Guidance for Risk-Informed In-Service Inspection Programs," dated June 2012 (ADAMS Accession No. ML12171A450). As discussed in a letter from the NRC to EPRI dated January 18, 2012 (ADAMS Accession No. ML11325A375), the NRC staff found that TR 1021467 was acceptable for referencing in licensing applications for risk-informed inservice inspection (RI-ISI) programs to the extent specified in the staff's safety evaluation enclosed with the letter (ADAMS Accession No. ML11325A340).

EPRI TR 1021467-A uses the guidance in Regulatory Guide (RG) 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," Revision 2. RG 1.200 endorses, with clarifications and qualifications, American Society of Mechanical Engineers (ASME)/American Nuclear Society (ANS) PRA standard ASME/ANS RA-Sa-2009. Section 1-5.4 of the PRA Standard defines PRA maintenance and PRA upgrades and states:

- "Changes in PRA inputs or discovery of new information identified pursuant to 1-5.3 shall be evaluated to determine whether such information warrants PRA maintenance or PRA upgrade. (See Section 1-2 for the distinction between PRA maintenance and PRA upgrade.)" [Appendix 1-A of the PRA Standard provides additional information and examples on PRA maintenance and PRA upgrade.]

- "Upgrades of a PRA shall receive a peer review in accordance with the requirements specified in the Peer Review Section of each respective Part of this Standard, but limited to aspects of the PRA that have been upgraded."

Based on Attachment 1 of RR I4R-01, the NRC staff's understanding of the development of the internal events (including internal flooding) PRA for LGS Units 1 and 2 is summarized below:

- In October 2005, a full-scope peer review was performed for the LGS internal events PRA (Version 2004B) against the supporting requirements in PRA standard ASME/ANS RA-S-2002 and the clarifications and qualifications in RG 1.200, Revision 0.

- Based on the discussions in Table 1 in Attachment 1 of RR I4R-01 (e.g., Supporting Requirements DA-C7, QU-B4, QU-B9, QU-04, QU-F5, QU-F6), a PRA update was performed in 2008, which included conversion to the use of CAFTA PRA software.

- In May 2008, the LGS internal flooding PRA was peer reviewed against the supporting requirements in PRA standard ASME/ANS RA-Sc-2007 and the clarifications and qualifications in RG 1.200, Revision 1.

- In January 2014, the most recent update of the LGS internal events PRA (Versions LG113A and LG213A) was completed.

- Plant changes made since the last PRA update in January 2014 have been reviewed and determined to not have a significant PRA impact.

Question

Based on the discussion above, changes have been made to the internal events PRA since the full-scope peer review in 2005 (e.g., the PRA updates in 2008 and 2014). It is not clear whether these PRA changes are considered PRA upgrades and whether these upgrades, if any, have been peer reviewed. Therefore, it is uncertain that the latest LGS internal events PRA (i.e., LG113A and LG213A) meets the PRA technical adequacy guidance in EPRI TR 1021467-A. The NRC staff requests that the licensee provide the following additional information:

1. Describe the changes made to the internal events PRA since the full-scope peer review in 2005. This description should be of sufficient detail to assess whether these changes are PRA maintenance or PRA upgrades as defined in Section 1-5.4 of the PRA Standard. Since the following may indicate a PRA upgrade, include in your discussion: any new methodologies, changes in scope that impacts the significant accident sequences or the significant accident progression sequences, changes in capability that impacts the significant accident sequences or the significant accident progression sequences.

2. Indicate, and provide justification, whether the changes described in Part 1 are PRA maintenance or PRA upgrades as defined in Section 1-5.4 of the PRA Standard.

3. Indicate whether focused-scope peer review(s) has been performed for those PRA upgrades identified in Part 2. As applicable, provide a list of the facts and observations (F&Os) from the peer review(s) that do not meet the appropriate Capability Category in accordance with EPRI TR 1021467-A, and explain how the F&Os were dispositioned for this application. If a focused-scope peer review(s) was not performed for these PRA upgrades, then provide a qualitative or quantitative evaluation (e.g., sensitivity or bounding analysis) of its effect until a focused-scope peer review can be completed.

Response:

There have been three updates to the internal events PRA model since the performance of the 2005 peer review of the 2004B (i.e., LG104B and LG204B) PRA model. The Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) values from the peer reviewed model and model of record updates since the peer review are provided below.

Models	U1 CDF	U1 LERF	U2 CDF	U2 LERF
LG104B and LG204B	3.7E-06	6.8E-08	3.7E-06	6.8E-08
LG104C and LG204C	3.9E-06	6.5E-08	3.9E-06	6.5E-08
LG108A and LG208A	3.2E-06	5.0E-08	3.2E-06	5.0E-08
LG113A and LG213A	3.2E-06	1.5E-07	3.2E-06	1.5E-07

The CDF results show that even with the implementation of several changes over the years, the overall results were very stable. The LERF results increased somewhat in the last update largely due to the refinement of the treatment of anticipated transient without scram scenarios and the incorporation of revised timing estimates for declaration of a General Emergency in some cases due to Emergency Action Level (EAL) changes, but the total LERF value is still very small and is less than 5% of the total CDF.

A summary of changes made to the internal events PRA models of record are documented in the introduction sections of the respective Full Power Internal Events (FPIE) PRA Update Quantification Notebooks (LGPRA-014) [References 1, 2, and 3]. Additionally, changes in the FPIE PRA model are tracked in the Limerick Updating Requirements Evaluation (URE) database which tracks PRA observations and open items identified in between scheduled FPIE PRA Update periods. URE items that involve model changes that were addressed in the updated models are also listed and described in the Quantification Notebooks. The summary of changes and table of UREs involving model changes were used to identify the changes made since the LG104B and LG204B models were peer reviewed.

A summary of the identified changes for each of the PRA model updates since the 2005 peer review are discussed below. For each change, a discussion is also provided to identify whether the changed item is *PRA Maintenance* or *PRA Upgrade*. A reference to the specific PRA Standard Appendix 1-A "Example" in which the change item relates to is provided when possible.

<u>LG104C and LG204C Model Changes</u>

The LG104C and LG204C models were developed as a result of an intermediate update to support preparation of the FPIE PRA model in CAFTA. Minor changes to the prior LG104B and LG204B models were made to create intermediate LG104C and LG204C models in WinNUPRA and these models were directly converted to the CAFTA software platform as detailed in Appendix K of Revision 1 to the Quantification Notebook [Reference 1]. The changes identified in Appendix K were reviewed and are discussed below.

- Minor model logic changes related to event tree transfers and use of event tree node flag files.
    - ***PRA Maintenance*** (Example 6). Logic model enhancement, no new methodology employed compared to the prior model.

- Added explicit representation of High Pressure Coolant Injection (HPCI) and Reactor Core Isolation and Cooling (RCIC) room coolers.

- ***PRA Maintenance*** (Example 7). Model enhancement to correct error or omission.

- Replaced events with event probabilities greater than 1.0 with combined events.
  - ***PRA Maintenance*** (Example 6). Logic model enhancement, no new methodology employed compared to the prior model.

- Conversion of model from WinNUPRA to CAFTA. The Quantification Notebook documents the conversion / benchmark where the results were in excellent agreement and the differences explained.
  - ***PRA Maintenance*** (Example 11). Example 11 of the Non Mandatory Appendix 1-A of the ASME / ANS RA-Sa-2009 states that the conversion of one fault tree linking code to another is PRA maintenance.

LG108A and LG208A Model Changes

The LG108A and LG208A models were the result of a regularly scheduled update per Exelon Risk Management Training and Reference Material (T&RM procedures). Changes incorporated into the model are discussed below.

- Prior to the completion of the LG108A and LG208A models, an Internal Flood PRA Update was performed to address peer review comments.
  - ***PRA Upgrade.*** A focused scope Internal Flooding Peer Review was performed in May of 2008. As indicated in the RI-ISI submittal [Reference 4], however, the RI-ISI traditional analysis employed for Limerick does not depend on the internal flooding analysis such that a detailed report of the F&Os from that peer review is not relevant to this application since all of the F&Os were related solely to the internal flooding analysis.

- Integrated the results of the internal flooding analysis that was completed in 2008 including an expansion to represent Unit 2.
  - ***PRA Maintenance.*** (Example 10). Similar to Example 10, this represents a completeness issue, no new methodology employed compared to the prior model.

- Revised the initiating event data utilizing the latest Limerick operating experience.
  - ***PRA Maintenance*** (Example 2). Using new plant-specific data, no new methodology employed.

- Revised the Loss of Offsite Power (LOOP) analysis for initiating event frequencies and non-recovery probabilities using latest data from NUREG/CR-6890.
  - ***PRA Maintenance*** (Example 3). Using new generic data, no new methodology employed.

- Revised the component failure data including use of available plant-specific component failure data gathered from the Limerick Maintenance Rule program through 2007.

- ***PRA Maintenance*** (Example 2). Using new plant-specific data, no new methodology employed.

- Incorporated revised generic component failure data with recent information available from NUREG/CR-6928.
  - ***PRA Maintenance*** (Example 3). Using new generic data, no new methodology employed.

- Revised the common cause failure (CCF) calculations to incorporate the updated individual random basic event probabilities and the most up to date alpha factor parameters from NUREG/CR-5497 and NUREG/CR-5485.
  - ***PRA Maintenance*** (Examples 3 and 26). Using new data, no new methodology employed.

- Updated the maintenance unavailability data based on the most recent plant operating experience through 2007.
  - ***PRA Maintenance*** (Examples 2 and 19). Using new plant-specific data, no new methodology employed.

- Performed a Human Reliability Analysis (HRA) update using the EPRI HRA Calculator and also based on operating crew interviews using the latest emergency operating procedures (EOPs) and support procedures.
  - ***PRA Maintenance*** (Example 11). The HRA assessment was converted to the EPRI HRA Calculator from the spreadsheet method. The conversion from the spreadsheet to EPRI Calculator for HRA is considered analogous to the conversion from WinNUPRA to CAFTA (which is considered a maintenance update) because the HRA Calculator uses the same HRA methodologies as were used in the spreadsheets.

- Updated the full set of System Notebooks which included updated System Engineer interviews.
  - ***PRA Maintenance***. Documentation enhancement, no new methodology employed.

- Resolved certain issues arising from the October 2005 peer review against the PRA Standard and RG-1.200. These changes fall into several different categories and are considered to be PRA maintenance as described below.
  - ***PRA Maintenance*** (Example 1). Removed credit for repair of the emergency diesel generators, Residual Heat Removal (RHR), Emergency Service Water, and RHR Service Water pumps. Also removed credit for re-opening of Main Steam Isolation Valves following closure. These model changes were done to address specific peer review comments. No new methodologies were employed.

  - ***PRA Maintenance*** (Examples 1 and 15). Separated out Loss of Coolant Accident (LOCA) initiating events into above and below top of active fuel. Separated out the LOOP initiating events into four causal categories. While new initiating events are modeled, it is a refinement of the old initiators. No new methodologies were employed.

- ***PRA Maintenance*** (Example 6). Updated the support system initiating event (SSIE) fault trees to not include the 365 multiplier approach, and expanded the LOOP initiating event to include a contribution from offsite source unavailability explicitly. The process of using SSIE fault trees had been previously implemented in the Limerick model that was peer reviewed. Restructuring some of the logic and expanding to include the LOOP initiating event represents minor model logic changes. No new methodologies were employed.

- ***PRA Maintenance*** (Examples 6 and 7). Corrected several minor errors or omissions in the system model fault trees. No new methodologies were employed.

- ***PRA Maintenance*** (Example 10). Incorporated a few changes related to success criteria completeness issues. Specifically, this included changes related to developing a fraction of small LOCAs that exceed RCIC make-up capabilities and treating HPCI failures that lead to condensate in the steam line consistent with other scenarios that result in water in the HPCI steam line. No new methodologies were employed.

- ***PRA Maintenance*** (Example 20). Refined and expanded some Human Error Probability (HEP) events to include more scenario specific timings. Specifically, this included fail to depressurize operator actions for various scenarios and similar refinements for other HEPs. No new methodologies were employed.

- ***PRA Maintenance*** (Example 25). Added a few common cause failure groups that were not previously included. No new methodologies were employed.

- Resolved several other open items and comments from the URE database which captures and collects model enhancements for the next update including plant and procedure changes. This includes minor logic error corrections (e.g., power dependency to different motor control center (MCC) in same division), or omissions (e.g., allowing both HPCI flow paths to the Reactor Pressure Vessel as success on restart consistent with the treatment for initial HPCI starts), and actual plant modifications (e.g., switch replacements).
  - ***PRA Maintenance***. Addressing plant and procedure changes as well as correcting identified errors (Example 6) and incorporating minor enhancements (Example 7) represent normal update activities. No new methodologies were employed.

<u>LG113A and LG213A Model Changes</u>

The LG113A and LG213A models were the result of a regularly scheduled update per Exelon Risk Management T&RMs. Changes incorporated into the model are discussed below.

- Incorporated updated LERF analysis based on new Modular Accident Analysis Program (MAAP) case results with later version of code, changes that were made to the site EALs, and latest evacuation time estimates.
  - ***PRA Maintenance*** (Example 2). Similar to using new plant-specific data, no

new methodology employed.

- Updated the initiating event data utilizing the latest Limerick operating experience and the latest generic frequencies provided by a revision to the NUREG/CR-6928 data (revision gathers data through 2010).
    - ***PRA Maintenance*** (Examples 2 and 3). Using new plant-specific and new generic data, no new methodology employed.

- Revised the component failure data including use of available plant-specific component failure data gathered from the Limerick Maintenance Rule program from January 1, 2010 through December 31, 2012.
    - ***PRA Maintenance*** (Examples 2 and 3). Using new plant-specific and new generic data, no new methodology employed.

- Incorporated revised generic component failure data with recent information available from a revision to the NUREG/CR-6928 data (revision gathers data through 2010).
    - ***PRA Maintenance*** (Example 3). Using new generic data, no new methodology employed.

- Revised the CCF calculations to incorporate the updated INL 2010 alpha factor data. The alpha factors were added to the CAFTA reliability database file as type codes which include the uncertainty parameters (alpha and beta) provided by INL 2010. The CCF calculations are performed in CAFTA via the equation (=) calc type which references the alpha factor type codes. This allows the alpha factor uncertainty parameters to be correlated during the uncertainty analysis.
    - ***PRA Maintenance*** (Examples 3 and 26). Using new generic data, no new methodology employed. The alpha factor methodology was still employed, but the total CCF values were now determined in the reliability database file in lieu of being determined in a separate spreadsheet and imported into the reliability database file.

- Updated the maintenance unavailability data based on the most recent plant operating experience from 2008 through 2012.
    - ***PRA Maintenance*** (Examples 2 and 19). Using new plant-specific data, no new methodology employed.

- Updated the HEP dependency analysis. The dependency analysis was not updated since the 2004 PRA Periodic Update.
    - ***PRA Maintenance*** (Example 20). HEP modeling enhancement, same methodology employed compared to the 2004 dependency analysis.

- Performed an HRA re-assessment using the EPRI HRA Calculator and also based on operating crew interviews using the latest EOPs and support procedures.
    - ***PRA Maintenance*** (Example 20). HEP modeling enhancement, no new methodology employed.

- Re-ran all Level 1 Thermal Hydraulic Analysis cases using MAAP 4.0.6.
    - ***PRA Maintenance*** (Example 11). Software update from MAAP 4.0.5 to

MAAP 4.0.6 does not result in a methodology change.

- Updated the full set of System Notebooks which included updated System Engineer interviews.
    - ***PRA Maintenance.*** Documentation enhancement, no new methodology employed.

- Resolved several other open items and comments from the URE database which captures and collects model enhancements for the next update including plant and procedure changes.
    - ***PRA Maintenance.*** Addressing plant and procedure changes as well as correcting identified errors (Example 6) and incorporating minor enhancements (Example 7) represent normal update activities. No new methodologies were employed.

APLA-RAI-02 (Question 2):

Attachment 1 of RR I4R-01 explains that a full-scope peer review was performed for the LGS internal events PRA in October 2005 against the supporting requirements (SRs) in PRA standard ASME/ANS RA-S-2002 and the clarifications and qualifications in RG 1.200, Revision 0. Differences exist between the SRs in PRA standard ASME/ANS RA-S-2002, as qualified by RG 1.200, Revision 0, and the SRs in ASME/ANS RA-Sa-2009, as qualified by RG 1.200, Revision 2. In accordance with RG 1.200, Revision 2, it is expected that the differences between the current version of the PRA standard (i.e., ASME/ANS RA-Sa-2009) and the earlier version of the standard used in the internal events PRA peer review (i.e., ASME/ANS RA-S-2002,) be identified and addressed (i.e., perform a gap assessment). While Table 1 in Attachment 1 of RR I4R-01 provides the SRs cross references between the 2002 and 2009 ASME/ANS PRA Standards (i.e., the first column in Table 1), the licensee did not appear to address the additional changes between the standards that would require re-evaluation of the PRA against the ASME/ANS PRA Standard. In addition, on Page 10 of RR I4R-01, the licensee indicates that any unaddressed gaps between the PRA and current PRA standards will be reviewed for consideration during the next LGS PRA update, but are judged to have low impact on the PRA model and its results; however, it's not clear what these gaps are and how they were determined to have a low impact.

The NRC staff requests that the licensee provide a gap assessment of the internal events PRA against ASME/ANS RA-Sa-2009, as qualified by RG 1.200, Revision 2. Note, Section 3.3, "Gap Assessment for PRAs Reviewed Against RG 1.200, Revision 1," of NEI 05-04, Revision 3, provides guidance on performing a gap assessment.

Response:

As a point of clarification, the 2005 PRA review was performed against the supporting requirements (SRs) in ASME PRA Standard 2005 Addenda B ballot version [Reference 5] to ASME RA-S-2002, not just the ASME RA-S-2002 version. A gap assessment from the PRA Standard assessed during the internal events PRA Peer Review (2005 Addenda B Ballot) to the current Standard (ASME / ANS RA-Sa-2009) [Reference 6] has been performed.

The results of that gap assessment are provided below.

Initially, a check was made between the peer reviewed version (i.e., 2005 Addenda B Ballot version) to the version endorsed in RG 1.200, Revision 1 (i.e., RA-Sb-2005 final version [Reference 7]) to identify other changes that need to be evaluated as part of this gap assessment. Other than formatting and reference changes, this review indicated that two SRs were impacted between the balloted Addenda B version and the final Addenda B version. First, IE-C12 (now IE-C14) incorporated additional Capability Category III requirements that do not impact the Limerick capability since it was assessed as meeting Capability Category I/II for that SR. Second, AS-C2 added a documentation requirement to include "The linkage between the modeled initiating event in the Initiating Event Analysis section and the accident sequence model." This linkage is documented at the beginning of the Event Tree Notebook for Limerick so the SR is still met.

Once the initial check confirmed that there were no significant differences between the version used for the 2005 peer review and the final 2005 Addenda B version endorsed in RG 1.200, Revision 1, the scope of the remaining gap assessment for Limerick is to examine the full set of changes identified in Section 3 of NEI 05-04, Revision 3 [Reference 8]. This includes the following three categories: (1) those SRs requiring re-evaluation due to changes in RG 1.200, Revision 2 and ASME / ANS RA-Sa-2009, (2) those SRs related to key assumptions and sources of uncertainty, and (3) other SRs affected by RG 1.200, Revision 1 clarifications to the 2005 Addendum B final version.

As indicated in NEI 05-04, Revision 3, the changes to the ASME/ANS PRA Standard High Level Requirements (HLRs) and SRs in the transition from 2005 Addendum B through RG 1.200, Revision 1, and finally Addendum A of the ASME/ANS PRA Standard were minor, and include the following:

1. incorporation into the ASME/ANS PRA Standard issues that were identified by the NRC in RG 1.200, Revision 1,
2. renumbering of the ASME/ANS PRA Standard HLRs and SRs to remove deleted SRs and SRs ending with a letter (e.g., SR QU-A2a),
3. changes in the cross-references updated to the new tables, and
4. corrections of typographical and grammar errors, and changes in wording.

There were a few examples of changes to the ASME/ANS PRA Standard or the RG 1.200, Revision 2 that would require re-evaluation of the PRA against the ASME/ANS PRA Standard requirements. These are discussed below.

Supporting Requirements Requiring Re-evaluation

SRs that require re-evaluation are those SRs that have changed significantly, including those with new issues identified in RG 1.200, Revision 2; the applicable SRs are identified in NEI 05-04, Revision 3 and their impact for Limerick and this application are provided in Table 1.

Table 1: SRs Requiring Gap Assessment Evaluation

Supporting Requirement	Comments from NEI 05-04, Revision 3	Impact on Limerick for this Application
HR-D6	RG 1.200, Revision 2, provides clarification that should be evaluated.	No impact. Clarification of HR-D6 makes the wording similar to HR-G9 which was met for Limerick. No change in Capability Category for HR-D6. Meets Capability Category I/II/III.
HR-G3	RG 1.200, Revision 2, provided clarification to items (d) and (g) of the SR. Some of the RG 1.200, Revision 1, wording remains, while some additional clarification is provided.	No impact. Clarification of HR-G3 for item (d) clarity of cues/indications, and for item (g) complexity of the response does not change the assessment for Limerick. No change in Capability Category for HR-G3. Meets Capability Category II/III.
New DA SR	RG 1.200, Revision 1, included a new SR -- DA-D8. The recommended new SR is included in RG 1.200, Revision 2, as DA-D9 (with the renumbering).	No impact. Repair is not credited in the current model. DA-D9 is assessed as N/A for Limerick.
QU-A2	Need to ensure QU-A2 evaluates LERF results.	No impact. Individual sequence estimates are provided for both CDF and LERF for Limerick. No change in Capability Category for QU-A2 (was QU-A2a). Meets Capability Category I/II/III.

Table 1: SRs Requiring Gap Assessment Evaluation (cont.)

Supporting Requirement	Comments from NEI 05-04, Revision 3	Impact on Limerick for this Application
QU-A3	Need to ensure QU-A3 evaluates LERF results.	No impact. Mean CDF and LERF values are determined by propagating the uncertainty distributions to account for the state-of-knowledge correlation between event probabilities. No change in Capability Category for QU-A3 (was QU-A2b). Initial peer review assessed as Meeting Capability Category II, but actually do meet Capability Category III requirements for calculating the mean CDF and LERF results.
QU-B5	RG 1.200, Revision 2, provides clarification that should be evaluated. Need to verify breaking logic loops does not result in undue conservatism.	No impact. Circular logic loop breaks are appropriately handled in the Limerick model without introducing undue conservatisms or non-conservatisms. No change in Capability Category for QU-B5. Meets Capability Category I/II/III.
QU-B6	Need to ensure QU-B6 evaluates LERF results.	No impact. System successes and failures are accounted for in the CDF and LERF accident sequence quantification for Limerick. No change in Capability Category for QU-B6. Meets Capability Category I/II/III.

Table 1: SRs Requiring Gap Assessment Evaluation (cont.)

Supporting Requirement	Comments from NEI 05-04, Revision 3	Impact on Limerick for this Application
QU-E3	Need to ensure QU-E3 evaluates LERF results.	No impact. Uncertainty intervals for CDF and LERF values are determined by propagating the uncertainty distributions to account for the state-of-knowledge correlation between event probabilities. No change in Capability Category for QU-E3. Meets Capability Category III.
QU-E4	Revision 1, Addendum A, of the ASME/ANS Standard rewords this SR. Additionally, RG 1.200, Revision 2, provides clarification to remove Note 1.	No impact. Limerick meets the current Capability Category I/II/III requirements for this SR. (Note that Limerick was the pilot plant for issuance of EPRI 1016737 [Reference 9] which provided industry guidance on how to meet this SR as currently written.)
Flooding SRs: IFPP-B1, B2, B3, IFSO-B1, B2, B3, IFSN-B1, B2, B3, IFEV-B1, B2, B3, and IFQU-B1, B2, B3	These are new requirements for flooding that expand on the original SRs in the ASME/ANS PRA Standard.	No impact. The RI-ISI traditional analysis employed for Limerick does not depend at all on the internal flooding analysis.
IFSN-A6	RG 1.200, Revision 2, provides clarification that should be evaluated.	No impact. The RI-ISI traditional analysis employed for Limerick does not depend at all on the internal flooding analysis.

The remaining part of the gap assessment provides a discussion on SRs affected by RG 1.200, Revision 1, issues, some of which were incorporated directly into Addendum A of the ASME/ANS PRA Standard [Reference 6].

"Key" Assumptions and Uncertainty

A number of the SRs changed in the ASME/ANS PRA Standard as a result of the NRC comments to remove the word "key" with respect to assumptions and sources of (modeling) uncertainty. However, NRC and EPRI documents have been issued in support of methods in the area of uncertainty analysis, which is commonly being used in the performance of uncertainty evaluations for PRAs. This includes EPRI TR-1016737 [Reference 9] and NUREG-1855. A number of peer reviews were performed against PRAs using the methods in one or both of these documents. Although use of these documents would not be considered the only way to meet the uncertainty SRs, generally, prior to the issuance of these documents, PRAs typically were assessed a Finding Level F&O in this area.

The following SRs are identified in NEI 05-04, Revision 3, for re-evaluation and their impact for Limerick and this application are provided in Table 2.

Table 2: SRs Requiring Gap Assessment Evaluation Related to Key Assumptions and Sources of Uncertainty

Supporting Requirements	Comments	Impact on Limerick for this Application
IE-D3, AS-C3, SC-C3, SY-C3, HR-I3, DA-E3, QU-E1, QU-E2, QU-F4, LE-D6, LE-G4	Clarification in RG 1.200, Revision 1, adopted in current version of ASME/ANS PRA Standard for these SRs.	No impact. Limerick meets the current Capability Category I/II/III requirements for these SRs. (Note that Limerick was the pilot plant for issuance of EPRI 1016737 which provides industry guidance on how to meet these SRs.)

Other SRs Affected By RG 1.200, Revision 1, Clarifications

As with the above discussion, a number of other SRs included NRC clarifications from RG 1.200, Revision 1. If the original peer review included a review of the PRA against the RG 1.200, Revision 1 clarifications, then NEI 05-04, Revision 3 guidance indicates that the gap assessment does not need to include any additional re-evaluation. However, since the Limerick 2005 peer review did not include the RG 1.200, Revision 1 clarifications, then the gap assessment needs to include these SRs.

The following SRs are identified in NEI 05-04, Revision 3 and their impact for Limerick and this application are provided in Table 3.

Table 3: SRs Requiring Gap Assessment Evaluation Related to Other RG 1.200, Revision 1 Clarifications

Supporting Requirement	Comments	Impact on Limerick for this Application
IE-A6	As indicated in NEI 05-04, Rev. 3, RG 1.200, Revision 2 includes a reduction in the requirements, which would not need to be re-assessed unless the SR was not met in the peer review as a result of the clarification.	No impact. The Limerick initiating event evaluation process considers initiating events resulting from multiple failures, including equipment failures resulting from common cause, or from system alignments resulting from preventive and corrective maintenance. No change in Capability Category for IE-A6 (was IE-A4a). Meets Capability Category II.
IE-B3	RG 1.200, Revision 1 changed "AVOID subsuming" to "**DO NOT SUBSUME**"	No impact. Limerick does not subsume scenarios into a group unless the requirements noted in the SR are met. No change in Capability Category for IE-B3. Meets Capability Category II.
AS-A10	RG 1.200, Revision 1 removed the modifier "significant" and provided examples of required operator interactions.	No impact. The Limerick accident sequence models include sufficient detail that differences in requirements on systems and required operator actions are captured. No change in Capability Category for AS-A10. Meets Capability Category II.
HR-E2	RG 1.200, Revision 1 added clarification to "**diagnose and then** recover a failed function".	No impact. Recovery actions include the need to diagnose the situation in the human reliability assessment for that action. No change in Capability Category for HR-E2. Meets Capability Category I/II/III.

Table 3: SRs Requiring Gap Assessment Evaluation Related to Other RG 1.200, Revision 1 Clarifications (cont.)

Supporting Requirement	Comments	Impact on Limerick for this Application
DA-C15	RG 1.200, Revision 1 added a qualification to "IDENTIFY instances of plant-specific **experience and, when that is insufficient to estimate failure to repair consistent with DA-D8**, applicable industry experience for each repair, COLLECT..."	No impact. Repair is not credited in the current model. DA-C15 is assessed as N/A for Limerick.
DA-D1	RG 1.200, Revision 1 removed reference to other statistical processes for combining plant-specific and generic data, And required use of a Bayes update process.	No impact. A Bayes update process is used for combining plant-specific and generic data for Limerick. No change in Capability Category for DA-D1. Meets Capability Category II.
IFSO-A1	Focused scope peer review of internal floods for Limerick was performed using RG 1.200, Revision 1.	No impact. The RI-ISI traditional analysis employed for Limerick does not depend at all on the internal flooding analysis.
IFSO-A5	Focused scope peer review of internal floods for Limerick was performed using RG 1.200, Revision 1.	No impact. The RI-ISI traditional analysis employed for Limerick does not depend at all on the internal flooding analysis.
IFSN-A8	Focused scope peer review of internal floods for Limerick was performed using RG 1.200, Revision 1.	No impact. The RI-ISI traditional analysis employed for Limerick does not depend at all on the internal flooding analysis.
IFEV-A2	Focused scope peer review of internal floods for Limerick was performed using RG 1.200, Revision 1.	No impact. The RI-ISI traditional analysis employed for Limerick does not depend at all on the internal flooding analysis.

Table 3: SRs Requiring Gap Assessment Evaluation Related to Other RG 1.200, Revision 1 Clarifications (cont.)

Supporting Requirement	Comments	Impact on Limerick for this Application
IFQU-A8	Focused scope peer review of internal floods for Limerick was performed using RG 1.200, Revision 1.	No impact. The RI-ISI traditional analysis employed for Limerick does not depend at all on the internal flooding analysis.

EVIB-RAI-1 (Question 3):

Background

Relief Request I4R-01 states that the Fourth 10-year Interval RI-ISI Program, for LGS units 1 and 2, will be a continuation of the Third 10-year Interval RI-ISI Program which was authorized by NRC letter dated March 11, 2008 (ADAMS Accession No. ML080500584). In its review of the Third Interval RI-ISI program, the NRC staff requested that the licensee supply additional information related to total number of welds included in the RI-ISI program, along with the number of examinations that are projected to be performed, and compare those with the ASME Code required examinations performed, as well as provide any changes from previous RI-ISI programs. Exelon's response dated November 8, 2007 (ADAMS Accession No. ML073170370) provided a summary of the requested information, the current Relief Request I4R-01, does not provide the level of detail that was previously provided.

Question

Provide summary tables for Limerick Units 1 and 2, which include the total weld population in scope of the proposed RI-ISI Program, the welds that were examined during the Third Interval RI-ISI Program and those that are projected to be examined during the Fourth Interval RI-ISI Program. The summary tables and the accompanying information should be consistent with information provided previously by Exelon letter dated November 8, 2007 (ADAMS Accession No. ML073170370). The information should also provide a summary of any deviations from the planned inspections, and the reasons for those changes.

Response:

The RI-ISI Program is required to be and has been maintained as a living program, assessing component and configuration changes and major Probabilistic Risk Assessment (PRA) model revisions throughout the Third ISI Interval. As part of the Fourth ISI Interval update process, the consequence and degradation assignments and resultant component risk rankings have been confirmed or updated, element selections have been adjusted, and the risk impact assessment has been revised. The final RI-ISI evaluation for the previous Third ISI Interval was Revision 5, dated December 2012. The latest evaluation, Revision 6, dated June 2016, is the current evaluation developed as part of the new Fourth Interval RI-ISI Program. The changes in inspection locations from the initial Third Interval RI-ISI Program (Revision 3 dated August

2007) to the new Fourth Interval RI-ISI Program are summarized in the tables below. Updated tables similar to those provided in the original submittal of the RI-ISI Program are included as part of this response.

Table 1: LGS Unit 1 Selection Summary

Risk Rank	Interval 3 Exams (RI-ISI Rev. 3)	Interval 4 Exams (RI-ISI Rev. 6)	Items Affecting Changes
High	62	57	▪ Limited Exam Coverage ▪ Plant/Component Modifications ▪ PRA Model Revisions[1]
Medium	79	69	▪ Limited Exam Coverage ▪ Plant/Component Modifications ▪ PRA Model Revisions[1]
Total	141	126	
[1] Latest incorporated revision is PRA Model LG113A			

Table 2: LGS Unit 2 Selection Summary

Risk Rank	Interval 3 Exams (RI-ISI Rev. 3)	Interval 4 Exams (RI-ISI Rev. 6)	Items Affecting Changes
High	63	57	▪ Limited Exam Coverage ▪ Plant/Component Modifications ▪ PRA Model Revisions[1]
Medium	82	74	▪ Limited Exam Coverage ▪ Plant/Component Modifications ▪ PRA Model Revisions[1]
Total	145	131	
[1] Latest incorporated revision is PRA Model LG213A			

Limited Exam Coverage – The welds selected for examination were changed in some cases to optimize examination code coverage.

Plant Modifications – As discussed above, the RI-ISI Program has been maintained throughout the Third ISI Interval as a living program. Various minor plant modifications were installed throughout the interval and were evaluated for impact to the RI-ISI Program, and when applicable, changes to the RI-ISI scope and element selections were made. No major component replacements or new system installations were made during this period affecting the RI-ISI program.

PRA Model Revisions – The LGS PRA Model applicable to the initial Fourth Interval RI-ISI Program was revised in January 2014 and issued as Models LG113A and LG213A. This revision of the model was incorporated into Revision 6 of the RI-ISI Program in June 2016. As the model is updated throughout the interval, impact on the RI-ISI Program is assessed and the program is updated as necessary.

Table 1
Failure Potential Assessment Summary for LGS Unit 1 and Unit 2[2]

System	Thermal Fatigue		Stress Corrosion Cracking				Localized Corrosion			Flow Sensitive	
	TASCS	TT	IGSCC	TGSCC	ECSCC	PWSCC	MIC	PIT	CC	E-C	FAC
CRD[1]											
CS	X		X								X
FW	X	X									X
HPCI		X									X
MS											X
RCIC	X	X	X								X
RHR	X		X							X	X
RPV-APP			X								
RR	X		X								
RWCU	X										
SLC	X										

Notes:
1. Includes scram discharge volume.
2. This table shows the assessed failure mechanisms for each system. The RI-ISI program addresses the cumulative impact of all mechanisms that were identified in each system.

TASCS – thermal stratification, cycling and striping, TT – thermal transients, IGSCC – intergranular stress corrosion cracking, TGSCC – transgranular stress corrosion cracking, ECSCC – external chloride stress corrosion cracking, PWSCC – primary water stress corrosion cracking, MIC – microbiologically influenced corrosion, PIT – pitting, CC – crevice corrosion, E-C – erosion-cavitation, FAC – flow accelerated corrosion.

Table 2
Number of Elements (Welds) by Risk Category for LGS Unit 1[3]

System	High Risk[2]			Medium Risk[2]		Low Risk[2]	TOTAL
	Category 1	Category 2	Category 3	Category 4	Category 5	Category 6 or 7	All Categories
CRD[1]						53	53
CS		14	26	20		232	292
FW	88		22		7	5	122
HPCI			37	32	4	154	227
MS			8	99		142	249
RCIC		2		25	35	96	158
RHR	75	64	124	128	30	383	804
RPV-APP		3		38			41
RR		24		95		4	123
RWCU		2		102		23	127
SLC		4		6		54	64
TOTAL	163	113	217	545	76	1146	2260

Notes:
1. Includes scram discharge volume.
2. See Figure 1 for definition of EPRI Risk Categories.
3. This table shows the results of the Risk Categorization for Unit 1. The risk categories are defined in Figure 3-4 of EPRI TR-112657 (Reference 1).

Table 3
Number of Elements (Welds) by Risk Category for LGS Unit 2[3]

System	High Risk[2]			Medium Risk[2]		Low Risk[2]	TOTAL
	Category 1	Category 2	Category 3	Category 4	Category 5	Category 6 or 7	All Categories
CRD[1]						57	57
CS		17	28	19		247	311
FW	90		20		5	4	119
HPCI			38	32	5	151	226
MS			8	99		140	247
RCIC		2		30	33	79	144
RHR	76	59	124	126	32	368	785
RPV-APP				41			41
RR		19		97		4	120
RWCU		2		119		22	143
SLC		4		5		59	68
TOTAL	166	103	218	568	75	1131	2261

Notes:
1. Includes scram discharge volume.
2. See Figure 1 for definition of EPRI Risk Categories.
3. This table shows the results of the Risk Categorization for Unit 2. The risk categories are defined in Figure 3-4 of EPRI TR-112657 (Reference 1). The minor differences between units are due to slight differences in the number of welds in these systems.

Table 4
Number of Inspections by Risk Category for LGS Unit 1[2,3,4]

System	High Risk						Medium Risk				Low Risk		All Risk Categories	
	Category 1		Category 2		Category 3		Category 4		Category 5		Category 6 or 7			
	Pre-RI-ISI	RI-ISI	Pre-RI-ISI	RI-ISI	Pre-RI-ISI	RI-ISI	Pre-RI-ISI	RI-ISI	Pre-RI-ISI	RI-ISI	Pre-RI-ISI	RI-ISI	Pre-RI-ISI	RI-ISI
CRD[1]											2	0	2	0
CS			9	4			5	2			16	0	30	6
FW	22	20			17	5			5	1	5	0	49	26
HPCI					2	7	10	4	0	1	13	0	25	12
MS							56	10			22	0	78	10
RCIC							7	3	2	5	12	0	21	8
RHR			37	16			14	13	2	3	20	0	73	32
RPV-APP							24	4					24	4
RR			3	3			23	11					26	14
RWCU			2	1			40	11			1	0	43	12
SLC			4	1			6	1			4	0	14	2
TOTAL	22	20	55	25	19	12	185	59	9	10	95	0	385	126

Notes:
1. Includes scram discharge volume.
2. This table provides a comparison of the current RI-ISI element selection to the previous Second Interval's 1989 ASME Section XI and BER programs (Pre-RI-ISI).
3. This table includes the number of welds previously selected for ASME Section XI and BER (Pre-RI-ISI), but excludes the number of welds previously selected for ASME Section XI and BER (Pre-RI-ISI) that now default to the augmented programs for IGSCC and FAC.
4. All new non-exempt welds added to the plant after the inception of the RI-ISI program are conservatively considered Pre-RI-ISI inspections solely for the purpose of performing the Risk Impact Assessment.

Table 5
Number of Inspections by Risk Category for LGS Unit 2[2,3,4]

System	High Risk						Medium Risk				Low Risk		All Risk Categories	
	Category 1		Category 2		Category 3		Category 4		Category 5		Category 6 or 7			
	Pre-RI-ISI	RI-ISI	Pre-RI-ISI	RI-ISI	Pre-RI-ISI	RI-ISI	Pre-RI-ISI	RI-ISI	Pre-RI-ISI	RI-ISI	Pre-RI-ISI	RI-ISI	Pre-RI-ISI	RI-ISI
CRD[1]											3	0	3	0
CS			5	6			5	2			16	0	26	8
FW	19	18			19	6			3	1	4	0	45	25
HPCI					2	7	12	4	0	1	14	0	28	12
MS							42	10			22	0	64	10
RCIC							7	3	0	5	12	0	19	8
RHR			45	15			17	13	5	5	33	0	100	33
RPV-APP							27	5					27	5
RR			0	3			17	10					17	13
RWCU			1	1			47	12					48	13
SLC			0	1			2	3			8	0	10	4
TOTAL	19	18	51	26	21	13	176	62	8	12	112	0	387	131

Notes:
1. Includes scram discharge volume.
2. This table provides a comparison of the current RI-ISI element selection to the previous Second Interval's 1989 ASME Section XI and BER programs (Pre-RI-ISI).
3. This table includes the number of welds previously selected for ASME Section XI and BER (Pre-RI-ISI), but excludes the number of welds previously selected for ASME Section XI and BER (Pre-RI-ISI) that now default to the augmented programs for IGSCC and FAC.
4. All new non-exempt welds added to the plant after the inception of the RI-ISI program are conservatively considered Pre-RI-ISI inspections solely for the purpose of performing the Risk Impact Assessment.

References

1. LG-PRA-014, Revision 1, Limerick Generating Station Probabilistic Risk Assessment Quantification Notebook, LGS104C and LGS204C Models, February 2008.

2. LG-PRA-014, Revision 2, Limerick Generating Station Probabilistic Risk Assessment Quantification Notebook, LG108A and LG208A Models, September 2009.

3. LG-PRA-014, Revision 3, Limerick Generating Station Probabilistic Risk Assessment Quantification Notebook, LG113A and LG213A Models, January 2014.

4. Exelon Generation Company, LLC, 10CRF50.55a Relief Request I4R-01, Revision 0, Attachment 1, Limerick Generating Station 2014 PRA (LG113A/LG213A) Technical Capability Assessment for Risk-Informed Inservice Inspection, April 2016. ADAMS Accession Number ML16104A122.

5. Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications, DRAFT Addendum B to ASME RA-Sa-2003, June 2005.

6. ASME/ANS RA-Sa-2009, Addenda to ASME/ANS RA-S-2008 Standard for Level 1 / Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications, February 2009.

7. ASME RA-Sb-2005, Addenda to ASME RA-S-2002 Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications, December 2005.

8. NEI 05-04, Process for Performing Internal Events PRA Peer Reviews Using the ASME/ANS PRA Standard, Revision 3, November 2009.

9. Treatment of Parameter and Model Uncertainty for Probabilistic Risk Assessments, EPRI, Palo Alto, CA: 2008. 1016737.