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10 CFR 50.90

February 14, 2019

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

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: Supplement to License Amendment Request to Revise Technical Specifications to Adopt Risk Informed Completion Times TSTF-505, Revision 2, "Provide Risk-Informed Extended Completion Times - RITSTF Initiative 4b."

References:

1. Letter from J. Barstow (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, "License Amendment Request to Revise Technical Specifications to Adopt Risk Informed Completion Times TSTF-505, Revision 2, 'Provide Risk-Informed Extended Completion Times - RITSTF Initiative 4b'," dated December 13, 2018 (ADAMS Accession No. ML18347B366).

2. Letter from V. Sreenivas (U.S. Nuclear Regulatory Commission) to B. Hanson (Exelon Generation Company, LLC), "Limerick Generating Station, Units 1 and 2 - Supplemental Information Needed for Acceptance of Requested Licensing Action to Adopt Risk-Informed Completion Times in Accordance with TSTF-505, Revision 2 (EPID L-2018-LLA-0567)," dated January 30, 2019 (ADAMS Accession No. ML19030A147).

In Reference 1, Exelon Generation Company, LLC (Exelon) requested an amendment to the Renewed Facility Operating License Nos. NPF-39 and NPF-85 for Limerick Generating Station (Limerick), Units 1 and 2, respectively.

The proposed amendment would modify Technical Specifications (TS) requirements to permit the use of risk-informed completion times (RICTs) in accordance with the Technical Specifications Task Force (TSTF) Traveler TSTF-505, Revision 2, "Provide Risk-Informed Extended Completion Times – RITSTF [Risk-Informed TSTF] Initiative 4b" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18183A493).

In Reference 2, the NRC requested that Exelon provide supplemental information by February 15, 2019 to support the acceptance review of the license amendment request. The attachment to this letter provides a restatement of the NRC questions followed by our responses.

Exelon has reviewed the information supporting a finding of no significant hazards consideration, and the environmental consideration, that were previously provided to the

NRC in Attachment 1 of the Reference 1 letter. Exelon has concluded that the information provided in this response does not affect the bases for concluding that the proposed license amendment does not involve a significant hazards consideration under the standards set forth in 10 CFR 50.92. In addition, Exelon has concluded that the information in this response does not affect the bases for concluding that neither an environmental impact statement nor an environmental assessment needs to be prepared in connection with the proposed amendment.

In accordance with 10 CFR 50.91, "Notice for public comment; State consultation," paragraph (b), Exelon is notifying the Commonwealth of Pennsylvania of this supplement to the application for license amendment by transmitting a copy of this letter and its attachment to the designated State Official.

This letter contains no regulatory commitments.

If you should have any questions regarding this submittal, please contact Glenn Stewart at 610-765-5529.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 14th day of February 2019.

Respectfully,

D. P. Helker

David P. Helker
Manager - Licensing and Regulatory Affairs
Exelon Generation Company, LLC

Attachment - License Amendment Request Supplement
Enclosure 1 - Peer Review Findings Resolved and Justified for Closure by Limerick 2016 Pilot Closure Process

cc: USNRC Region I, Regional Administrator
USNRC Project Manager, Limerick
USNRC Senior Resident Inspector, Limerick
Director, Bureau of Radiation Protection – Pennsylvania Department of Environmental Protection

ATTACHMENT

License Amendment Request Supplement

Limerick Generating Station, Units 1 and 2
NRC Docket Nos. 50-352 and 50-353

License Amendment Request to Revise Technical Specifications to Adopt Risk Informed Completion Times TSTF-505, Revision 2, "Provide Risk-Informed Extended Completion Times - RITSTF Initiative 4b."

In Reference 1, Exelon Generation Company, LLC (Exelon) requested an amendment to the Renewed Facility Operating License Nos. NPF-39 and NPF-85 for Limerick Generating Station (Limerick), Units 1 and 2, respectively. The proposed amendment would modify Technical Specification (TS) requirements to permit the use of risk-informed completion times (RICTs) in accordance with the Technical Specifications Task Force (TSTF) Traveler TSTF-505, Revision 2, “Provide Risk-Informed Extended Completion Times – RITSTF [Risk-Informed TSTF] Initiative 4b” (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18183A493).

In Reference 2, the NRC requested that Exelon provide supplemental information by February 15, 2019 to support the acceptance review of the license amendment request. A restatement of the NRC questions followed by our responses is provided below.

<u>Regulatory Basis</u>

This LAR would modify TS requirements to permit the use of RICTs in accordance with TSTF-505, Revision 2.

LAR Attachment 1, Section 1, states:

> The methodology for using the risk-informed completion time (RICT) program is described in Nuclear Energy Institute (NEI) 06-09-A, “Risk-Informed Technical Specifications Initiative 4b, Risk-Managed Technical Specifications (RMTS) Guidelines, Revision 0, which was approved by the NRC on May 17, 2007 [ADAMS Accession No. ML071200238]. Adherence to NEI 06-09-A is required by the RICT program.

NEI Topical Report (TR) 06-09-A (ADAMS Package Accession No. ML122860402) provides guidance for implementation of a generic TS improvement that establishes a risk management approach for voluntary extensions of completion times for certain Limiting Conditions for Operation (LCOs). The NRC staff’s SE, dated May 17, 2007 (ADAMS Accession No. ML071200238), found the guidance in NEI 06-09-A, to be acceptable, with clarifying NRC staff positions, limitations, and conditions. The NEI issued NEI 06-09-A by including the NRC staff’s SE in the front of the NEI 06-09 document, but not incorporating the NRC staff positions, limitations, and conditions into the guidance described in the document. Accordingly, NEI 06-09-A could be acceptable for referencing by licensees proposing to amend their TSs to implement RMTS when the NRC staff positions, limitations, and conditions described in the NRC staff’s SE dated May 17, 2007, are met.

Limitation and Condition 3 in the NRC staff’s safety evaluation on NEI 06-09 dated May 17, 2007 states:

> The LAR will provide a discussion of the results of peer reviews and self-assessments conducted for the plant-specific PRA models which support the RMTS, including the resolution or disposition of any identified deficiencies (i.e., findings and observations from peer reviews). This will include a comparison of the requirements of RG [Regulatory Guide] 1.200 using the elements of ASME [American Society of Mechanical Engineers] RA-Sb-2005 for capability Category II for internal events PRA models, and for other models for which RG 1.200 endorsed standards exist. If additional standards have been endorsed by revision to RG 1.200, the LAR will also provide similar information for those PRA models used to support the RMTS program.

RG 1.200, Revision 2, was issued in March 2009 (ADAMS Accession No. ML090410014), and endorsed with comments and limitations, the ASME/ANS (ASME/American Nuclear Society) Probabilistic Risk Analysis (PRA) Standard 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."

1. Fire PRA supporting requirements that might have been assigned a Capability Category I without any Facts and Observations

LAR Enclosure 2, Section 4, states that a full-scope peer review of the fire PRA was performed in November 2011, using the NEI 07-12 Fire PRA peer review process. NEI 07-12 states that, "[i]f the utility chooses to be reviewed against CC [Capability Category] I for a given SR [supporting requirement], an F&O [fact and observation] need not be written for those SRs if assessed as CC I."

RG 1.200, Revision 2, placed internal fires into the internal hazard category, and endorsed ASME/ANS RS-Sa-2009 Part 4, Technical and Peer Review requirements for At-Power Internal Fires, with comments and limitations.

Therefore, consistent with RG 1.200, Revision 2, and the NRC staff's safety evaluation on NEI 06-09 which describe that a LAR should include a comparison of plant-specific risk models against CCII of the ASME/ANS PRA Standard, provide the following:

i. A statement confirming that the Limerick Fire PRA used to support this LAR was peer-reviewed against ASME/ANS PRA Standard CCII SRs, or
ii. A description of any fire SRs that were assigned a CC I (or not met), but were not provided with an associated peer review F&O, as permitted by NEI 07-12. For each SR assigned only a CC I (or a not met) provide a description of why the SR was not assigned a CC II and disposition the impact of not meeting CC II on this application.

Response

i. The Limerick Fire PRA peer review against the ASME/ANS PRA Standard assessed SRs against CC II.

ii. N/A, see response to i.

2. Use of Facts and Observation closure process prior to final accepted version

LAR Enclosure 2 Sections 3 and 4 state that in July 2016 an F&O closure review was performed by an independent assessment (IA) team on all internal events, internal flooding and fire finding-level F&Os. This July 2016 F&O closure review was a pilot review to develop the process to be detailed in Appendix X to the guidance in NEI 05-04, NEI 07-12, and NEI 12-13 (ADAMS Accession No. ML17086A431). The NRC staff accepted, with conditions, a final version of Appendix X to NEI 05-04, 07-12, and 12-13 in the NRC letter dated May 3, 2017 (ADAMS Accession No. ML17079A427), which differed from the guidance used by the licensee in the July 2016 F&O closure. Therefore, provide the following:

i. A description of the evaluation performed to confirm that the July 2016 IA F&O Closure review is consistent with the Appendix X process as accepted by NRC in the staff memorandum dated May 3, 2017.

ii. The licensee's documented justification and the IA team's documented assessment supporting the classification of each F&O finding resolution for closed F&Os as either a PRA upgrade or PRA maintenance update, as defined in the ASME/ANS RA-Sa-2009 PRA Standard endorsed, with comments and limitations, by RG 1.200, Revision 2.

iii. The IA team's confirmation that for the closed F&Os, the aspects of the underlying SRs in ASME/ANS RA-Sa-2009 that were previously not met, or met at CC-I, are now met or met at CC-II,

iv. Alternatively to items i, ii, and iii above, provide all F&Os (i.e., all those that were not closed by any subsequent focused scope peer review) and their proposed resolution or disposition of impact on the TSTF-505 amendment request.

Response

i. An evaluation was not performed to confirm that the July 2016 IA F&O Closure review is consistent with the Appendix X process as accepted by NRC in the staff memorandum dated May 3, 2017. See Item iv.

ii. See item iv.

iii. See item iv.

iv. The Limerick 50.69 submittal (reference NRC ADAMS ML17179A161) included separate attachments of Peer Review findings that were assessed as either Closed (Attachment 3b in ML17179A161) or Open or Partially Resolved (Attachment 3a of ML17179A161) as of the time of that submittal. Enclosure 1 of this supplement provides the same Peer Review findings that were provided as Attachment 3b of the Limerick 50.69 submittal, including the original Capability Category, which were justified for closure during the 2016 Limerick pilot F&O closure review. Because all of the findings listed in Enclosure 1 have been fully resolved in the current Limerick internal events and internal fire PRA models, Exelon considers these findings no longer relevant to any risk-informed application, including the TSTF-505 amendment request. With resolution of these peer review findings, Exelon considers that the Capability Category II requirements for these internal events and fire PRA supporting requirements are met. These resolutions were reviewed by the NRC as part of the 50.69 LAR and deemed to be acceptable via audit and response to request for additional information (RAI) questions.

The following items were listed in the Attachment 3a of the 50.69 LAR (ref. ML17179A161) but have been subsequently closed via either an Appendix X closure process or a Focused Scope peer review to support 50.69 implementation.

Finding	SR
SY-A11-03	SY-A11
HR-A1-01	HR-A1
1-16	FQ-F1
2-8	PRM-B6

Finding	SR
4-6	HRA-A3
4-30	IGN-A7
4-34	FSS-G1
4-47	FQ-D1

Findings listed in Attachment 3a of the 50.69 LAR (ref. ML17179A161) that have not been subject to an Appendix X closure review, including finding 4-35 (SR FSS-G2), were provided in Tables E2-1 and E2-2 of the Limerick TSTF-505 LAR. All findings listed in Tables E2-1 and E2-2 have been addressed in the Limerick PRA models.

3. Missing discussion and resolution of 50.69 license amendment implementation items

On July 31, 2018 (ADAMS Accession No. ML18165A162) the NRC issued license amendments approving requests to implement 10 CFR 50.69 at Limerick Generating Station, Units 1 and 2. These amendments included the following license condition identifying PRA changes that shall be made prior to implementation of the 10 CFR 50.69 categorization process.

> Exelon will complete the implementation items listed in Attachment 2 of Exelon letter to NRC dated April 23, 2018 prior to implementation of 10 CFR 50.69. All issues identified in the attachment will be addressed and any associated changes will be made, focused-scope peer reviews will be performed on changes that are PRA upgrades as defined in the PRA standard (ASME/ANS RA-Sa-2009, as endorsed by RG 1.200, Revision 2), and any findings will be resolved and reflected in the PRA of record prior to implementation of the 10 CFR 50.69 categorization process.

Attachment 2 of Exelon letter to NRC dated April 23, 2018, included a table listing the implementation items; this table is reproduced below.

Limerick 50.69 PRA Implementation Items	
Description	Resolution
i. Update the HRA pre-initiators in the internal events PRA model to meet Capability Category II of the ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Revision 2, conduct a focused-scope peer review of the pre- initiator analysis, and resolve any resulting F&Os, as indicated in response to RAI 01.a contained in Exelon letter dated January 19, 2018.	The HRA pre-initiators in the internal events PRA model will be updated to meet Capability Category II of the ASME/ANS RA-Sa-2009 as endorsed by RG 1.200, Revision 2. A focused-scope peer review will be conducted of the pre-initiator analysis, and any resulting F&Os will be resolved, as indicated in response to RAI 01.a contained in Exelon letter dated January 19, 2018.

Limerick 50.69 PRA Implementation Items		
	Description	Resolution
ii.	Remove credit for recovery of instrument air from the internal events PRA model, as indicated in response to RAI 01.d contained in Exelon letter dated January 19, 2018.	Credit for recovery of instrument air will be removed from the internal events PRA model, as indicated in response to RAI 01.d contained in Exelon letter dated January 19, 2018.
iii.	Update the success criteria for main steam isolation valve (MSIV) spurious opening, as indicated in response to RAI 02.a contained in Exelon letter dated January 19, 2018.	The success criteria for main steam isolation valve (MSIV) spurious opening will be updated, as indicated in response to RAI 02.a contained in Exelon letter dated January 19, 2018.
iv.	Model undesired operator actions in the FPRA, conduct a focused-scope peer review, and resolve any F&Os, as indicated in response to RAI 02.c contained in Exelon letter dated January 19, 2018.	Undesired operator actions will be modeled in the FPRA. A focused-scope peer review will be conducted, and any F&Os will be resolved, as indicated in response to RAI 02.c contained in Exelon letter dated January 19, 2018.
v.	Update the FPRA model to model junction box fires consistent with frequently asked question (FAQ) 13-0006, as indicated in response to RAI 2.e contained in Exelon letter dated January 19, 2018.	The FPRA model will be updated to model junction box fires consistent with frequently asked question (FAQ) 13-0006, as indicated in response to RAI 2.e contained in Exelon letter dated January 19, 2018.
vi.	Update the FPRA model to incorporate transient fires in the multi-compartment analysis, as indicated in response to RAI 2.f contained in Exelon letter dated January 19, 2018.	The FPRA model will be updated to incorporate transient fires in the multi-compartment analysis, as indicated in response to RAI 2.f contained in Exelon letter dated January 19, 2018.
vii.	Update the pipe rupture frequencies in the internal flooding PRA to the most recent EPRI pipe rupture frequencies, as indicated on page 7 of Exelon supplement letter dated August 14, 2017.	The pipe rupture frequencies will be updated in the internal flooding PRA to the most recent EPRI pipe rupture frequencies, as indicated on page 7 of Exelon supplement letter dated August 14, 2017.
viii.	Remove credit for core melt arrest in-vessel at high reactor pressure vessel (RPV) pressure conditions from the internal events PRA model, as indicated on page 7 of Exelon supplement letter dated August 14, 2017.	Credit for core melt arrest in-vessel at high reactor pressure vessel (RPV) pressure conditions will be removed from the internal events PRA model, as indicated on page 7 of Exelon supplement letter dated August 14, 2017.
ix.	Update the PRA model to account for load shedding when crediting serial operation of high pressure coolant injection (HPCI) and reactor core isolation cooling (RCIC) in loss of offsite power (LOOP) and station blackout (SBO) scenarios, as indicated on page 6 of the Exelon supplement letter dated August 14, 2017.	The PRA model will be updated to account for load shedding when crediting serial operation of high pressure coolant injection (HPCI) and reactor core isolation cooling (RCIC) in loss of offsite power (LOOP) and station blackout (SBO) scenarios, as indicated on page 7 of Exelon supplement letter dated August 14, 2017.

Limerick 50.69 PRA Implementation Items	
Description	Resolution
x. There are several parameters used in the THIEF model that may affect the calculated time available for manual suppression, and therefore, the probability of manual suppression in fire PRA scenarios where manual suppression is credited. Although the impact on the relative importance of modeled components is expected to be small, there is uncertainty associated with these parameters.	As part of the categorization process for the fire PRA, in addition to the list of fire PRA categorization sensitivities specified in NEI 00-04, Table 5-3, a sensitivity will be performed in which credit is taken for immediate manual suppression in scenarios in which manual suppression is already modeled, as indicated in Exelon letter dated April 23, 2018.

The LARs submitted by Exelon to adopt TSTF-505 and implement a RICT program at Limerick Generating Station, Units 1 and 2, do not provide the status of the 50.69 implementation items described above. Therefore, please:

i. Confirm that all of the 50.69 implementation items have been completed, or

ii. If the 50.69 implementation items listed above have not been completed, describe:

a. When the 50.69 implementation items are scheduled to be completed and how this schedule supports the proposed review schedule for the TSTF-505 LAR.

b. How the 50.69 implementation items, which may include additional focused-scope peer reviews which may result in additional F&Os, will be adequately resolved during this LAR review.

c. How potential changes to the risk profile and the total core damage frequency and large early release frequency resulting from completion of the 50.69 implementation items, will be addressed for these LARs.

Response

i. All of the 50.69 implementation items listed above have been completed. These items have been incorporated into the FPIE PRA and FPRA Models of record. These PRA model revisions were completed in 2018. All focused scope peer reviews necessitated by the implementation items listed above have been completed as part of the August 2018 focused scope peer review. All findings associated with the focused scope peer review have been closed in accordance with the Appendix X closure process. Therefore, the LAR reflects resolution of the listed 50.69 implementation items.

ii. Refer to i above.

4. Scope of focused-scope peer review(s)

LAR Enclosure 2, Section 3, states that a focused-scope peer review of changes considered upgrades was performed in August 2018 for the internal events and the fire PRA. The LAR did not provide a description of the August 2018 scope of this focused-scope peer review or if any F&Os were generated. Additionally, a number of the 50.69 implementation items involve performing focus-scope peer review(s). Therefore, provide the following:

i. A description of the scope of the August 2018 peer review.

ii. Describe any other focused-scope peer reviews of the internal events, internal flooding or the fire PRA, performed after the most recent full-scope peer review, that have not been described in the TSTF-505 LAR. These focused-scope peer reviews could have been resulted from either addressing the 50.69 implementation items or from performing other changes to the PRA models.

iii. A description of all F&Os resulting from the focused-scope peer reviews listed in items i and ii above, and for each F&O, a disposition of the impact on this application.

<u>Response</u>

i. The Focused Scope Peer Review included pre-initiators covered by HLR HR-A through HR-D, HR-I, operator response to spurious alarms covered by HLR HRA-A and HRA-E, and fire quantification covered by HLR FQ-A through FQ-F.

ii. No other focused scope peer reviews have been performed beyond those that are listed in the TSTF-505 LAR.

iii. The Focused Scope Peer Review & Finding Level F&O Independent Assessment Report 032362-RPT-10, Rev. 0, Oct. 2018 documents the closure of finding F&Os from the focused scope peer review. The resolved findings are listed in Table 4-1 below. There is, therefore, no impact on the TSTF-505 application from these findings.

Table 4-1
August 2018 Focused Scope Peer Review Findings

F&O # (related F&O if applicable)	Related SR	Basis for Significance	Discussion of Issue	Possible Resolution	Closure Evaluation
3-1	FQ-A4 (QU-A3)	A mean CDF and mean LERF have not yet been developed accounting for the state-of-knowledge correlation for the latest Fire PRA model.	Although parametric uncertainty has been evaluated in the past (2016 model documentation), it has not yet been updated for the 2018 model.	Evaluate parametric uncertainty accounting for the state-of-knowledge correlation (e.g., UNCERT).	**Status: Resolved, PRA Maintenance** Basis: Appendix K of the Limerick Generating Station Fire PRA Summary and Quantification Notebook (LG-PRA-021.11, Revision 0b) provides the updated parametric uncertainty results. Application of the state-of-knowledge correlation is described in Section 3.4 of the Uncertainty and Sensitivity Notebook (LG- PRA-021.12). Therefore, this SR is MET at CC II or higher. No PRA Upgrade (re-performed an existing analysis with the same method. No impact to base model results.)
3-2	FQ-B1	Investigation of U2 LERF slower convergence identified a modeling error (i.e., U2 gate for the Suppression Pool	The incorrect gate type was identified by the utility while responding to a Peer Review question.	Correct the gate type and requantify the model. If the U2 LERF does not converge following model correction, enhance the	**Status: Resolved, PRA Maintenance** Basis: The LG217A1F0 model contains the revised

Table 4-1
August 2018 Focused Scope Peer Review Findings

F&O # (related F&O if applicable)	Related SR	Basis for Significance	Discussion of Issue	Possible Resolution	Closure Evaluation
		Instrument logic (e.g., see gate GHEP50000C-LPRCL) was an AND gate rather than an OR gate as in the U1 model).		documentation to describe the review made to ensure that no significant accident progression sequences for U2 LERF are being missed based on the truncation level achieved.	gate type for GHEP50000C-LPRCL. Therefore, this SR is MET at CC II or higher. No PRA Upgrade (simple logic error correction, per Example 6 in the PRA Standard. No significant changes to model results.)
3-5	FQ-F1 (QU-F1)	Although sufficient model review was presented by the Fire PRA model development team, some level of detail was omitted from the final documentation in two areas. Improving the documentation could facilitate use by analysts not part of the original development team in the future.	Two items are identified where additional detail is judged warranted to support future users who may not have been part of the PRA development team. (1) Although the top CDF and LERF cutsets are presented in the FPRA Summary and Quantification Notebook (e.g., Table 4-4 through 4-7), there is no discussion as to the scenario details (e.g., fire- induced failures that do not appear in the cutset) that present the full picture of impacts. (2) Although accident sequence contributors are presented in graphical form	Include additional detail in the Fire PRA documentation related to top cutsets and top accident sequences. For example, (1) Add a column to Tables 4- 4 through 4-7 in which each of the top 10 cutsets is discussed, including the fire-induced failures that do not appear in the cutset. (2) Add tables that present the significant accident sequences, their contribution, and their general description.	**Status: Resolved, PRA Maintenance** Basis: For comment (1) Tables 4-4 through 4-7 of the Limerick Generating Station Fire PRA Summary and Quantification Notebook (LG-PRA-021.11, Revision 0b) provide additional cutset detail for the top contributors to CDF and to LERF at Unit 1 and Unit 2. For comment (2) Section 4.2 of the Limerick Generating Station Fire PRA Summary and Quantification Notebook (LG-PRA-021.11,

Table 4-1
August 2018 Focused Scope Peer Review Findings

F&O # (related F&O if applicable)	Related SR	Basis for Significance	Discussion of Issue	Possible Resolution	Closure Evaluation
			(e.g., Figures 4-15 & 4-16), there is no discussion of what these sequences represent.		Revision 0b) now includes Table 4-4-0 (CDF) and 4- 4-1 (LERF) that summarizes accident sequences contributing >1% to fire risk, presenting a ready comparison unit to unit. Additionally, pointers to the Event Tree Notebook and Level 2 Notebook have been added where additional details of sequences are provided. Therefore, this SR is MET at CC II or higher. No PRA Upgrade (documentation enhancement only)
3-8	FQ-A4	In review of high CCDP fire scenarios and discussion with the Fire PRA development team it was determined that one high CCDP / CLERP scenario (%F024_MCB07_10C601_648_Y2) with a CCDP of 0.348 was included in the model in error.	One MCR scenario with a high CCDP/CLERP which has been superseded by other refined scenarios should be removed from the single-top model.	Remove the superseded fire scenario from the single-top model.	**Status: Resolved, PRA Maintenance** Basis: Tables B-1 and B-2 of the Limerick Generating Station Fire PRA Summary and Quantification Notebook (LG-PRA-021.11, Revision 0b) now shows this CCDP as 0

Table 4-1
August 2018 Focused Scope Peer Review Findings

F&O # (related F&O if applicable)	Related SR	Basis for Significance	Discussion of Issue	Possible Resolution	Closure Evaluation
		This fire scenario was refined and superseded but was inadvertently not removed from the single top model.			(not modeled) for Unit 1 and Unit 2. Therefore, this SR is MET at CC I-III. No PRA Upgrade (removing a fire scenario does not involve a new method, similar to Example 6 in the PRA Standard for correcting a logic error. No significant changes to model results.)
3-9	QU-D7	The pre-initiator DXV193DMI is risk significant for LERF and therefore requires a detailed HEP per SR HR- D2.	When reviewing importance measures, one HRA pre-initiator (DXV193DMI; PRE-INIT - RECIRCULATION PUMP SDC PATH RESTORATION ERROR) that uses a screening HEP (1E-02) was found to be risk significant for LERF (i.e., FV=0.00956) and therefore requires a detailed HEP per SR HR-D2.	Develop a detailed HEP for pre-initiator DXV193DMI.	**Status: Resolved, PRA Maintenance** Basis: Section 3.1.15 and Appendix B.22 of LG- PRA-004 Volume 2 provide a detailed analysis of pre-initiating event human failure event DXV193DM and the value is included in the single top model. Therefore, this SR is MET at CC II or higher. No PRA Upgrade (applied existing HRA methods to one more

Table 4-1
August 2018 Focused Scope Peer Review Findings

F&O # (related F&O if applicable)	Related SR	Basis for Significance	Discussion of Issue	Possible Resolution	Closure Evaluation
					pre-initiator, per Example 20 in the PRA Standard. No significant changes to model results.)

5. Additional justification required by TSTF-505, Revision 2, Table 1

Table 1, "Conditions Requiring Additional Technical Justification," of TSTF-505 Revision 2 contains a list of required actions that may be proposed for inclusion in the RICT Program, but requires additional technical justification to be provided by the licensee.

The following LCOs are proposed to be included in the scope of the RICT program, but are identified in Table 1 as requiring additional justification:

3.3.4.2: End of Cycle Recirculation Pump Trip (EOC-RPT) Instrumentation (mapped to TSTF-505 NUREG-1433 Condition 3.3.4.1.A)

3.7.8: Main Turbine Bypass System (mapped to NUREG-1433 Condition 3.7.7.A)

Consistent with TSTF-505 Revision 2, Table 1 provide:

i. Justification for the ability to calculate a RICT for the LCOs above, including how the system is modeled in the PRA, whether all functions of the system are modeled, and, if a surrogate is used, why that modeling is appropriate.

Response

TS 3.3.4.2
As indicated in the Enclosure 1 Table E1-1 of the LAR, the EOC-RPT is explicitly modeled in detail in the Limerick PRA and, therefore, a RICT can be calculated. The TS function described in Attachment 1 of the LAR is the PRA modeled function. There are no non-modeled functions for this system. The proposed change to the Action statements for this TS include a note restricting the use of RICT if trip capability is not maintained. Therefore, the LCO meets the listed requirements for inclusion in the RICT program.

TS 3.7.8
The Main Turbine Bypass Valves are modeled in a conservative fashion in the Limerick PRA as noted in Table E1-1 of Enclosure 1 of the LAR. Therefore, the RICT can be calculated for this LCO. The TS function to limit peak pressure in the main steam lines and to maintain reactor pressure within acceptable limits during events that cause rapid pressurization is the PRA modeled function. The combined pressure control function of the turbine control valves and bypass valves while the main turbine is online is not modeled but this is not a mitigation function that would affect risk. Therefore, the LCO meets the listed requirements for inclusion in the RICT program.

Additional Observations

While not determined to be sufficiency or completeness of scope items, the NRC staff made the following additional observations during its initial review of this LAR that may, upon additional detailed review, require additional information:

1. <u>NUREG-1855 guidance revisions</u>

LAR Enclosure 4, Information Supporting Justification of Excluding Sources of Risk not Addressed by the PRA Models, references Revision 1 of NUREG-1855, “Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decision Making.” LAR Enclosure 9, Evaluating Key Assumptions and Sources of Uncertainty, references Revision 0 of NUREG-1855 (ADAMS Accession No. ML090970525). NUREG-1855 most directly supports the evaluation done in Enclosure 9. Revision 1 of NUREG-1855 (ADAMS Accession No. ML17062A466) references EPRI TR-1026511 “Practical Guidance on the Use of PRA in Risk-Informed Applications with a Focus on the Treatment of Uncertainty”, which includes guidance and generic issues on key assumptions and sources of uncertainty associated with the fire and external hazard PRAs. Therefore, provide the following:

i. Confirmation that the evaluation of key assumptions and sources of uncertainty provided in LAR Enclosure 9 was done using Revision 1 of NUREG-1855, or
ii. A supplement which is consistent with Revision 1, or
iii. Justification for why the use of Revision 0 of NUREG-1855 is adequate for this application.

<u>Response</u>

The evaluation of key assumptions and sources of uncertainty provided in LAR Enclosure 9 was done using Revision 1 of NUREG-1855. The reference in Enclosure 9 is incorrect and should be NUREG-1855 Revision 1 consistent with Enclosure 4.

<u>References</u>

1. Letter from J. Barstow (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, “License Amendment Request to Revise Technical Specifications to Adopt Risk Informed Completion Times TSTF-505, Revision 2, 'Provide Risk-Informed Extended Completion Times - RITSTF Initiative 4b'," dated December 13, 2018 (ADAMS Accession No. ML18347B366).

2. Letter from V. Sreenivas (U.S. Nuclear Regulatory Commission) to B. Hanson (Exelon Generation Company, LLC), "Limerick Generating Station, Units 1 and 2-Supplemental Information Needed for Acceptance of Requested Licensing Action to Adopt Risk-Informed Completion Times in Accordance with TSTF-505, Revision 2 (EPID L-2018-LLA·0567), dated January 30, 2019 (ADAMS Accession No. ML19030A147).

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IE-A7-01	IE-A7 Now IE-A9 Cat I	Cat II	Category II requires a review of initiating event precursors. There was no documentation demonstrating that this review was performed.	RESOLVED. Appendix D of the initiating event notebook contains a listing of all LERs over the ten year period preceding the last PRA update and their disposition in terms of their relevance to PRA initiating events.
IE-D3-01	IE-D3 Cat I/II/III	Cat I/II/III	Key assumptions and key sources of uncertainty are not specifically identified in the documentation by element. The summary document does include a list of key model uncertainties and includes a number of sensitivity cases; however, it is not clear that it goes far enough to support the intent of the latest requirements. A systematic process should be documented considering each of the standard PRA elements, including appropriate definitions. It is recognized that EPRI is preparing a product intended to address this issue and Limerick is a pilot plant. A draft of the EPRI uncertainty report	RESOLVED. The Summary Notebook includes a comprehensive characterization of key assumptions and model uncertainty. The results of that assessment are factored into the identification of potentially key assumptions for applications of the model.

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			for Limerick was provided which represents the state of the art in this area. When finalized, this document is expected to meet the intent of the supporting requirements.	
AS-A5/A6-01	AS-A5 Cat I/II/III	Cat I/II/III	MSIV re-opening is modeled in many of the transient event trees. It is unclear whether this action would be directed via EOPs (either 100 or 101) or other procedures. This action provides minimal mitigative potential due to the timing and equipment necessary for successful operation or restoration of FW and PCS in short term scenarios. Also, recovery of feedwater is also modeled in transient event trees and fault trees. FW recovery requires MSIV re-opening and provides limited mitigative potential. In the IORV/SORV event tree, both MSIV re- opening and FW recovery are modeled. It is likely that level control issues as well as action timing would prevent MSIV re-	RESOLVED. As a result of Finding 86 (FPIE PR) QU-A4-01, which questioned credit for FW/PCS recovery, credit for re-opening the MSIVs was removed during the 2008 update.

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			opening for a large spectrum of initiating events in which it is credited.	
AS-B3-01	AS-B3 Cat I/II/III	Cat I/II/III	Loss of coolant accidents outside primary containment are modeled in several event trees. The discussion contained in the event tree notebook indicates that there are no additional impacts associated with the breaks of RWCU, main steam, HPCI and others when the break occurs outside the containment.	RESOLVED Section 18 and 19 of the Event Tree Notebook documents consideration of other impacts of breaks outside containment, and a basis was provided for cases where no impacts were expected. There was a discussion of how RHRSW would be failed in the case of an ISLOCA in one of two core spray lines.
AS-B6-01	AS-B6 Now AS-B7 Cat I/II/III	Cat I/II/III	Vapor suppression via manual actuation of drywell sprays and rapid depressurization are each assigned an HEP of 0.1 for medium LOCAs. This results in a combined HEP for the two actions ("ANDed" together) of 1E-02 per demand. It is judged that these actions should be assigned a high probability of failure given the timing of the event sequence, specifically the timing to reach containment failure.	RESOLVED. The two separate actions were combined into a single action, VHUDS1DXI "FAILURE TO CONTROL CONTAINMENT PRESSURE IN MLOCA WITH VS BYPASS," with a common cognitive. This represents the likelihood that the operators fail to recognize the need to control containment pressure (which fails all methods) or that they fail to execute the control using one of the two available methods. The individual 0.1 screening HEPs were replaced with a detailed analysis to develop an overall HEP that accounts for the

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				dependencies.
SC/SY-B1-01	SC-B1 Cat II	Cat II	The success of fire water makeup to the vessel to prevent core damage after depressurization needs a rigorous analysis. Currently, the fire pump and operator action to crosstie fire protection water to RHR is modeled as a "super component" with a probability of failure of 0.5. Reportedly, the probability is high to include the uncertainty as to whether or not the fire protection system can actually prevent core damage after depressurizing the reactor and within four hours after an initiating event. The failure to crosstie fire water to RHR appears in the third highest frequency core damage cutset and has a RAW of 1.05. Choosing a 0.5 probability of	RESOLVED. A detailed HRA calculation was performed for aligning fire water makeup to the reactor vessel as documented in FPIE PRA Post Initiator Calculation: A29 (Operator fails to cross-tie fire water to RHR). Further discussed in response to RAI 1.d in ML18019A091, Response to request for additional information application to adopt 10CFR50.69: “The Limerick PRA RHR System Notebook documents the ability of the fire water system to provide 300 gpm of water to the reactor vessel when the pressure of the reactor vessel is 100 psig or less. This confirms that sufficient flow and amount of water is

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			failure for this event is tantamount to using a screening value. Screening values should not appear in the dominant cutsets.	available as assumed for the HRA calculation. This alternate injection source is modeled as a success path in the PRA in late scenarios when the RPV has been depressurized.”
SC/HR-B1-03	SC-B1 Cat II	Cat II	The HRA calculation for manual depressurization for Medium LOCA events (HRA Notebook Calculation #45) credits an available time of 22 minutes based on MAAP run LI0035a. MAAP Case LI0035a (Success Criteria Notebook, Table A-1) states that the break area is 0.01 ft2 (equivalent to a 1.4" diameter line break) for the Medium LOCA event. This break size seems more consistent with a Small LOCA event. This same issue exists for MAAP Cases LI0031, LI0033, and LI0035. Using a larger break size (e.g., 4" diameter) could significantly decrease the estimated time available to	RESOLVED. A detailed HRA calculation was performed for operator failure to initiate emergency depressurization (medium LOCA, steam break) as documented in FPIE PRA Post Initiator Calculation: A14 (AHUSS1DXI, operators fail to initiate emergency depressurization (medium LOCA, steam break). A detailed HRA calculation was performed for operator failure to initiate emergency depressurization (medium LOCA, water break) as documented in FPIE PRA Post Initiator Calculation A16 (AHUWS1DXI, operators fail to initiate emergency depressurization (medium LOCA, water break).

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			manually depressurize for Medium LOCA events.	
SY-A6-03	SY-A6 Cat I/II/III	Cat I/II/III	The HVAC notebook excludes CCF of EDG fans based on it being included in the EDG CCF values. This may not be true. If HVAC failures were included in the EDG, then HVAC modeling for EDGs is not required at all.	RESOLVED. Appendix I of the data notebook, Volume 1 Table I-1 defines the equipment boundaries. For the EDGs Room heating and ventilating is not included. Appendix A, Section A.10 of the data notebook, Volume 2 documents the CCF analysis for the EDG ventilation fans. The CCF for failure pairs are included for the fans.
SY-A11-01	SY-A11 Now SY-A10 Cat I/II/III	Cat I/II/III	The diesel cooling, after a LOOP event, credits ESW and RHRSW. RHRSW has two locked closed valves that must be opened and the RHRSW pumps manually started in order to establish cooling to the diesels. Early flag events fail this crosstie with operator action WHURSWDX10.	RESOLVED. The logic for crediting RHRSW to ESW cross-tie capability is removed in the current model.

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			However, when the long term flag, XHOSHR, is used the crosstie succeeds 90% of the time. It is inappropriate to credit RHRSW for diesel cooling since, given a LOOP, the diesels auto start and require cooling within a few minutes. RHRSW being available via the crosstie after 5 hours does not meet the immediate cooling requirement. It is understood that the EDGs will trip on high temperature for LOOP events. Given this trip occurs, the model should account for the operator action and time involved in reestablishing cooling and restarting the EDGs.	
SY-A11-04	SY-A11 Now SY-A10 Cat I/II/III	Cat I/II/III	Fault tree GEP11423 (typical) is used as the ESW power supply for pump A of loop A. This fault tree credits cross tying the 4 KV buses. Ultimately, the 4 KV cross tying is credited for the ESW power when ESW is cooling the diesels. No credit should be given for 4 KV crossties to power ESW when ESW is cooling the diesels since there is insufficient time to perform this task before the diesels overheat. The	RESOLVED. The model logic was changed to only credit crosstie actions > 2hrs. See the 4kV system notebook.

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			application of the 4KV crosstie should only be used in scenarios where the powered equipment is not needed until the crosstie can be accomplished per the plant procedures. This same concern applies to the 480V loads that are fed from 4KV.	
SY-A12b-01	SY-A12b Now SY-A13 Not Met	Met	The failure of the HPCI minimum flow valve to close will cause a flow diversion which can challenge the CST inventory. The minimum flow valve failure to close should be modeled and water inventory addressed. Note: if HPCI is operated with elevated suppression pool temperatures, switching HPCI suction to the suppression pool can cause HPCI to fail from inadequate lube oil cooling.	RESOLVED The HPCI injection line has a diameter of 14". The min flow line has an orifice with a diameter of 1.7". Given these diameters, the flow area is approximately 150sq. in. and the flow area of the min flow line is approximately 4 sq. in. A general assumption used in many PRAs that has been traditionally accepted is that a flow diversion with area less than 10% of the main flow path is considered negligible (because of conservatisms in the design basis) without the need to perform a specific analysis. Therefore, modeling of this flow diversion is not required.

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SY-A13-01	SY-A13 Now SY-A14 Cat I/II/III	Cat I/II/III	Spurious operation of instruments and transmitters that can trip a mitigating system have not been included in the system fault trees. Note that the ASME Standard makes a distinction between miscalibration and spurious operation.	RESOLVED. The data notebook, Table D-1 documents the failure probability for miscalibration and spurious operation. The failure probability for spurious operation are two orders of magnitude less than those for miscalibration (spurious operation 1% of miscalibration). SR SY-A14 states "One or more failure modes for a component may be excluded from the systems model if the contribution of them to the total failure rate or probability is less than 1% of the total failure rate or probability for that component, when their effects on system operation are the same." Therefore, excluding the spurious operation failure mode is acceptable.
SY-B8-01	SY-B8 Cat I/II/III	Cat I/II/III	A calculation justifying HPCI operation beyond six hours is needed. It is not adequate to assume that if suppression pool cooling is available HPCI room cooling is available.	RESOLVED. A best-estimate analysis of room heatup for HPCI was performed (it was also performed for RCIC, although this was not a subject of the Finding). The calculation (CC-AA-309-1001, Rev. 7, Calc LM- 0400) shows that the room temperatures for each room reach a stable

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				temperature after a few hours and that temperature is maintained from that point forward by natural processes. In each case, temperature margin against failure is maintained. Therefore, room cooling is not required.
HR-G4-01	HR-G4 Cat III	Cat III	The assumed time available to manually depressurize the RPV for non-ATWS events is assumed to be 55 minutes, based on the time to core damage (HRA Notebook, Appendix A, Calculation 33, MAAP Case LI0008). Using the entire time to core damage as the time available for manual depressurization could be non-conservative. The HRA Notebook states that *"Once depressurization starts, steam cooling will prevent core damage, thus depressurization is credited to the point of when core damage is estimated to begin."* This statement is judged not to be supported by the Limerick MAAP cases.	RESOLVED. Appendix A of the HRA Notebook (LG-PRA-004, Rev. 3) shows that the time used for time available to depressurize (using two valves) is 38.9 minutes. It is stated that this is based on analysis provided in the SC notebook, section 3.3.2.

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			A similar MAAP case (Case LI0012) indicates that if manual RPV depressurization with 2 SRVs is initiated at 49 minutes (i.e., time to TAF + 30 minutes), core damage would still occur at 54 minutes. MAAP Case LI0012 appears not to support using the entire time to core damage as the time available for manual RPV depressurization. In addition, MAAP Case LI0011 indicates that if manual RPV depressurization with 2 SRVs is initiated at 39 minutes (i.e., time to TAF + 20 minutes), then core damage can be averted.	
HR-H3/I1-01	HR-H3 Cat I/II/III	Cat I/II/III	Common cause operator error events are included across system boundaries, but it appears that some cross system combinations are not addressed, but rather are dismissed as risk negligible.	RESOLVED. The HRA notebook Section 5.2 discusses the process used to identify the HFE combinations that have the potential to be significant risk contributors due to dependency analysis. The process followed, which sets the HEPs to artificially high values so that the combinations come to the top, is typical of current practice across the industry. The

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				dependency levels are based on consideration of PSFs and implemented in the HRAC, with manual adjustments made based on specific review of the combinations. This process makes no distinction regarding whether or not the dependency is across system boundaries since all HFEs are assigned the same high values, thus all important combinations are captured. Additional details on the analysis of key combinations are provided in Appendix H.
DA-B1-01	DA-B1 Cat II	Cat II	Category II requires usage characteristics to be included in the component grouping. The use of maintenance rule data may take this into account for some components, however, there is no discussion to support the extent to which this requirement is met.	RESOLVED. The updated data analysis utilizes groupings consistent with the available data including the recently implemented generic data from NUREG/CR-6928. Section 2.6 and Appendix F of the data notebook provides a description of type codes used in the model.
DA-B2-01	DA-B2 Cat I/II	Cat I/II	There is no discussion of unique components or how outliers (if any) were treated. No specific examples were found that created an issue, however there is no assurance that they were evaluated.	RESOLVED. Section 2.6 and Appendix B of the data notebook provides a description of plant-specific data used in the model. Section B.1 documents that the plant specific data analysis included consideration for excluding

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				outliers in the data. That is, infrequently tested/operated components were not included in the plant specific data update group.
DA-C6-01	DA-C6 Not Met	Met	The methods used to determine exposures (demands, runtime, etc.) were not documented. The reviewer could not validate how demands were obtained.	RESOLVED. The data notebook was updated to clearly identify the MSPI as the primary data source for demands, runtime, etc., with the Maintenance rule providing functional failure data. Component failure data, demands, and run hours compiled by Limerick system managers was used for some key SSCs that are not within the scope of the Limerick Maintenance Rule Program's data collection and reporting efforts or the Limerick MSPI basis document. The results of the data collection were confirmed with system engineer interviews. See Appendix B of the Data Notebook for details of the discussions held with the system managers.

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DA-C7-01	DA-C7 Not Met	Met	The methods used to determine exposures (demands, runtime, etc.) were not documented. The reviewer could not validate how demands were obtained.	RESOLVED. See DA-C6 disposition.
DA-C10-01	DA-C10 Cat II	Cat II	There is no documentation to support this requirement. If surveillance test data was not used, then this SR is "n/a". Otherwise, additional documentation is needed to determine how surveillance test data was used as a basis to count component demands to validate that the SR is met.	RESOLVED. Section C.4, Table C-4, of the data notebook, Volume 1 includes details on the basic events that are calculated using quarterly or bi-annual surveillance interval. Tables B-3 through B-6 provide the plant specific maintenance rule and MSPI component experience data. The use of this data is sufficient to meet the intent of the SR.
DA-C12-01	DA-C12 Now DA-C13 Cat I/II/III	Cat I/II/III	Category II requires interviews of maintenance and operations for significant basic events. The significant basic events are not specifically defined although the documentation indicates that engineering had input. It	RESOLVED. The maintenance data is taken directly from the MSPI when possible. In the situations that reliable estimates for particular equipment are not available, interviews with

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			is likely that engineering used maintenance and operations input but this is not documented.	system engineers were performed to generate/confirm the unavailability estimates used in the PRA. During the 2013 PRA Update system manager interviews, system unavailability was discussed with the respective system manager. The change in the unavailability value in comparison to the previous update (2008 PRA Update) was discussed. During this discussion, reasons for the unavailability values increasing or decreasing were provided. These notes are documented in Appendix H of the data notebook, Volume 1.
DA-C14-01	DA-C14 Now DA-C15 Cat I/II/III	Cat I/II/III	Hardware recoveries are applied to EDG, IA, RHR, RHRSW, and ESW. There was no plant specific data used to determine Mean Time To Repair (MTTR) values and some of the data sources (WASH-1400 and IEEE-500) are dated. Standard practice excludes hardware recoveries, especially when there is minimal benefit. The summary document indicates about a 1% CDF impact due to the hard ware recoveries. A second recovery term is also applied in the level 2 fault trees	RESOLVED. Appendix G of LG-PRA-010 Data 2013 V1 addresses the hardware recoveries are applied to EDG, IA, RHR, RHRSW, and ESW. Section G.1 addresses recovery estimates and G.2 addresses repair estimates. Section G.2.1.13 of LG-PRA-010 Data 2013 V1 addresses EDG repair times. Section G.2.2 addresses IA repair time. Section G.2.3 addresses RHR. RRHSW, and ESW repair times. Further discussed in response to RAI 1.d in

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			with very little explanation.	ML18019A091, Response to request for additional information application to adopt 10CFR50.69: "The Limerick PRA Data Notebook provides historical information on repair estimates for EDGs and RHRSW / ESW / RHR pumps. However, the basic events modeling these repairs are set to "T" (True) in the Limerick PRA flag file and are compressed out in the quantification process. Therefore, repair of SSCs modeled by these events is not credited in the PRA model. The Limerick PRA Data Notebook evaluates the recovery of instrument air only for the purpose of recovering the emergency containment vent. This evaluation is based on judgment, consideration of Limerick accident scenario specifics (MAAP runs), and review of industry studies (EPRI study NSAC-161, WASH-1400). The recovery of instrument air has been included in the model based on this recovery evaluation. Given that there is uncertainty in the recovery steps that would be taken to recover

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				instrument air to support containment venting, this event is being set to 'True' in the flag file during the current PRA model update and thus will also be compressed out of the quantification process."
QU-A4-01	QU-B4 Cat I/II/III	Cat I/II/III	The quantification results provide credit for hardware recovery of FW/PCS, ESW, RHRSW, and EDGs based on WASH-1400 MTTR models or other repair models. There appears to be more credit for hardware recovery than in most industry PRAs. (See similar F&O for supporting requirement DA-C14.)	RESOLVED. Credit for repair of EDGs, and RHRSW, RHR, and ESW pumps was removed from the model as part of the 2008 update. Recovery of FW/PCS requires re-opening of the MSIVs. Credit for re-opening the MSIVs was also removed during the 2008 update. Further discussed in response to RAI 1.d in ML18019A091, Response to request for additional information application to adopt 10CFR50.69: "The Limerick PRA Data Notebook provides historical information on repair estimates for EDGs and RHRSW / ESW / RHR pumps. However, the basic events modeling these repairs are set to "T" (True) in the Limerick

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				PRA flag file and are compressed out in the quantification process. Therefore, repair of SSCs modeled by these events is not credited in the PRA model. The Limerick PRA Data Notebook evaluates the recovery of instrument air only for the purpose of recovering the emergency containment vent. This evaluation is based on judgment, consideration of Limerick accident scenario specifics (MAAP runs), and review of industry studies (EPRI study NSAC-161, WASH-1400). The recovery of instrument air has been included in the model based on this recovery evaluation. Given that there is uncertainty in the recovery steps that would be taken to recover instrument air to support containment venting, this event is being set to 'True' in the flag file during the current PRA model update and thus will also be compressed out of the quantification process."

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QU-B4-01	QU-B4 Not Met	Met	There are several cases where basic event probabilities exceed 0.1. In some cases, the basic event probabilities are significantly greater than 0.1 and occasionally 1.0 is used to represent logic or events that are no longer used. In these cases, the rare event approximation is not valid. When used under "OR" gates, this treatment can be excessively conservative and potentially invalid. In addition, this treatment can increase the complexity of model review since some events that appear in the logic are actually not used (i.e., assigned a failure probability of 1.0). See also supporting requirements AS-C1 and QU-B8.	RESOLVED. The issue is addressed by the conversion to CAFTA, the associated use of TRUEs (.T.) as opposed to 1.0 probabilities, and the upper bound algorithm in CAFTA. Most of the basic events that have values greater than 0.1, have a probability of 1.0 (not credited HEPs, flag events, recovery tags, etc.). These are set to .T. in either the flag file or the recovery file. Those events that are greater than 0.1 but not 1.0 are mostly Level 2 phenomenological basic events in which there may be little basis to refine the point estimate. There are also some HEPs that could have a probability greater than 0.1 which are refined during the HRA update. Other basic events could be fractional multipliers (0.5 of the time pump A is running and 0.5 of the time pump B is running) which are modeled under AND gates. For those 1.0 events that represent logic or events that are no longer used (repair events, etc.), the basic events are set to .T. in the flag file which compresses that particular logic out during quantification.

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QU-B8-01	QU-B8 Now QU-B9 Not Met	Met	There are several cases where logic in the model has been "disabled" via the use of failure rates of 1.0. Several cases are noted as follows: • LPIC "A" fault tree page 7 models the cross-tie for A&C but the HEP values used are 1.0 for all cases. • Accident class IIID event tree contains nodes that are not used since the conditions for the failure of containment are known prior to entering the event tree. • LPI fault tree (VTR 2), specifically the gates for early injection and the basic event for operators fail to open RHRSW cross-tie are assigned a 1.0. • In the event tree notebook, page 22-12, gate GBD2532 is an "OR" gate with event HHUFWXDX1 which is set to a probability of 1.0. This treatment poses several issues. These include the unnecessary complexity of the model, difficulty in reviewing the model as well as the	RESOLVED. For those 1.0 events that represent logic or events that are no longer used (repair events, etc.), the basic events are set to .T. in the flag file which compresses that particular logic out during quantification. The LPCI A cross tie value for realigning the crossover valve DHU82XDXI was set to 1.0 in the fault tree and .T. in the flag file. Accident Class nodal basic events not used are set to .T. in the flag file. The Level 2 Notebook provides details on the containment event trees (CET). The RHRSW crosstie for injection action specific to MLOCA scenarios (JHU073DXI) which is set to 1.0 and .T. in the flag file. Basic Event HHUFWXDXI Failure To Isolate HPCI Injection Through Core Spray Line (ATWS) is set to 1.0 in the model and .T. in the flag file.

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			increased potential for misinterpretation of the model. In addition, in certain circumstances the mathematics of Boolean logic may be adversely impacted due to violation of the rare event approximation as well as the generation of non-minimal cutsets.	
QU-D1c-01	QU-D1c Now QU-D3 Cat II/III	Cat II/III	In Table 3.5-1 of the PRA Summary Notebook, LERF cutset #3 (2.94E-9/yr) appears to be non-minimal compared to LERF cutset #2 (1.32E-8/yr). Cutset #2 includes an HEP of 1.0 for RHRSW crosstie injection. A secondary failure of 0.223 to preclude the RHRSW crosstie is non-minimal compared to cutset #2. This leads to a conservative result. Eliminating this cutset would reduce the LERF by approximately 5%.	RESOLVED. For those 1.0 events that represent logic or events that are no longer used (repair events, etc.), the basic events are set to .T. in the flag file which compresses that particular logic out during quantification. The modeling continues to be captured in the CAFTA model for historical purposes.
QU-D3-01	QU-D3 Now QU-D4 Not Met	Met	The PRA Summary Notebook provides a table to compare CDF results to other Exelon plants. However, the documentation does not provide any discussion for the differences in the results.	RESOLVED. Table 4.6-1 compares the current CDF results for all BWR Exelon PRAs as a function of Accident Class. The CDF for Limerick is in the middle range for the Exelon BWR plants.

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				Table 4.6-2 provides a detailed contribution breakdown by initiating event. The notes to this table also provide discussion of differences. The comparison of the Limerick PRA is performed on two levels: The plant system comparison and the model comparison These comparisons allow the insights derived from the uncertainty analysis on a similar plant to assist in the identification of insights on Limerick. The comparison plant used here is a composite or "typical" plant. The first examination addresses the plant system comparison. Table I.5-3, Critical Safety Functions At Limerick Compared With "Generic" BWR," compares the plant systems and identifies the potential impact on the risk spectrum.
LE-C9a-01	LE-C9a Now LE-C11 Cat II/III	Cat II/III	For Loss of Vapor Suppression events (Level 1 Accident Class 3D), the Level 2 analysis is modeled with a detailed containment event tree. Most industry Level 2 PRAs model Loss of Vapor Suppression core damage events as leading directly to a Large, Early	RESOLVED. Treatment of vapor suppression failure cases (Accident Class 3D) now lead directly to a Large, Early Release. Reviewed the Level 2 Fault and Event Trees for the DI, RX, and CZ nodes and confirmed that the probabilities

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			Release for the following reasons: ·Loss of Vapor Suppression events would cause a rapid pressurization of the drywell and result in drywell overpressure. The Level 2 node that addresses the status of the drywell (DI node) should have a probability of 1.0 instead of 0.26. ·The failure of the drywell could have a significant impact on the ability for continued RPV injection (e.g., pinching of the injection piping). This would lead to high failure probability for in-vessel recovery (Level 2 RX node). ·The Level 2 Containment Intact node (CZ node) should be 1.0 because early containment failure is guaranteed for Loss of Vapor Suppression events.	were set to 1.0 which are subsequently set to .T. in the flag files to effectively remove the logic during quantification.
IF-C3-01	IF-C3 Now IFSN-A6 Cat I	Cat II	Failure by spray and submergence were considered for all internal flooding initiating events. Section 2.2.5 stated that dynamic effects of pipe breaks were considered in the design process and that the effects were not considered further in the internal flooding PRA. No documentation of	RESOLVED. Pipe whip effects were investigated and determined to not be a concern for piping containing moderate energy water sources. Jet impingement effects were also determined to not be a concern for piping encapsulated by aluminum lagging. Section

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			the specific equipment evaluated in the PRA compared to equipment considered in the design analyses, e.g., EQ lists, was documented Since the PRA can credit non-safety-related equipment, relying on design basis evaluations to dismiss these dynamic effects may credit equipment that cannot withstand the effects considered in the design analysis. Also, the PRA models may evaluate breaks beyond those of the design basis.	3.4.9 of the internal flood notebook provides additional information to address pipe whip and jet impingement concerns. Any damage inflicted on plant equipment due to sprays from a pipe rupture were shown to affect only those components located within a radius of influence of about 16 feet, which implies that whether due to water sprays or jet impingement, equipment located within this radius of influence was considered to be rendered unavailable. Section 3.4.18 addresses pipe whipping due to HELB.
IF-E6-01	IF-E6 Now IFQU-A7 Not Met	Met	No quantification of flood-related LERF is performed or documented.	RESOLVED. Section 4.2, Figure 4.2, and Figure 4.4 of the internal flood notebook provide results of flood- related LERF. Flood scenarios that contribute to LERF are quantified. Figure ES-2A and Figure ES- 3B of the summary notebook provide flood-related contributions to total LERF.

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IF-F3-01	IF-F3 Now IFQU-B3 Not Met	Met	Discussion of Issue: Sources of uncertainty and assumptions associated with the internal flooding analysis were not documented in the analyses reviewed.	RESOLVED. The internal flood notebook was updated to include uncertainty and assumptions. Section 2.2 includes assumptions and Appendix G includes uncertainty and sensitivity.
1-1	ES-C1 Not Met	Met	No instrumentation related to the operator actions are identified and modeled in Limerick fire PRA. This results in a limited amount of instrumentation included in the equipment list, consisting of the SSEL instruments (Rx Level, Pressure, etc.). Additionally, the FPRA modeling does not fully model the impact of failed instruments. In particular, the HRA is performed assuming the non-credited instruments are not available. Overall, the resulting HEPs are conservative resulting in an overall estimate of CDF from operator failures that is conservative.	RESOLVED. Instrumentation supporting human failure events is currently explicitly modeled in the Fire PRA. The plant response model has been expanded to include explicit logic for the instrumentation. The documentation is available in both the equipment selection and plant response model notebooks The appropriate instruments have been assigned and modeled for the corresponding human failure events in the HRA analysis.

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1-8	IGN-B5 CC I/II/III	CC I/II/III	Section 1.3.3 of the FIF Notebook describes the assumptions and uncertainty sources. However, these uncertainty parameters for fire ignition frequencies are changed to other distribution types from the original (ex: variance to lognormal in the final quantification), but no description is provided for the impact on uncertainty changes.	RESOLVED. The lognormal distributions from NUREG-2169 were used to quantify uncertainty. These distributions are documented in the ignition frequency and uncertainty notebooks.
1-11	HRA-A2 Cat I/II/III	Cat I/II/III	Procedures referred for this operator actions are SE-1 and SE-6 which are dedicated to remote shutdown and alternate shutdown. However, the operator actions are applied to other sequences as well as MCR abandonment scenario. - SE-1 or SE-6 is applicable for only when specific condition is provided to operators as described in the procedures. - This operator action requires at least one of multiple cue information. Without modeling of indication(s),	RESOLVED. The discussion provided in the assessment of this HFE in the fire HRA notebook states that credit for the local action is based on a general instruction to try to open the valve, and that because of the training given at Limerick the operators would try all means to open the valve, including locally, even if not specifically stated in the procedure (that is, the operators interpret the instruction "open the valve" as including local operation if remote operation fails). Some credit in such an instance is reasonable. The HRA modelling takes credit for the existence of a procedure (other than SE-1 and SE-6) that gets the

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			the HEP should be 1.0. -for information, note that internal logic doesn't have a auto signal logic as well as manual action. Reviewer's key concern raised for SR, HRA-A2 is the potential unavailability of cue information due to fire damage and this concern is not limited to the OA, JHUSPVDX10. Other examples identified are AHUXTRDXI(-R1) and ZHULVCDXI. In case of AHUXTRDXI(-R1), HRA report (LG-PRA-021.04) presents some of cue information and HEP was calculated based on the availability of indications in the MCR and relied on fact that SSEL has RPV pressure and level instruments. To support validity of HEP calculated for AHUXTRDXI (- R1), availabilities of cue information including their dependencies (power, interlock) need to be reviewed for every related scenario or to be included in the logic model.	operators to that point during non-abandonment scenarios. In this case, the non- abandonment procedure T-102 PRIMARY CONTAINMENT CONTROL would lead to an instruction calling for the re-alignment. OP-LG103- 102-1002STRATEGIES FOR SUCCESSFUL TRANSIENT MITIGATION would provide for critical parameter monitoring that would also lead to instructions for re-alignment. Thus there are other, non-abandonment procedures that would lead to the actions. The FPRA was updated to include the credited cues in the logic model. Appendix D of the equipment selection notebook and Appendix A of the fire HRA notebook provides the details regarding which instruments are included for each action. The general assumption regarding the availability of instruments because the instrument is on the SSEL is no longer used. Instrumentation logic (and the applicable power supplies) is included with the operator actions as applicable. Cables are included in the FPRA model such that if a cable is damaged in a given fire scenario then the instrumentation logic would fail.

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			However, it was identified that neither of the above were addressed in the Limerick fire PRA for these example events.	
1-15	HRA-A2 (HR-E3) Not Met	Met	No discussion is provided in PRA-021-04 of the FPRA for review and interpretation of the procedures with plant operations or training personnel to confirm that interpretation is consistent with plant operational and training practices.	RESOLVED. The fire HRA Notebook, Appendix D includes a discussion of the operator interviews conducted that covered the following general areas: • General control room practices • Operations response in fire events • Performance Shaping Factors expected in fire events • Potential undesired operation actions in response to fire-induced instrumentation failures

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				• Plant procedures and performance shaping factors (PSFs) for post-fire shutdown rom outside the control room In addition, in the detailed HFE analyses contained in Appendix A notes in certain cases additional interviews were conducted to address specific actions where further clarification was deemed necessary. Appendix E of the FPIE HRA notebook contains summaries of interviews conducted in 2004, 2008 and 2013. These included discussions of specific HFEs. Again, Appendix A provides examples where additional interviews were conducted as needed.
1-19	FQ-F1 (LE-F3) Not Met	Met	LERF uncertainty distribution is provided in Figure 5-2 and 5-4 for Unit 1 and Unit 2, respectively. However, LERF specific uncertainty and assumptions or limitations, were not provided in the results. For example, no discussion of LERF sources of uncertainty are documented in Table 5-1 of the quantification notebook.	RESOLVED. LERF specific assumptions are discussed in Table 3-1 of the uncertainty notebook. An uncertainty matrix for each of the 16 NUREG/CR-6850 tasks is provided in Table 3-1, NUREG/CR-6850 uncertainty matrix that includes LERF assumptions. There is also a more detailed discussion in Section 3.2 of same notebook.

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			Additionally, the Limerick fire PRA has no review results of containment isolation system which is a potential source of uncertainty.	
2-3	CS-A4 Cat II/III	Cat II/III	Based on discussion with Limerick risk management team, an assumption has been made that instruments were not identified by assuming that safe shutdown analysis ensured that one train of instrument is always available. As a result, the identification of instruments was not performed. However, such treatment may not be adequate for multi-compartment analysis, which could potentially fail multiple channels of instruments.	RESOLVED. Instrumentation supporting human failure events is now explicitly modeled in the FPRA. The plant response model has been expanded to include explicit logic for the instrumentation. The documentation is available in both the equipment selection and plant response model notebooks. The appropriate instruments have been assigned and modeled for the corresponding human failure events in the HRA analysis.
2-5	PRM-A4 Cat II/III	Cat II/III	A number of excluded fire impact items (~400,000) were included in FRANX FireImpact table. However, the technical basis was not evident.	RESOLVED. The basis for the table was added to the fire scenario development notebook. PAU targets are identified based on walkdown

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			Additionally, the basis for this table, including the source of the table information, is not provided. Finally; the scenario report includes a list of excluded events and targets, but does not include the listing of events in the FireImpact table.	observations and drawing reviews by qualified Exelon personnel. PAU targets are included in the scenario reports in Appendix A of the fire scenario development notebook. This walkdown data is then entered into the ARCPlus™ Fire PRA module software where the data is maintained. ARCPlus™ Fire PRA module software develops the FRANX file which includes the inputs to the FireImpacts table. It is noted that per the FRANX user's manual, FRANX uses the table to store the excluded targets. The ARCPlus™ software is a software product in which the code was verified to correctly populate the FRANX tables.
2-7	CS-A6 Cat I/II/III	Cat I/II/III	The self-assessment indicates that the requirement of CS-A6 is met by the follows: Circuit failure modes associated with the effects of de-energizing as a result of the operation of overcurrent protective devices was considered when performing circuit analysis to find additional cables. However, no discussion in Section 4 of	RESOLVED. The cable selection methodology identified in NUREG/CR-6850, specifically in Section 3.3 of the notebook, and states that, for FPRA selected components, cables that can result in the overcurrent protective device responding to a hot short should be included. A review of Specification NE-294, Exelon Specification for Post-Fire Safe

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			LG-PRA-021.03, Model Development Notebook is included. Table F-1 is not evident either.	Shutdown Program Requirements, Section 5.4, determined that for FSSD cable, the same methodology was applied.
2-11	PRM-C1 (SY-A4) Not Met	Met	There is no evidence that plant walkdowns and interviews with knowledgeable plant personnel (e.g., engineering, plant operations, etc.) to confirm that the systems analysis correctly reflects the as-built, as-operated plant. The MSO expert panel reviewed the Limerick-applicable MSO scenarios. However, the model changes for MSO scenarios in final FPRA models have not been confirmed by plant walkdowns and interviews with knowledgeable plant personnel.	RESOLVED. The MSO process is documented in a series of locations. Appendix B of equipment selection notebook provides the results of the expert panel assessment of the MSOs and the disposition as to whether or not the MSO would be modeled in the FPRA. There is a series of detailed individual technical evaluations for the MSOs that provide details about the assessment of each MSO. Where the disposition is that the MSO needs to be modeled in the FPRA, the technical evaluation includes appendices for the MSO Fault Tree, P & IDs, MSO Component Circuit Analysis Data Sheets and MSO Component Circuit Analysis Marked Up Schematics The plant system engineers, who qualify as "knowledgeable individuals" with respect to this SR, were directly involved in the

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				development of these technical assessments. Their involvement meets the intent of the SR.
2-12	PRM-B12 Cat I/II/III	Cat I/II/III	In the Unit 1 CCDP cutsets for 026_F0A scenario, 3 initiating event (IE) flags were set to some values that add up to 100%. However, in this cutset file, there is another significant IE flag '$VLP', which contributes to more than 20% CDF. The treatment with IE flags does not seem to be appropriate.	RESOLVED. The initiating event treatment has been fully updated since the peer review. Currently, there is an event tree that map fire scenarios to the corresponding tree in the fault tree. The revised approach of using the fire initiating event decision tree (FIEDT) allows the fire induced initiating event logic to propagate through the appropriate event tree sequences. Therefore, there is a mapping of components to the specific initiating event that triggered in each scenario. The treatment is documented in the Fire PRA PRM notebook LG-PRA-021.55 Section 4.2 and Appendix D (the decision tree is

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				described in detailed in Appendix D). Evaluated as PRA maintenance in response to RAI 3.i in ML18019A091, Response to request for additional information application to adopt 10CFR50.69.
2-14	PRM-A4 Cat I/II/III	Cat I/II/III	Section 11.0 of the Fire Scenario Notebook (LGPRA-021.05) documents the conditional plant trip probabilities. This treatment is not consistent with the ES/CS task results. Once a fire scenario is developed, the fire is assumed to have resulted in a plant trip, either due to immediate plant response or manual shutdown per Tech Spec. A conditional trip probability should not be applied. For example; in the EDG room, the model shows a loss of the EDG, loss of the AC bus and loss of the DC bus. A plant shutdown would be required, and a conditional probability of trip should not be credited. Additionally, the conditional probability is applied for scenarios in the main control room; which would likely result in a shutdown	RESOLVED. The conditional trip probabilities were removed from the model. Opposite unit scenarios with no impact result in a manual shutdown. This represents a small conservatism in the fire risk.

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			for a challenging fire. As for the impact to the other unit, detailed fire modeling and plant response procedures should be evaluated to determine whether the other unit would be tripped or not.	
2-15	PRM-C1 (SY-B1) Cat I/II/III	Cat I/II/III	A number of CCF BE probabilities were listed in ASM-02 and ASM-03 notebooks. However, the calculation methods and data sources for generating CCF basic events and failure probabilities are not documented. For example, MV HF type code used for the new CCF event is not documented in the FPIE DA notebook.	RESOLVED. The current version of the Data Notebook contains this and other CCF type code data that were added for the fire PRA. Data Notebook, Rev 2, Volume 1 Table D-1 provides the parameters and source for the independent failure of the type code. Data Notebook, Rev 2, Volume 2 provides the CCF parameters and source (either a generic source reference or a type-code specific calculation in Appendix A) for the CCF type codes.
2-19	PRM-C1 (AS-C3) Not Met	Met	The sources of model uncertainty and related assumptions for the added or modified system models, the added MCRAB event tree with respected to accident sequences, success criteria were not documented.	RESOLVED. Table 3-1 and Section 3.2.14 of uncertainty notebook provide a discussion of the sources of model uncertainty. Model uncertainty is generally considered to be

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				those things that are not (cannot) be addressed through parametric uncertainty analysis (e.g., assumptions used where another equally valid assumption could have been. Section E.5 of the plant response model notebook provides additional sources of uncertainty specific to MCRAB.
2-21	FSS-A6 Cat I/II	Cat I/II	LG-PRA-021.05, Fire Scenario Notebook, Appendices A and B document the fire scenarios. At least one scenario is defined for each main control board where more than one function is failed. In the FRANX model, some MCR fire scenarios have a severity factor to account for the conditional trip probability. However, inside these MCR fire scenarios, MCRAB sequences are embedded (by setting IE flag $RSP to a value for the specific MCRAB scenario). Therefore, this treatment is not appropriate for the MCRAB scenarios.	RESOLVED. The conditional plant trip probability has been completely removed from the Fire PRA model. No fire scenario receives credit for conditional trip probability in the model. In the specific case of the main control room, a fire in either a Unit 1 or Unit 2 electrical cabinet or main control board that results in abandonment conditions is modeled as a plant trip for both units given that the operators will be leaving the MCR to shutdown both units using the remote shutdown methods

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2-24	FSS-C6 Cat I/II	Cat I/II	A number of cabinet fires were evaluated with scenario-specific non-suppression probabilities that account for target damage times based on the thermal response of the damage target. This method is documented in Appendix E of LG-PRA-021.05, Fire Scenario Notebook. Table 10-2 documented the resulted non-suppression probabilities based on the Mathcad calculations. Appendix E documented the assumptions and a sample of the calculation. However, the detailed calculations have not been formally documented and verified. The process to use this method has not been developed to ensure consistent use and results.	RESOLVED. The use of the Mathcad calculation has been replaced in the current version of the FPRA with the use of the Fire Modeling Workbook approach, which is described in detailed in the fire modeling treatments notebook. The workbook approach was reviewed for selected fire scenarios to ensure that the fire growth for both the ignition source and secondary combustibles is correctly implemented in the analysis and that the time to target damage has been updated. The fire modeling workbook approach calculates time to target damage using the THIEF model (which is documented in Supplement 1 to NUREG 1805) with representative cable properties. Evaluated as PRA maintenance in response to RAI 3.i in ML18019A091, Response to request for additional information application to adopt 10CFR50.69.

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2-27	FSS-F1 Cat III	Cat III	LG-PRA-021.07, Exposed Structural Steel Analysis, documents the consideration of unprotected structural steel. Section 1.1 documents the assumptions used in this analysis. Assumption 3 states that failure of more than one structural steel member is required before threat of building collapse is challenged. The basis supporting this assumption is engineering judgment. Due to the significance of this assumption (all scenarios were screened out), the technical basis should be enhanced to include some civil engineering design information.	RESOLVED. Table 1.1-1 of the structural steel notebook provides the basis for the assumption that more than one structural steel member is required before threat of building collapse. The basis includes the following: "…the building design is performed in accordance with ACI and AISC design codes. These industry codes contain provisions that ensure ductile behavior of members and their connections. The scenario involving the loss of a single column results in localized damage and loss of function (excessive deformations), but not likely collapse. However, a failure of two or more major vertical steel columns engages a larger portion of the building and would likely exceed the capacities of adjacent floor, beam, and column members."

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2-28	FSS-F1 Cat III	Cat III	LG-PRA-021.07, Exposed Structural Steel Analysis, Table 2-1, includes the walkdown results. PAUs 93 and 106 are AIR COMPRESSOR AREA, EHC POWER UNIT AREA, AND TURBINE LUBE OIL STORAGE TANK AREA. However, these two PAUs were screened by stating that high hazard sources were not identified in PAU and therefore walkdowns for structural steel were not performed. This does not seem to be appropriate.	RESOLVED. The structural steel notebook documents that fires in PAUs 93 and 106, involving lube oil storage tanks, are included in the structural steel analysis. Appendix A of the fire scenario development notebook documents that catastrophic scenarios including collapse of the turbine building are included in the PRA.
2-29	FSS-F3 Not Met	Met	A qualitative assessment has been performed for area in which a high hazard source and structural steel has been identified. However, the quantitative assessment of the risk of the selected fire scenarios including collapse of the exposed structural steel was not performed.	RESOLVED. A quantitative assessment of the risk that includes a collapse of the turbine building has been included. As shown in the SS notebook (Section 4), the FSS notebook (Appendix A) and the Summary and Quantification notebook (Tables B-1 and B-2), structural steel scenarios that collapse the turbine building are quantified in the FPRA.

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2-30	FSS-H10 Not Met	Met	Walkdowns to develop the fire scenarios was performed. However, the walkdown process has not been documented, i.e. formal walkdown procedure has not been used which describes the purpose of each walkdown conducted, dates, participants and results. Per the SR note: Typical walkdown results may include the purpose of each walkdown conducted, dates and participants, supporting calculations (if any), and information gained. This was not documented as a part of the FPRA.	RESOLVED. The walkdown notebook provides guidance when performing walkdowns for plant partitioning, fire ignition frequency, and fire scenario selection. Scenario summary reports are included in Appendix A of the FSS notebook. The F&O response indicates that additional details are maintained in the ARCPlus™ software.
3-2	PP-B7 Not Met	Met	Confirmatory walkdowns were not performed to confirm the conditions and characteristics of the credited partitioning elements. According to the response to question 03-05 'Confirmatory walkdowns were not performed to confirm the conditions and characteristics of the credited partitioning elements. The use of Fire Areas, as defined in the regulatory fire protection program, was judged to	RESOLVED. Section 3.2.7 of the plant partitioning notebook documents that confirmatory walkdowns were conducted in October 2015. Appendix B gives a description of each barrier.

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			provide assurance that the conditions and characteristic of credited partitioning elements are as stated in the Fire Safe Shutdown Analysis (FSSA).'	
3-3	SF-A1 Not Met	Met	The scenario walkdowns documented in the 1995 IPEEE only report identifying scenarios where flammable gas or liquid storage vessels could create a significant fire hazard due to a seismic event. Investigation of other unique fire scenarios is not documented.	RESOLVED. Section 3 and 4 of the seismic fire interactions notebook were reviewed, and sections 3.1.1 and 4.1.1 discuss unique interactions. These sections reference new walkdowns that were performed. Additionally, the Seismic PRA walkdown notebook includes discussion of observed interactions and the walkdown checklists include a specific section to check for these interactions.

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3-5	SF-A3 Not Met	Met	Review of Appendix I of the Limerick Fire Scenario Notebook indicates that spurious operation of the fire suppression systems is conducted however common cause failure of these systems is not addressed. Review of the 1995 IPEEE Seismic/Fire Interaction reflects this as well; common cause failure of fire suppression systems is not addressed.	RESOLVED. The seismic fire interactions notebook, Section 4.1.3 addresses this finding. An assessment was performed of potential common cause failures of the fire suppressions systems in the plant. The assessment concluded that there were no significant vulnerabilities in this regard.
3-6	SF-B1 Not Met	Met	The Seismic Fire Interaction Analysis is based on the 1995 IPEEE. Accordingly, this analysis is 16 years old and should be revisited to ensure accuracy of the information contained. In addition, this analysis does not satisfy all of the requirements of ANS RA-Sa-2009 for Seismic Fire Interaction Analysis. This results in analysis and documentation that does not satisfy the intent of the Seismic Fire Interaction Analysis.	RESOLVED. As noted, while originating in SF-B1 the finding exists because of the Findings on SF-A1 to SF-A5 (the documentation is incomplete because the analyses for those SRs was not adequately performed). The documentation has been updated.
3-8	FSS-C2 Cat II/III	Cat II/III	Time dependent growth curves are used to describe fire growth in profiles in risk significant contributors in scenarios that are investigated using detailed fire modeling methods such as	RESOLVED. The fire modeling treatments notebook lists the detailed fire scenarios defined for the risk significant rooms.

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			CFAST and the Expansion of Generic Fire Modeling Treatment technique described in Section 10 of the Fire Scenario Notebook. Additional detailed fire modeling is required and planned for some risk significant scenarios. This level of modeling has not been provided for all risk significant PAUs.	The fire modeling treatments notebook, Section 3.3 describes the heat release rate growth profile implemented in the fire modeling analysis, which is consistent with the guidance in Appendix G of NUREG/CR-6850.
3-12	FSS-A1 Cat I/II/III	Cat I/II/III	During conduct of the Peer Review walkdown several locations were identified that would have been expected to have been selected as transient scenarios because of low cable trays or cable trays penetrating the floor. Discussion in the field indicated that some of these locations were not selected as transient scenarios. Examples of such locations include cable tray installations along the south wall of PAU 025, low cable trays located between column lines M5 and N5 and K18 to K91 in PAU 94, and cable trays located above storage areas in PAU 107 at column line N39.2. These examples are simply	RESOLVED. Walkdowns were conducted in areas in which bounding transients were not included to identify potential pinch point locations. New transient scenarios were added to address the specific examples from the F&O, as documented in the fire scenario selection notebook, Appendix A. Transient scenarios have expanded from 168 transient scenarios in the peer review model to 283 transient scenarios in the current model (excluding full room scenarios), indicating that many new transient scenarios were added.

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			representative and are not expected to be inclusive of all potential scenarios.	
3-14	FSS-A1 Cat I/II	Cat I/II	During conduct of the Peer Review walkdown target selection for fire scenarios was challenged in several locations. This was performed by reviewing the targets found in the field against the Scenario Definition Report Targets using the appropriate ZOI information from Appendix C of the Fire Scenario Report. This exercise was fully conducted for two initiators; PAU 0107: T01-2 and PAU 013 F0E1- 2. This exercise was conducted to validate selection of the targets listed and to determine if any potential risk relevant targets were missed. Because Fire PRA raceway data was used during target selection it was expected that raceway	RESOLVED. Section 3.2.3.1 of the fire scenario development notebook documents that target set identification is based on plant walkdowns and drawing reviews. The target set for each scenario is listed in Appendix A of the notebook. Missing targets identified during the peer review were related to a new system that had been added after the FPRA targets had been identified. Walkdowns were performed to identify additional targets to be added. The particular examples of targets missed were corrected. The FPRA is now maintained in the ARCPlusTM Fire PRA module software. To ensure new targets are not excluded, when

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			targets would be found in the field that were not listed as targets. Field identified targets that were not listed in the Scenario Definition Report Targets were listed for later disposition. Seven potential targets were identified for PAU 0107: T01-2. Of these, one was determined to be potentially risk relevant but not included in the target selection for this scenario. Seven potential targets were identified for PAU 013: F0E1-2. Of these, two were determined to be potentially risk relevant but not included in the target selection for this scenario. This scenario involved a medium voltage Switchgear HEAF; the risk relevant cables were captured in the scenario by their endpoints in the cabinet. Details of the target raceways that are not included in these scenarios are provided in the response to question LGS-99-06.	new targets are added to the ARCPlusTM software the targets are then included for all scenarios for the locations the targets are located. The analyst then must perform the necessary analysis/walkdowns to manually exclude the targets as applicable. This was the process used during this update and will be used to maintain and update the FPRA moving forward. Exelon procedure CC-AA-102, Design Input and Configuration Change Impact Screening, is the process used to identify if a modification will have an impact on the fire risk. If it is determined that a modification may impact the fire risk a URE is created to track the modification to ensure the FPRA is appropriately updated. Additionally, the FPRA maintenance and update procedure requires review of modifications for impact on the FPRA.

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4-1	ES-A1 Not Met	Met	The Limerick FPRA modeling does not include identification of equipment whose failure, including spurious operation, caused by an initiating fire would contribute to or otherwise cause an automatic trip, a manual trip per procedure direction, or would invoke a limiting condition of operation (LCO) that would necessitate a shutdown. Table 3-1 of the Model Development calculation provides the results of a comparison of the CDF (CCDP) given an initiating event in comparison to a turbine trip followed by a loss of the system. The differences are shown as small for all listed Initiating Events. However, the discussion does not include any comparison of CCDPs for various fire scenarios (with equipment failed, or a discussion on the expected timing and thermo hydraulics following each event. As a result, although the difference for the base CCDP may be small, the impact for specific fire scenarios may be much larger. A	RESOLVED. Induced initiating event logic to propagate through the appropriate event tree sequences. Therefore, there is a mapping of components to the specific initiating event that triggered in each scenario. The treatment is documented in the plant response notebook, Section 4.2 and Appendix D

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			question asked about the top 10 scenarios indicated a small difference in most of the top 10 scenarios, if modeled differently. In almost all cases, the existing modeling is slightly non-conservative. For example, the top scenario would have a CCDP of 9.72E-02 versus 9.67E-02 (in the existing model), if modeled as a loss of RECW or loss of FW. Additionally, the verification performed to model the results in Table 3-1 are produced by basically setting CCF values to true to model the impact of system failures. These failure events do not have any cables assigned. As a result, there does not appear to be documentation that all of the equipment that is included in the initiating event modeling are mapped with specific cable routing performed. As clarified in the note, the Initiating Events modeled in the FPRA are basically expected to be modeled in	

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			the same manner that initiating events are modeled under the IE requirements in Section 2. Without specific identification of equipment that can cause an initiating event, this requirement cannot be met.	
4-2	ES-A5 Not Met	Met	The FPRA model did not include potential initiating events that were identified in the MSO expert panel review. For example, MSO scenario 2ai was not considered for FPRA modeling, due to credit for Level 8 trip. Appendix I of the model development calculation lists this as not applicable to Limerick. However, an overfeed can occur at Limerick, with the TD FW pumps. As a result, no review of the number of MSOs required to cause the scenario was performed.	RESOLVED. The initiating event treatment has been updated since the peer review. Now a fire initiating event decision tree (FIEDT) is used that allows the fire induced initiating event logic to propagate through the appropriate event tree sequences. Therefore, there is a mapping of components to the specific initiating event that triggered in each scenario. The treatment is documented in the plant response model notebook, Section 4.2 and Appendix D (the decision tree is described in detailed in Appendix D). The MSO scenarios have been incorporated into the PRA model using a systematic process that includes a comprehensive review of the generic MSO list from both a

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				PRA and deterministic perspective. The documentation is available in both the equipment selection and plant response model notebooks. The appropriate MSO scenarios have been included in the plant response model. A disposition for each scenario, including those screened from the plant response model, is available. The specific scenario listed in the finding as an example, i.e., scenario 2ai, is currently modeled in the FPRA. Evaluated as PRA maintenance in response to RAI 3.i in ML18019A091, Response to request for additional information application to adopt 10CFR50.69.
4-8	FSS-G6 Cat II/III	Cat II/III	The Battery Room Fires assume a 69kw HRR for batteries, per Table 11-1. However, the analysis does not include the possibility of a hydrogen fire, as defined in the Misc. Hydrogen Fires bin. The HRR and damage zone for these fires is discussed in NUREG/CR-6850, N.2.4.	RESOLVED. NUREG/CR-6850 states that bin 19, misc. hydrogen fires, does NOT include battery rooms. Therefore, the finding that miscellaneous hydrogen fires bin need to be included in battery rooms is not in agreement with NUREG/CR-6850.

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Finding Number	**Supporting Requirement(s) and Original Capability Category**	**Current Capability Category Assessment (CC)**	**Finding Description**	**Resolution**
			Failure to include Hydrogen Fires in the battery rooms affects the Ignition Frequency Calculation, the fire modeling as well as the Multi-Compartment Analysis from these compartments.	
4-9	FSS-G2 Not Met	Met	The MCA notebook includes both qualitative and quantitative screening criteria. The quantitative screening criteria used for the MCA is set at 1E-07/year. See the MCA notebook, Section 4 for a discussion on screening. This is applied for screening of MCA sequences, where the ignition frequency, severity factor, non-suppression and CCDP are applied. As applied, the contribution of screened PAUs can be significant, especially if the CCDP is near 1.0 as it is for many of the MCA scenarios.	RESOLVED. No quantitative screening is performed on the multi compartment scenarios that survived the qualitative screening step. That is, there is no longer the screening of multi compartments based on a threshold value. If a multi compartment combination is determined to survive qualitative screening, a scenario is developed, quantified and maintained as a risk contributor in the FPRA model. This process is documented in section 3.3 of the multi-compartment notebook.

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4-11	CS-A2 Cat II	Cat II	LG-PRA-021.03 Section 4 includes a discussion of the cable selection process and analysis using NE-0294. Once the equipment and cables are selected, the process involves the identification of all cables and circuits, including hot shorts, which would affect equipment. However, the documentation of the components with no cables due to primary component mapping is not clear in the FPRA documentation.	RESOLVED. The complete fire PRA equipment list is included in Appendix A of LG-PRA-021.52, the Equipment Selection report. Table A-1 includes a "CODE" column in which some Fire PRA basic events are designated as CODE N2, which indicated that the basic event is not connected to a Fire PRA component ID because the specific equipment does not have cables in the Fire PRA. For many of these components, the cables are included with a Fire PRA ID, such as a primary component, that represents the failure. Primary components are identified in the Comments column in Table A-1 of LG-PRA-021.52. Similarly, Table C-1 of LG-PRA-021.52 provides disposition of safe shutdown equipment and identifies if cables are mapped to another component. These relationships are also included in Table A-1 of the CS notebook (LG-PRA-021.53), in which a sub-component, if applicable, is listed in the

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				INDMS column.
4-16	FSS-C4 Cat II	Cat II	The low voltage cabinet Severity Factors were applied to Inverters in the FPRA. Per the guidance in the draft methodology, the severity factor should only be applied to cabinets containing no power components, and only low power instrumentation, relays, etc.	RESOLVED. This finding is related to the application of the severity factors following a draft methodology that was not consistent with the guidance in Chapter 8 of NUREG/CR-6850. This methodology has been removed from the model and no longer used. The Fire PRA has been updated to apply severity factors consistent with the guidance in NUREG/CR- 6850 as described in the Fire Modeling Treatments notebook LG-PRA-021.07.02. Currently, severity factors are applied to electrical cabinets that are not modeled as high energy or low energy arcing faults. That is, high and low energy arcing fault scenarios do not credit severity factors

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				as calculated following the methodology in Chapter 8/Appendix E of NUREG/CR-6850 (i.e., a severity factor of 1.0 is applied).
4-17	FSS-C4 Cat II	Cat II	The Electrical Cabinet Severity Factors are applied in a few locations in the FPRA. However, the approach is not yet reviewed by the Industry FPRA methods panel. As a result, use of these severity factors is considered an Unreviewed Analytical Method.	RESOLVED. The use of the Unreviewed Analytical Method and the Expansion of Generic Fire Modeling Treatment technique has been replaced in the latest version of the Fire PRA with the use of the Fire Modeling Workbook approach, which is described in detailed in the Fire Modeling Treatments notebook LG-PRA- 021.07.02. The workbook approach was reviewed for selected fire scenarios to ensure that the fire growth for both the ignition source and secondary combustibles is correctly implemented in the analysis and that the time to target damage has been updated from the unreviewed analytical method. The fire modeling workbook approach calculates

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				time to target damage using the THIEF model (which is documented in Supplement 1 to NUREG 1805) with representative cable properties. Evaluated as PRA maintenance in response to RAI 3.i in ML18019A091, Response to request for additional information application to adopt 10CFR50.69.
4-18	PRM-B2 Not Met	Met	A review of the FPIE Peer Review F&Os related to FPRA did not include a review of all F&Os (including suggestions) from the FPIE Peer Review. SR lists exceptions and deficiencies. Note that suggestions in the internal events could be more important to the FPRA in some cases.	RESOLVED. The plant response model notebook, Appendix C provides a disposition of the internal events peer review items. Internal events PRA peer review suggestions have been incorporated into the PRA (i.e., there are no open suggestions)
4-19	PRM-B2 Not Met	Met	An assessment of the FPIE PRA was not provided against Addendum A of the standard as part of the FPRA documentation.	RESOLVED. An assessment of the internal events PRA against Addendum A has been performed and is documented in the roadmap notebook.

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4-21	PRM-C1 (AS-A3) Not Met	Met	The Main Control Room Abandonment (MCRAB) event tree is developed using the existing Limerick process, allowing for explicit modeling of systems, operator actions, and key safety functions. The event tree is shown in Figure 3-25 of ASM-03. Key Safety Functions are listed in 3.1.1.13.1. However, the ASM-03 discussion does not clearly document the success criteria for each key safety function. For example, on page 3-12 of the Limerick PRA Event Tree Notebook, success criteria for depressurization using ADS includes a full discussion of timing (via MAAP), systems required, components required (2SRVs), expected operator actions, etc. This type of discussion is not provided for the MCRAB event tree.	RESOLVED. A check was made of the basis for the time available for actions from the RSP in the HRA. The action to depressurize from the RSP (AHUX1RDXI- FRA, OPS FAILS TO DEPRESSURIZE AT RSP PER SE-1) has an available action time of 38.9 minutes, based on T/H run LI0010. The conditions of this run are loss of all injection and one LPCI train available, and while based on the non-abandonment condition is the same as for MCRAB, so not additional run would be required. A similar check was made for the action to utilize RCIC from the RSP (RHURSPDXI-FRA, OPERATOR FAILS TO USE RCIC FOR RPV LEVEL CONTROL FROM RSP). The time available to perform this action was 45 minutes, however it was noted that the T/H run supporting this action was also LI0010, which as noted was for depressurization and LPI. Subsequently, the PRA team stated that a more representative run was LI0014, which shows that core damage has not

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				occurred by 45 minutes with no injection and no action (LI0001 shows the same thing), but neither shows the precise case where RCIC is started at 45 minutes although it could be implied that this would be successful. The PRA team ultimately provided a set of plots for the case where RCIC was started at 45 minutes, which conclusively shows that CD is averted.
4-23	PRM-C1 (AS-A9) Cat I/II/III	Cat I/II/III	MCRAB Event tree uses existing FPIE success criteria and T-H analysis. This was not confirmed in the documentation as applicable to the new event tree development.	RESOLVED. A review and spot check was conducted of how the T/H runs were used to support the success criteria for MCRAB actions. In general, the use of internal events and/or fire non-abandonment T/H runs for MCRAB actions is appropriate when the scenario details match closely enough. The use of the runs is adequately documented in the HRAC file. Further discussed in response to RAI 2.d in ML18019A091, Response to request for additional information application to adopt 10CFR50.69: "The thermal-hydraulic analysis for in-Main Control Room (MCR) accident sequences and

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				Main Control Room Abandonment (MCRAB) postulated sequences are not different for the fire PRA. The differences are in the operator action response. The fire PRA human reliability analysis for MCRAB operator actions include distinctions accounting for the differences in timing to accomplish credited operator actions for the differing scenarios (i.e., non-MCRAB and MCRAB). Specifically, the MCRAB credited operator actions include additional timing delays for the diagnosis, decision, and execution to establish the credited systems for MCRAB postulated scenarios based on procedures and operator interviews. The time available for operator actions, rather than the system window, is the difference between non-MCRAB and MCRAB sequences. Therefore, the terms “in general” and “closely enough” in the F&O resolution were used to indicate that the thermal-hydraulic calculations are appropriate with the understanding that the timing to initiate certain functions differ between non-MCRAB and MCRAB scenarios. These timing differences were addressed in the human reliability analysis.”

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4-25	PRM-C1 (LE-C12) Not Met	Met	The FPRA documentation did not include any review of significant accident progress sequences (with respect to fire) to determine operator actions or engineering analysis that could be included in the FPRA that could reduce LERF.	RESOLVED. Reviewed Section 4 of the Summary and Quantification Notebook (LG-PRA—021.11). Several reviews were performed and the significant contributors to LERF were reviewed, including review of top cutsets.
4-26	FSS-C4 Cat II	Cat II	The FPRA FSS report page 6-1 lists that All Motor Control Centers (MCC) have been treated as closed, sealed and robust in which damage beyond the ignition source was not postulated. Per the electrical cabinet FAQ 043, MCCs are never considered sealed, based on two events in the EPRI DB where fire propagated from the MCCs. Additionally, the ERIN supplemental report and the GE BWROG report shows a rough severity factor of 0.1 to 0.2 for MCCs, meaning some percentage of fires will get out of the MCCs.	RESOLVED. The F&O response indicates that the latest guidance in FAQ 14-0009 has been applied and damage beyond the MCC is postulated. This was corroborated by Section 3.5 (Table 3-3) of LG- PRA-021.07.01, in which the severity factor of 0.043, based on qualified MCC, thermoset target cables, and target distance of 0.5 ft is listed as an input. In addition, the FSS notebook (Appendix A) and the Summary and Quantification notebook (Tables B-1 and B-2) include scenarios involving sealed MCCs that propagate (for example 027_00B131_L_Y). In the F&O response, no justification is provided for crediting qualified MCC and thermoset cables, however, the peer review

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				assessment was "Met Cat 1-2" for FSS-C5 (JUSTIFY that the damage criteria used in the Fire PRA are representative of the damage targets associated with each fire Scenario), based on the plant using damage criteria for thermoset cables. The PRA team provided documentation indicating that cables at Limerick are thermoset. Evaluated as PRA maintenance in response to RAI 3.i in ML18019A091, Response to request for additional information application to adopt 10CFR50.69.
4-31	PRM-13 (DA-C2) Not Met	Met	Most new FPRA components are based on existing FPIE parameters, where plant specific data was performed. However, new failure probabilities and parameters in the FPRA do not have plant specific data reviews in the FPRA. For example, a new type code not in the FPIE is included in the FPRA: MV HF. Additionally, other events not using the generic type code should be reviewed for possible plant specific data review.	RESOLVED. The current version of the Data Notebook contains this and other CCF type code data that were added for the fire PRA. Data Notebook, Rev 2, Volume 1 (LG-PRA-010) Table D-1 provides the parameters and source for the independent failure of the type code. Tables B-3 through B-6 provide the plant specific maintenance rule and MSPI component experience data.

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4-32	HRA-C1 Not Met	Met	The FPIE HEP KHUSPPDX10 was based on an alarm response, and is now a procedural driven action from FSSG-3022 in the FPRA. However, the action for failure to perform the procedural step for the control room action is not included in the HEP. Action JHUSPVDX10 was based on the FPIE HRA, but as implemented in the FPRA (without full indication or alarms available), the operator action should include a non-proceduralized diagnosis of the failure of SPC based on rising SP temperature. This operator action step is not included in the FPRA analysis for this action. These are just examples. It appears there are other HEPs with similar issues; where the FPIE operator actions are different (different procedures, different actions) for the FPRA. A utility comment was provided and reviewed by the peer review team. The comment included an argument that	RESOLVED. As regards the issue that certain actions should be modeled as being implemented without full indications and alarms, the indications for HFEs evaluated using detailed modeling are now included in the model directly and their failure fails the action (see Finding 1-11) unless there are alternative alarms available. This latter case is addressed generically through cue delay (see Finding 4-41), which is applied whether or not the primary instruments are lost. Therefore, the issue of non-proceduralized diagnosis due to loss of indications or alarms is directly addressed in the modeling, and there is no credit given for the non-proceduralized case. In addition, for CBDTM, the fire HEP is developed assuming there is no alarm (Pcb is changed from "alarm" to monitor.) All significant (F-V > 0.005 or RAW>2) are evaluated using detailed modeling, as are many of the non-significant ones, but there

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			inclusion of the modeling of the procedural step was a matter of analyst preference. However, review of the standard indicates that both diagnosis and performance HEPs are required to be modeled. On the second action; the comment noted that the actual manipulation of the valve was not proceduralized, since local manipulation of an MOV can be accomplished without explicit procedural direction. Although this may be true; local operator action failure should be considered in the overall HEP. Since these were just examples (F&O disposition should look at other similar HEPs), and given the more complete modeling will result in the HEPs changing, the F&O was retained.	are non-significant ones that use screening HEPs. These may not have the instrumentation modeled. On the surface this appears to be questionable because if the instrumentation was modeled then in certain scenarios the HEP would be effectively 1.0. Also, the contention that CC II for SR HRA-C1 implies instrumentation availability does not have to be considered if a screening HEP is used is incorrect. However, setting the HEP to 1.0 is essentially the definition of RAW – how important is the HFE versus not crediting the action (HEP=1), so it can be concluded that not including the instrumentation when the HFE RAW is less than 2 should not be significant.

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4-36	FSS-G4 Not Met	Met	In the MCA, the barrier failure probability assigned to each scenario is based on the worst case barrier failure probability. However, the NUREG/CR-6850 approach as well as previous approaches guides analysts to sum up the failure probability for each possible failure path. For example, if there is a door and a fire wall with penetrations, the barrier failure probability is the sum of the two individual rates.	RESOLVED. The MCA notebook indicates that "The MCA barrier failure probability classification is determined by the summation of all applicable barrier types. In the case of a particular barrier containing more than one of the same element (e.g., more than one door), only one failure probability is applied for that element." This was confirmed by identifying the credited barriers listed in MCA interaction matrix (Appendix A), identifying the barrier failure probability values from Table 3-1 for each barrier, summing the applicable values and comparing to the BFP value in the FSS notebook, Appendix A, for the particular scenario.
4-37	HRA-D1 Not Met	Met	Recovery Actions are included in the Table 2-1 listing of the HRA notebook. This table includes the recovery events already indicated in the Fire Response Procedures. The process to include actions was performed using an iterative process; adding actions when needed to	RESOLVED. At the on-site review the FPRA team produced their hand-written notes from the cutset reviews. These notes contained comments about HRA actions to add credit for recovery actions. These actions were then assigned to the HRA lead to develop the necessary HFEs and HEPs. The actions identified were found in

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			address the risk significant sequences. However, a review of the existing PRA results, including the LERF results, did not include a complete review of cutsets for possible recovery actions that can restore the functions, systems, or components to provide a more realistic evaluation of significant accident sequences.	the FHRA Notebook (LG- PRA-021.09) and incorporated in the model. It is *suggested* that the cutset review notes should be incorporated into the documentation.
4-40	HRA-A2 Cat I/II/III	Cat I/II/III	Several operator actions are included in the FPRA that appear to be crediting local action of MOVs where 92-18 protection is not present. As a result, spurious operation of the valve may occur, bypassing the limit and torque switches, resulting in the valve motor or stem failure. As a result, local action may not be possible, given the spurious operation continues for some time.	RESOLVED. LG-PRA-021.52 was reviewed. Table B-1 is a compilation of the disposition of MSOs. 5K is the generic MSO for 92-18 valves. The comments column states "MOVs with the 92-18 concern are not recovered in the FPRA." Table A-1 contains the basic event disposition for the equipment selected for the fire PRA. A number of valves were identified as having a potential 92- 18 issue, and the comment column for each states "Mapped for 92-18 potential." A spot check was done of the modeling approach in

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				CAFTA/FRANX for these valves. The gate structure was such that the valve failed without any recovery credit for certain fire scenarios. In addition to the valve failing, it was noted that the recovery action was also mapped in FRANX such that it was listed as "affected equipment" that was failed in certain fire scenarios.
4-41	HRA-B1 Cat I/II	Cat I/II	In many cases, the delay time assumed for diagnosis of an action for Fire is adjusted by 2 minutes from the FPIE timing. Review of several events indicates that since the procedural guidance is much different in the case of the fire, and the actions may no longer be driven by alarm response, the 2 minute time delay is inappropriate. This is especially applicable for actions where the alarm or indications are not on the SSEL. Review of a Limerick operator during the peer review on local actions during fire in the cable room may not occur until an hour. However, the FPRA models these basically as 14 minutes	RESOLVED. LG-PRA-021.09 Appendix D discusses the operator interviews and presents the case for applying a two-minute time delay. As explained in that document, the two minutes applies only to account for cue delay. The delay appears to be primarily related to the need for the operators to consider secondary indications to confirm plant status because primary indications may be giving false readings and also for general distraction due to the fire. It is not intended to account for other delays that affect execution. Also, it was noted that the indications are now modeled directly in the fire PRA (see

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			based on 2 minutes longer than the FPIE modeling.	discussion above under F&O 1-11) and failed indication will fail the action, the adjusted HEP for the fire PRA is only applied when there is sufficient information available for the diagnosis, so in this case the two minute delay is in line with what has been used in other fire PRAs for adjusting T-delay – it is neither generally conservative nor generally optimistic and so represents a reasonable assumption (and a source of uncertainty).
4-44	HRA-E1 (HR-I3) Not Met	Met	Uncertainty bounds for each HEP are provided in Attachment A of the HRA Notebook. The FQ notebook Table 5-1 includes one item on general HEP uncertainty (HEPS are highly uncertain), but does not include any discussion on related specific Limerick FPRA assumptions or sources of uncertainty. For example, without tracing much of the non-SSEL instrumentation, the treatment for recovery actions and non-SSEL indicated HEPs is very conservative. Additionally, the modeling of fire impacts, including the time delay assumptions, additional stress factors	RESOLVED. Table 3-1 and Section 3.2.14 of LG-PRA-021.12 provide a discussion of the sources of model uncertainty. Model uncertainty is generally considered to be those things that are not (cannot) be addressed through parametric uncertainty analysis (e.g., assumptions used where another equally valid assumption could have been used). While the list is relatively short and it could be argued that there are other items that could be considered to constitute HRA model uncertainty (for example, the selection of the

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			and other modeling methods applied provides additional uncertainty that may be considered.	quantification model used as opposed to another acceptable model), these are judgement calls by the analyst. What cannot be disputed is that sources of model uncertainty were considered and identified, which is what is required.
4-45	FSS-C1 Cat II	Cat II	Some risk significant scenarios involve full room burnout. For example, PAU 43W top scenario for LERF.	RESOLVED. LG-PRA-021.11 (Summary and quantification) indicate that the top contributors for CDF and LERF do not include full room burnout scenarios. For example, Figures 4-5 through 4-7 show that the top scenarios for CDF and LERF are the Remote Shutdown Panels, switchgear HEAFs, transient fires, MCA oil fire, and electrical panel fires.

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4-48	HRA-C1 Not Met	Met	HEP for control room abandonment for an area 25 fire is modeled using a screening value of 0.1 with no detailed modeling of credited equipment.	RESOLVED. Area 25 is the AER. The AER is not an abandonment area, and so MCRAB does not apply. The 0.1 value was a screening CCDP applied in the absence of detailed fire modeling, and no abandonment credit is applied. Detailed fire modeling has now been done for the AER, and examining the FRANX file shows that there are well over 100 fire scenarios in the AER (as opposed to only a single scenario in the model that was peer reviewed). Those scenarios are now treated in the same way as other scenarios in the plant fire model – specific equipment fails as the result of fire impacts and the same HEPs are applied as appropriate. A spot check was made in the FRANX file that showed that the scenarios had cable impacts mapped. A spot check was made in the integrated fault tree (with fire scenarios inserted) and it was seen that the AER scenario impacts were modeled for each

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				impact alongside other scenarios that had the same impact.
4-51	FQ-F1 (QU-B1) Not Met	Met	Limerick fire PRA model was quantified in two forms: CAFTA and FRANX. FTREX was used as a quantification Engine. However, the FPRA documentation does not discuss the method-specific limitations and features that could impact the results.	RESOLVED. Reviewed Appendix G, "Model Quantification Limitations" of LG-PRA-021.11, "Summary and Quantification Notebook." Limitations with referenced code versions are provided in Appendix G. Appendix G summarizes the some of the potential critical limitations that may influence the FPRA model quantification and its application related to the use of the CAFTA suite of codes. A discussion of the limitations associated with using FRANX for the FPRA model development process is also provided.

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4-52	FQ-F1 (QU-D1) Cat I/II/III	Cat I/II/III	Review of significant sequences was performed and documented in the quantification notebook. However, the review to show the logic of the cutsets or sequences is correct was not documented. Additionally, a review of the results of the PRA for modeling consistency (e.g., event sequence model's consistency with systems models and success criteria) and operational consistency (e.g., plant configuration, procedures, and plant specific and industry experience) was not included in the FPRA documentation. A review of the results to determine that the flag event settings, mutually exclusive event rules, and recovery rules yield logical results was also not documented. A review of a sampling of nonsignificant accident cutsets or sequences to determine they are	RESOLVED. Section 4.2.7 of the Summary and Quantification Notebook documented review. Table 4-4 and Table 4-5 summarize the top 10 CDF cutsets from quantification of the Unit 1 and Unit 2 Single-Top Fire PRA model, respectively. Table 4-6 and Table 4-7 summarize the top 10 LERF cutsets from quantification of the Unit 1 and Unit 2 SingleTopFire PRA model, respectively. The cutsets were reviewed for reasonableness and were determined to make logical sense. The review of the cutsets indicates that the results are consistent with the system models and associated success criteria, and that the flag event settings, mutually exclusive event rules, and recovery rules yield logical results. As part of the final cutset review, multiple cutsets were selected at random for each decade that is relevant in the cutset file (both CDF and LERF). Also, the bottom cutsets for CDF and LERF,

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			reasonable and have physical meaning was not performed. A review of the importance of components and basic events to determine that they make logical sense was not documented in the FPRA quantification notebook. The above should be provided also for LERF (See LE-F SRs).	respectively, were reviewed in order to identify the non-significant cutsets. These cutsets were evaluated in a similar way as the ones documented in Tables 4-4 through 4-7, but are not documented in this notebook. These cutset reviews for CDF and LERF evaluated top cutsets, as well as cutsets randomly chosen in the cutset file. Cutset searches were also performed to look for particular type of scenarios (e.g., MCR abandonment, MSOs) that were often nonsignificant cutsets. Changes were identified based on these cutset reviews and incorporated into the final fire model. The details of these reviews are not documented in the PRA notebooks, but at the on-site review the FPRA team produced their hand-written notes from the cutset reviews. These notes demonstrated that the cutset reviews sufficient to support these confirmations were conducted, that issues were identified, and that actions were assigned to address the issues. However, the

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				cutset review notes were not incorporated into the PRA documentation.
4-53	FQ-F1 (QU-F6) Not Met	Met	The quantitative definition used for significant basic event, significant cutset, and significant accident sequence was not referenced or provided in the FPRA documentation.	RESOLVED. The FPRA uses definitions consistent with the standard per Section 3.5 of the summary and quantification notebook: Significant Basic Event: A basic event that contributes significantly to the computed risks for a specific hazard group. For internal events, this includes any basic event that has an FV importance greater than 0.005 or a RAW importance greater than 2. Significant Cutset: One of the set of cutsets resulting from the analysis of a specific hazard group that, when rank ordered by decreasing frequency, sum to a specified

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				percentage of the core damage frequency (or large early release frequency) for that hazard group, or that individually contribute more than a specified percentage of core damage frequency (or large early release frequency). For this version of the Standard, the summed percentage is 95% and the individual percentage is 1% of the applicable hazard group. Significant Accident Sequence: One of the set of accident sequences resulting from the analysis of a specific hazard group, defined at the functional or systematic level, that, when rank-ordered by decreasing frequency, sum to a specified percentage of the core damage frequency for that hazard group, or that individually contribute more than a specified percentage of core damage frequency. For this version of the Standard, the summed percentage is 95% and the individual percentage is 1% of the applicable hazard group.

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5-1	PP-C2 Not Met	Met	The analysis is good in identifying those locations outside the PA but within the OCA; however, it is silent in terms of those locations that were screened from further consideration.	RESOLVED. As stated in the F&O, the documentation at the time of the peer review did not include a comprehensive listing of structures in the GAB and those that were qualitatively screened. To resolve the F&O the plant partitioning report and qualitative screening report were revised. The plant partitioning report includes a comprehensive listing of structures in the licensee controlled area included as part of the GAB. Then, the qualitatively screening report provides a comprehensive listing of those structures screened. For example, PAUs ADMIN (Admin. Tower) and BLR (Boiler Building) are identified in Figure 4-1, which shows the GAB, and also listed in Table 4-1 of the QLS notebook, which indicates that they are screened because "This PAU does not contain PRA equipment, cables, and a fire in the PAU does not result in a required manual or automatic plant trip or a manual shutdown based on

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				Technical Specifications."
5-2	ES-A5 Not Met	Met	It does not appear that all spurious operations were appropriately dispositioned. For example, generic scenarios 5a, 5d, 5f, were dispositioned as pending; however, no analysis of the MSO applicable to these scenarios were identified.	RESOLVED. The MSO scenarios have been incorporated into the PRA model using a systematic process that includes a comprehensive review of the generic MSO list from both a PRA and deterministic perspective. The documentation is available in both the equipment selection and plant response model notebooks (LG-PRA-021.52 and LG-PRA- 021.55). The appropriate MSO scenarios have been included in the plant response model. A disposition for each scenario, including those screened from the plant response model, is available. The specific scenarios listed in the finding, i.e. 5a, 5d, 5f, are no longer pending

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				and have been either added to the model or dispositioned. A similar comprehensive approach has been applied to all the MSO scenarios.
5-3	ES-A6 Cat II	Cat II	It does not appear that all spurious operations were appropriately dispositioned. For example, generic scenario 4u was dispositioned as not applicable to Limerick because it is a COP issue. Actually, 4u is not a COP issue, but rather a containment isolation issue, and therefore applicable to Limerick.	RESOLVED. The MSO scenarios have been incorporated into the PRA model using a systematic process that includes a comprehensive review of the generic MSO list from both a PRA and deterministic perspective. The documentation is available in both the equipment selection and plant response model notebooks (LG-PRA-021.52 and LG-PRA-021.55). The appropriate MSO scenarios have been included in the plant response model. A disposition for each scenario, including those screened from the plant response model, is available. The specific scenarios listed in the finding, i.e. 4u, is appropriately dispositioned. A similar comprehensive approach has been applied to all the MSO scenarios.

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5-7	IGN-A7 Cat I/II/III	Cat I/II/III	A consistent methodology was used to determine ignition frequencies. The method applied uses a 0.1 weighting factor, which is not included in the generic approach referenced in NUREG/CR-6850. Note that the ranking of 1 is listed as a minimal level in NUREG/CR-6850.	RESOLVED. The Ignition Frequency Notebook (LG-PRA-021.56), Section 3.1.8, explains the method used for calculating transient ignition frequencies. A weighting factor of 0.1, noted by the peer review finding, is no longer used for calculating the ignition frequencies. The method used is based on NUREG/CR-6850 and FAQ 12-0064, in which ignition frequencies are calculated using influence factors for maintenance, hotwork, storage, and occupancy. The method documented in LG-PRA-021.56 (Section 3.1.8, Appendix D) is consistent with the guidance in FAQ 12-0064 and therefore the F&O is resolved. Evaluated as PRA maintenance in response to RAI 3.i in ML18019A091, Response to request for additional information application to adopt 10CFR50.69.

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5-10	FQ-1 (LE-F1) Not Met	Met	Significant contributors corresponding plant damage states (accident classes) are required in accordance with FQ- E1, but this information was not provided in the FPRA documentation.	RESOLVED. Reviewed Section 4 of LG-PRA-021.11. Significant contributors to LERF are discussed in LG-PRA- 021.11 (Summary and Quantification Notebook): Section 4.2.1, Figures 4-1 through 4-4, provide Physical Analysis Unit (PAU) contributions for CDF and LERF. Section 4.2.2, Figures 4-5 through 4-8, provide fire scenario contributions for CDF and LERF. Section 4.2.6, Figures 4-15 through 4-16, provide CDF accident sequence contributions for LERF In Figure 4-15 and 4-16 for LERF contributors by sequence for Unit 1 and Unit 2, the sequences represent containment event tree end states. The containment event trees include nodes for the various LERF contributors which include those listed in Table 2-2.8-9 of the Standard.

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5-12	FMU-C1 Not Met	Met	The FPRA configuration control process is documented by Exelon fleet procedure ER-AA-600-1061. Section 2.5 describes the process for assessing pending changes to the model of record (MOR). These reviews are performed on a case-by-case basis, and the independent impact on the model is determined. The procedure is silent in terms of assessing the 'cumulative' impact of multiple changes. Exelon comment on this F&O is as follows: "Although the procedure does not specifically mention 'cumulative' impacts, the intent of the statement that includes "evaluate the impact of pending changes to the FMOR" is considered to implicitly include the cumulative nature of the pending changes. This is consistent with the guidance established for control and update of the internal events PRA. This issue was discussed with the reviewer near the end of the peer review. "Although the peer review team agrees that more experienced PRA	RESOLVED. The current revision of the FPRA maintenance and update procedure, ER-AA-600-1061 includes explicit provision for evaluation of the cumulative impact of outstanding changes.

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			professionals will understand the implicit requirement; less experience PRA professionals may not understand the requirement. As a result; the F&O remains a finding.	
6-2	CS-C2 Cat I/II/III	Cat I/II/III	The input version of the cable routing database and related inputs are not provided in the references. Inputs were used from Appendix R, MSO resolution project, and ES related Fire PRA Tasks. This information is fed on other tasks such as scenario development and quantification.	RESOLVED. Section 4.1 of the cable selection notebook discusses the sources for the data in Table A-1. Table A-1 identifies the source for each cable to FPRA component. FPRA data is contained in the cable selection notebook tables. INDMS data and MSO data were derived from references 4 and 7, respectively, in Section 5.0 of the cable selection notebook. These references include dates to identify the input version of the data.
6-3	SF-A4 Not Met	Met	The Seismic - Fire Interactions results is found in LG-PRA-021.05 Appendix I – Seismic Fire Interactions. Impact on post-earthquake response by the plant is not addressed. (SR SF-A4)	RESOLVED. The seismic fire interactions notebook, Section 4.1.4 addresses the first part of the finding. An assessment was performed that identified the extent to which needing to enter procedure SE-8 (Fire) would affect the

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			The report does not address the storage and placement of firefighting equipment nor are the brigade access routes addressed. (SR-SF-A5)	execution of the already entered procedure SE-5 (Earthquake). The section does note some limitations in these areas, which are assessed as minor. Section 4.1.5 addresses the second part of the finding. An assessment was performed that identified the extent to which the brigade training prepares the brigade to deal with earthquakes access routes and how the earthquake can affect the equipment. The section does note some limitations in these areas.
6-5	FSS-D3 Not Met	Met	Limerick uses a bounding approach for the initial treatment of fire scenarios using a generic fire modeling calculation and the information and further information documented in the generic treatments notebook. One PAU was treated with additional fire modeling (4kV Emergency Switchgear room) with the CFAST fire modeling summarized in the scenario workbook Appendix E. However, a number of other PAUs have results	RESOLVED. The summary and quantification notebook documents the risk significant PAUs. The fire modeling treatments notebook lists the detailed fire scenarios defined for these rooms. The fire modeling treatments notebook describes the fire modeling analysis, which is consistent with the current industry guidance.

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			that are significant contributors to overall unit fire risk (e.g. PAU 025, Auxiliary Equipment Room). These PAUs/Scenarios could benefit from additional fire modeling.	
6-6	FSS-D4 CAT I/II/III	CAT I/II/III	Limerick uses a bounding approach for the initial treatment of fire scenarios using a generic fire modeling calculation and the information and further information documented in the generic treatments notebook. The fire modeling tools include CFAST as used to create the Generic Fire Modeling Treatments (including supplements) and the Main Control Abandonment Analysis. Technical basis is provided in the treatments/tools above. The detailed fire modeling was performed for the Switchgear Room	RESOLVED. The F&O response indicates that the CFAST analysis is no longer being used in the switchgear HGL analysis, so the F&O is no longer applicable. Inputs used for HGL calculations in the FMT notebook and the input files for CFAST used in the Main Control Room Abandonment notebooks are provided.

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			fires and the results documented in the scenario development report Attachment G. The basis for a number of inputs was explicitly provided; however, the basis for some of the CFAST inputs was not explicitly provided. For example, a spreadsheet was developed to create the input deck for the CFAST model. The spreadsheets and input deck were not available to the peer team to check. References: LG-PRA-021.05, Generic Fire Modeling Treatment, Supplement to Generic Fire Modeling Treatment - Hot Gas Layer, MCRAB Analysis.	
6-7	FSS-D7 Not Met	Met	Generic estimates per NUREG/CR-6850 are used and the system is operational during plant operation per plant procedures. No evidence was found to indicate a review for outlier was performed. Also, scope of risk relevant fire suppression and detection systems not identified.	RESOLVED. Section 3.8 of the fire modeling treatments notebook documents that the fire protection detection and suppression system impairments review. This included a review of the fire protection health report performance indicator worksheet for multiple years. No major failures of systems were identified.

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				The scope of the FP systems (i.e. a list of all the credited systems, not just risk-relevant areas) is identified in Table 3-1 of the fire modeling treatments notebook.