Waterford 3 (WF3) Fire PRA Peer Review Position Paper

Background

The NRC requested additional information on the Waterford 3 Fire PRA peer review to determine if changes to the Waterford-3 Fire PRA since the peer review would require a focused-scope peer review.

Summary

The Waterford 3 Fire PRA Peer Review was performed in November 2010 [1]. The peer review evaluated the Fire PRA against all technical elements in Section 4 of the ASME/ANS PRA Standard with the exception of the Qualitative Screening and Quantitative Screening elements, which are not applicable to Waterford-3. These sections are not applicable to WF3 because WF3 did not screen any fire Plant Analysis Units (PAUs) from the Fire PRA based on qualitative or quantitative criteria (e.g., no automatic or manual scram or low CDF values).

The Waterford 3 Fire PRA Peer Review report [1] states:

"At the time of the peer review, the WSES Fire PRA was complete but on-going enhancements to reduce the Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) were in progress. This review was conducted against the completed WSES PRA as of November 2010."

The ongoing enhancements to reduce CDF and LERF involved review of fire impact on component failures for important fire scenarios and were performed within the methodology reviewed by the peer review team. In addition, the peer review findings were addressed to meet Capability Category II of the Fire PRA standard requirements [2] with the exception of seven Fire Scenario supporting requirements (SRs) where the conservative analysis for Capability Category I provides acceptable results for Waterford 3. These seven requirements are discussed in the attached Table V-2.

Appendix 1-A of the ASME/ANS PRA Standard [2] discusses the types of changes that would require an additional peer review including multiple examples of changes that would or would not require a peer review. PRA model upgrades generally satisfy one of three criteria: (1) new methodology, (2) change in scope that impacts the significant accident sequences or the significant accident progression sequences, and (3) change in capability that impacts the significant accident sequences or the significant accident progression sequences. None of the changes made for the Waterford-3 Fire PRA since the Peer Review would be considered PRA upgrades as defined by the PRA Standard [2] or NEI 07-12 [4].

Attached is a detailed table providing an explanation for how each of the Fact & Observations (F&Os) findings was closed or why this issue does not affect the NFPA 805 results (Note that Suggestions from the Peer Review were excluded from this Table).

From the discussion on 11/23/11 with the NRC, the primary areas of interest by the NRC were associated with the completeness of LERF, HRA, and Uncertainty elements of the Fire PRA at the time of the Peer Review. The F&Os associated with these three elements are summarized in the following paragraphs.

Large Early Release Frequency (LERF) Element

Four of the findings identified were associated with LERF calculations.

- The first issue is associated with bypass paths missing from the fault tree. These bypass paths had been reviewed and screened as a large release path. However, the penetration screening was not sufficiently detailed in the report documentation at the time of the peer review and was corrected based on the peer review comment.
- The next two findings involve the reasonableness review of the internal events LERF and Fire CDF and LERF. The internal events LERF cutsets were reviewed for reasonableness and the LERF results were compared with the other Entergy PWRs, but additional documentation is needed to clarify that the reviews were performed, and this can be done when the Fire PRA documents are next updated. The Fire PRA cutsets were reviewed for CDF and LERF at the time of the peer review. However, Entergy was planning on enhancements to reduce Fire CDF and LERF. Multiple cutset reviews and uncertainty evaluations were performed on the updated fire results following the Peer review. These enhancements are consistent with the ASME/ANS PSA Standard HLR-QU-D and HLR-FQ-E requirements.
- The final finding was associated with review of LERF sources of model uncertainty. At the time of the Peer Review, a quantitative assessment of Fire LERF uncertainty had not been performed. This addition for Fire LERF Uncertainty follows the methodology used for Internal Events which has already been reviewed by other Peer Reviews and therefore does not represent a change in the methodology used to perform the LERF evaluation.

Human Reliability Analysis (HRA) Element

Five of the findings identified were associated with Human Reliability Analysis.

- The first finding involved a self-identified HRA F&O. A conservative screening value for select HRA events was initially used. However, cutset reviews indicated a detailed HRA evaluation was needed. This HRA was subsequently evaluated (after the Peer Review) using the same HRA methodology as was used for other HRA events.
- The second finding involved a review of fire procedures to identify fire-specific HRAs. The Operator Manual Actions (OMAs) in the Fire Abnormal Operating Procedures (AOPs) were reviewed and none are included in the Fire PRA as necessary to reduce significant fire scenarios for the transition from Appendix R to NFPA-805 (See WF3 805 LAR Attachment G).

- The third finding involves the more detailed review of instrumentation for impact of fire on credited operator actions. The instrumentation review was enhanced after the Peer Review with simulator runs and operator reviews to more realistically address the impact of instruments. If the failure of an instrument prevents a cue required to perform an operator action, then the operator action would be considered failed in the fire scenarios involving that instrument. This issue affected only the credit for HRAs in areas where the instrumentation is affected by the fire and therefore does not represent a Fire PRA Methodology change.
- The next finding involves a feasibility review of operator actions that are primarily performed in the control room but have some ex-control room actions. Additional discussions were conducted with plant operators to verify feasibility before the Peer Review but were added to the documentation after the Peer Review.
- The final finding involves new combinations of operator actions that had not been evaluated at the time of the peer review. The Entergy HRA methodology ensures that a conservative HRA value is applied so that these new combinations are not missed. This same method is also used for internal event HRAs and has been determined by previous Peer Review teams to meet the PSA Standard.

Uncertainty Element

Five of the findings identified were associated with uncertainty analyses. Uncertainty analysis consists of two parts: parametric uncertainty and modeling uncertainty. Parametric uncertainty involves running a Monte Carlo code to determine the upper and lower bounds of CDF or LERF given the uncertainty in basic event probabilities. Modeling uncertainty involves the impact of changing certain assumptions in various model elements on CDF or LERF. A change in assumptions would not be classified as a change in Methodology.

- The first finding involved the discussion of uncertainties associated with plant partitioning. A qualitative uncertainty evaluation was added after the Peer Review to the Fire PRA documentation to address this comment. This qualitative review of the potential impact of an assumption on the Fire PRA results does not represent a methodology change.
- The next two findings involved the discussion of uncertainties associated with the fire modeling. Waterford included a qualitative discussion of uncertainty for the generic fire modeling technique used. Adding this discussion is only a qualitative evaluation and does not represent a methodology change.
- The fourth finding involved the documentation of the truncation sensitivity. A draft of this process was provided for the peer review team. The final convergence evaluation results were added to the documentation after the Peer Review as part of the documentation to support the LAR [3].
- The final finding involved a review of model assumptions for impact of these assumptions on the Fire PRA results. Most of these assumptions were qualitatively evaluated. The most important assumptions were reviewed quantitatively in the final model documentation for the LAR. The additional

assumptions or sensitivity cases added would not be considered a methodology change.

Conclusions

The Waterford 3 Fire PRA model was reviewed per the ASME Standard and F&Os from the review have been addressed or dispositioned for the NFPA 805 application per the ASME PRA Standard [2] and the NEI 07-12 peer review guidelines [4]. Each of the subject findings at Waterford 3 are considered to be Maintenance items. A focused scope peer review is therefore not needed for these changes per the ASME PRA Standard [2] and the NEI 07-12 peer review guidelines [4].

References

1. Attachment to LTR-RAM-II-11-003, "Fire PRA Peer Review of Waterford Steam Electric Station Unit 3 Fire Probabilistic Risk Assessment against the Fire PRA Standard Supporting Requirements from Section 4 of the ASME/ANS Standard," February 23, 2011
2. 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."
3. W3F1-2011-0074, "License Amendment Request to Adopt NFPA 805 Performance-Based Standard for Fire Protection for Light Water Reactor Generating Plants (2001 Edition)," November 17, 2011.
4. NEI 07-12, Revision 1, "Fire Probabilistic Risk Assessment (FPRA) Peer Review Process Guidelines," May 2010.

Table V-1 Fire PRA Peer Review – Findings and Observations						
SR	**Topic**	**Status**	**Finding/Observation**	**Disposition**	**Classification of Change**	**Explanation**
CS-A3-01 Other Affected SR ES-B4	Cables Associated with Interlocks	Closed	The instruments and cables associated with permissives and interlocks do not appear to have been comprehensively addressed in the PRA. Starting interlocks for pumps and breaker closure or tank interlocks that open or close valves or flow switches that start pumps all could have fire effects that would adversely affect the success of various system functions.	The mapping of all items on the SSEL was reexamined with particular attention to instruments to ensure that their consequential impacts have been properly linked to the PRA model. The methodology and results of the analysis are documented in the Waterford 3 Component and Cable Selection Report (R0247070001.02, Revision 2). Specific rational of impacts on permissives and interlocks is documented for several components/ cables in the MSO Expert Panel discussions (Appendix I).	Maintenance	This issue involves mapping of instrument and cable faults to PRA failure modes. Instrument and cable mappings are performed based on discussions with Fire Protection and Electrical Engineers. Additional mapping are performed in accordance with the peer reviewed methodology.
CS-B1-01	Electrical Coordination	Closed	Electrical coordination is addressed in the scenario development report (R0247070001.06 Appendix E). Appendix E of R0247070001.06 provides information concerning electrical coordination. However, it is incomplete because the supplemental coordination evaluation is missing from the document. Preliminary coordination review has been performed and exists in an email (though not formally documented). Complete Appendix E of R0247070001.06 by adding the supplemental coordination analysis discussion. When this is completed, the category for this SR will be category II/III.	The Supplemental Coordination Evaluation has been added to Appendix E of the Waterford fire PRA Scenarios Report (R0247070001.06, Revision 2, Appendix E). The Waterford 3 FPRA meets the Category II/III requirements for CS-B1.	Maintenance	This issue is primarily a documentation issue and therefore does not represent a methodology change. Electrical coordination of the SSD buses was include in the report at the time of the peer review. Supplemental electrical coordination of non-SSD buses was available at the time of the peer review, but the documentation was missing from the report. The method for reviewing the non-SSD buses is the same as the SSD buses. This gap has now been closed.
ES-A2-01	Documentation of Breaker Coordination	Closed	Breaker coordination does not appear to be properly modeled in the PRA. The SSD analysis is credited to ensure there is breaker coordination, but the actual fire induced failure of the circuits that ensure the coordination do not appear to be modeled. The configuration of the plant requires the concurrent failure of 2 DC busses for this loss of coordination; however, the documentation of this is insufficient. A failure of the over-current trip relays on a bus could allow a fault to transfer to the upstream bus. The documentation should explicitly discuss the breaker coordination with respect to the PRA model and how the process used ensures comprehensive review.	The Supplemental Coordination Evaluation has been added to Appendix E of the Waterford FPRA Scenarios Report (R0247070001.06, Revision 2, Appendix E). The Waterford 3 FPRA meets the SR requirements for ES-A2.	Maintenance	This issue is primarily a documentation issue and therefore does not represent a methodology change. Electrical coordination of the SSD buses was include in the report at the time of the peer review. Supplemental electrical coordination of non-SSD buses was available at the time of the peer review, but the documentation was missing from the report. The method for reviewing the non-SSD buses is the same as the SSD buses. This gap has now been closed.

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ES-A3-02 Other affected SR CS-A3	Inadequate Evaluation of Loss of DC	Closed	The loss of DC does not appear to be adequately addressed in the fire PRA. For example a failure of DC to supply control power to the RCP breakers would inhibit the operator action to trip the Reactor Coolant Pumps (RCPs) in a loss of seal cooling scenario. This was compensated for by a spurious start of the RCPs which would affect the same state in the model. Similarly, a loss of DC power could potentially transfer a fault due to inhibition of coordination. The plant has redundant DC supplies to the two breakers which makes this failure less probable. However, additional documentation is required to clarify the issue. The fire effects on DC could adversely affect coordination as well as remote operation of breakers.	The impact of loss of DC power on the ability to trip the RCP breakers is addressed in the Waterford 3 FPRA. The details are documented in the Waterford 3 Fire Probabilistic Risk Assessment Fire Scenarios Report (R0247070001.06, Revision 2). Appendix G in the report - 'Loss of Overcurrent Protection Review' specifically addresses the impact of losing DC power. This review in Appendix G specifically addresses FPRA Treatment of Switchgear DC Control Power.	Maintenance	This issue addresses the discussion of Fire PRA treatment of DC Control Power, particularly for RCPs breaker tripping. A detailed review of the power cables and overcurrent protection found that no modifications to existing fire scenarios are needed to address this finding. Therefore, the impact of this finding is primarily on the documentation of this review and does not represent a methodology change.
ES-B1-01	Inclusion of High Risk-Importance Components	Closed	The process and documentation did not demonstrate that all high risk-importance components identified in the internal events PRA had been considered. Demonstrating and documenting that all high risk-importance components identified in the internal events PRA had been considered systematically.	The Component and Cable Selection Report (R0247070001.02, Revision 2) discusses the method of Identifying additional components from the internal events PRA (Section 2.7). Additionally, a sensitivity analysis was completed to evaluate the impact of components with unknown cable routing (typically components in the PRA model, but not in the SSL). The methodology applied and the sensitivity analyses together provide adequate justification that all high risk components have been included in the FPRA.	Maintenance	This issue addresses cable routing for risk important components that are not included in the SSEL. Components without specific cable routing are assumed failed for the Fire PRA. Credit for these components is performed on an as needed basis to enhance the fire scenarios in accordance with the peer reviewed methodology. This does not represent a methodology change.
ES-B2-01	LERF/Bypass logic Missing from Fault Tree	Closed	Section 2.4 of the Equipment Selection notebook and Appendix C documents the review of containment penetrations to identify potential containment bypass paths for LERF evaluation. Valves not screened were to be added to the Fire PRA model. The Fire PRA fault tree (WF3-L2-Toplogic_Mgd_Fire-f.caf) was reviewed to determine if valves associated with un-screened penetrations were included. The review determined that valves associated with un-screened penetrations 27, 32, 33, 34A/B, 40, 41 and 44 were not included in the Fire PRA fault tree. The self assessment noted that this may be because the documentation is not up to date with the current PRA fault tree, but if that is the case no documentation of these changes have been noted. Multiple paths for LERF exist from spurious actuations which have are not included in the Fault Tree (FT) and could impact LERF analysis in fire scenarios.	The Component and Cable Selection Report (R0247070001.02, Revision 2) provides sufficient detail on penetrations to disposition this finding. Appendix C of the report is a Containment Penetration Review. In this review, the penetrations listed in Finding have been 'screened'. The details provided in the Component and Cable Selection Report support a Category II classification for ES-B2.	Maintenance	This issue is primarily a documentation issue. All penetrations listed in the Finding are screened out but were not so noted in the documentation. Therefore this issue does not affect the results. This does not represent a methodology change.

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SR	**Topic**	**Status**	**Finding/Observation**	**Disposition**	**Classification of Change**	**Explanation**
ES-C1-01	Instruments for Human Actions	Closed	The instrumentation used by the operators has been addressed by utilizing instruments in the SSD analysis and relying on redundancy of instruments to ensure that proper cues are utilized. This approach could impede the operator's ability to simultaneously combat a fire and transient. For significant operator actions, the knowledge of what instrumentation fails allows the operator to more readily assess the transient.	In detailed HRA analysis and development for the Fire PRA, each action was reviewed. During this review cues were identified for each credited action. For each credited action, directly available instruments were mapped for each HFE in the model. Appendix D of the Waterford3 Fire Probabilistic Risk Assessment Quantification Model Preparation and Database Development Report (R0247070001.03 – Revision 2) contains the relevant HFE development details, including instruments credited for cueing operators.	Maintenance	This issue is primarily a documentation issue and therefore does not represent a methodology change. The instrumentation associated with annunciators and indications required for operator actions were reviewed to determine that redundant instruments are available to allow for credit for the operator actions. No single instrument failure was identified that would prevent the operators from performing an action modeled in the PRA. Therefore this issue does not affect the results.
ES-C2-01 Other Affected SR HRA-A3, HRA-A4	Documentation of Operator Review of Single Instrument Vulnerabilities.	Closed	Component and Cable Selection Report R0247070001.02, Revision 0 in Section 2.6 states, "An instrumentation review was conducted using the simulator and operators to identify single instrument reliance and single indication/instruments whose malfunction would cause operators to take action that would result in un-recoverable states. No single instrument vulnerabilities were identified." However, there is no documentation or discussion of this activity. Engineering standard EN-FP-S-008- Multi has a process for reviewing indication needs for post fire in the simulator in 5.3.4, but this does not specifically address spurious indications that cause unwanted actions. What is needed to meet Category II for this SR is to develop a process for how various indications are reviewed and screened and then considered for inclusion into the FPRA model. There is a sample process that the PWROG did for ERGs for Westinghouse sites, this process is more detailed than required for meeting this SR for this application, but does show the process. No evidence other than statement that a simulator walkdown was performed.	Details of the simulator review and additional operator insights are documented in Appendix E “Operator Interview Results” of the Waterford 3 Fire Probabilistic Risk Assessment Quantification Model Preparation and Database Development Report (R0247070001.03 – Revision 2). This Appendix outlines the purpose, methods, and results of detailed discussions with several operators and the documentation of a simulator observation. The details provided in the listed attachment support a Category II classification for ES-C2.	Maintenance	This issue is primarily a documentation issue and therefore does not represent a methodology change. The Fire Quantification report reviewed by the peer review discussed the performance of operator interviews and simulator observations. However, the documentation did not include the information gained from these reviews. Appendix E was added to the Fire Quantification report that includes the information from the interviews and observations. No model or methodology changes were required to address this finding.

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SR	**Topic**	**Status**	**Finding/Observation**	**Disposition**	**Classification of Change**	**Explanation**
FQ-A3-01 Other Affected SR CF-A1	Self Healing Circuit Failures	Closed	Self Healing circuit failure likelihoods are applied in various fire scenarios in the Fire Scenario Selection Notebook. The use of self healing factors in every scenario should be evaluated for success criteria and documented why the use of the self healing is applicable. However, there is no documentation for the scenarios evaluated for the cables used. This is also true for manual exclusion of components noted – exclusion notation is often inadequate. Requirement for developing a basis for all impacts to the fire scenarios quantification factors. This has a clear impact on scenarios included and non-conservative factors could be applied to the scenario. Review where self healing and exclusion is used and document clearly why each case is correct for the scenario. Example – a Reactor Head Vent valve when self healed would return to closed – reference analysis on why the time to self healing with the vent valve open will not affect success criteria for that scenario. While basis for exclusion is noted cryptically, it needs a more robust discussion to allow understanding of basis.	The FPRA Fire Scenarios Report (R0247070001.06, Revision 2) discusses credited application of self-healing hot shorts (Section 10.5). The listed section provides details for each case (only 2 scenarios credit self healing). The details in the revised Fire Scenario Report include judgments used in applying method and calculated time available for given scenarios. The details provided in the listed document support a Category II/II classification for SR CF-A1. The listed details on circuit failure also meet all listed SR requirements for SR FQ-A3.	Maintenance	This issue is primarily a documentation issue, and therefore does not represent a methodology change. No self-healing of hot shots was added or removed following the peer review. The documentation was updated to clearly state the two applications of self-healing and the basis for the timing. No fault tree or quantification changes were made as a result of credit for self-healing. Therefore, no methodology changes were made to address this finding.
FQ-B1-01	Truncation Sensitivity	Closed	The Fire PRA Summary Report does not include documentation of the process of truncation sensitivity performed. Back Referenced SRs QU-B3 and QU-B4 (referenced in FQ-B1) require a truncation sensitivity to be documented. Document the apparent draft truncation sensitivity was provided to the review team on EXCEL Spreadsheet.	Uncertainty and sensitivity methods and results as well as formal convergence evaluation are documented in the Waterford 3 Fire Probabilistic Risk Assessment Summary Report (Report 0247070001.07, Revision 2). Section 2.14 of the Summary Report documents the results of the convergence evaluation and displays CDF and LERF values at a range of truncation settings. The details provided in the Summary Report meet all listed requirements for SR FQ-B1.	Maintenance	A convergence study was provided to the peer review team but was not included in the Summary Report. Model convergence involves quantifying the model at various truncations limits (1E-11, 1E-12, 1E-13) until the difference between the CDF or LERF is sufficiently small to indicate that the further reduction in truncation would not impact the result. The quantification methodology does not change as the truncation is reduced. The convergence study was updated after the CDF and LERF were updated for the final report and therefore does not represent a methodology change.
FQ-C1-01	Dependencies on Combinations of HFEs	Closed	The WSES3 Fire Probabilistic Risk Assessment Quantification Model Preparation and Database Development report (R0247070001.03), Revision 0 section 5 uses verbs in the future tense implying that certain analysis will be done at some future date. One of these future actions is the analysis of combinations in the scenario cutsets. To date, the dependency analysis applies various factors to combinations that appeared in the internal events PRA only. Doing a dependency analysis is required to meet the ASME/ANS standard.	The Quantification Model & Database report (Report 0247070001.03, Revision 2) has been updated. The updated document does not use future tense verbs, and clearly explains how completed analysis items were done and documented. Section 5.2.2 or the report and Appendix B address joint human failure actions and their associated dependencies. The details provided in R0247070001.03 Revision 2 fulfill the listed Supporting Requirements for FQ-C1.	Maintenance	Some combinations of HRAs were not evaluated at the time of the peer review. However, the methodology for performing these evaluations is identical to the method evaluated in the internal events PRA and evaluated for the HRA combinations in the Fire PRA at the time of the peer review. If an HRA combination has not been explicitly evaluated, the conservative HEP associated with a subset of the HRAs is applied.

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SR	**Topic**	**Status**	**Finding/Observation**	**Disposition**	**Classification of Change**	**Explanation**
FQ-D1-02	Internal Events LERF	Closed	There has been no detailed assessment of LERF cutsets from the internal events LERF model per peer review finding LE-F1-01 and LE-F3-01 note that no review has been documented. This would include documentation of a review of LERF cutsets. Without this review it cannot be confirmed per the standard the results of the LERF model are valid. The resolution noted is a comparison with a similar plant results, but this does not meet the intent of the Finding from the internal peer review. Review the internal events cutsets and document reasonableness of the cutsets. If changes are required per this review to the LE model update that used for Fire.	A reasonableness review was completed on the internal events LERF results in response to the internal events peer review (though it was not well documented in time for the Fire RPA review). As documented in response to LE-F1b-01 in Attachment U of this LAR, the Waterford PRA documentation on this issue will be expanded and clarified. However, the inclusion of additional documentation for the PRA does not impact the FPRA results. Additionally, Appendix D of the Summary Report (Report 0247070001.07, Revision 2) provides details on sources of uncertainty for each individual task in the FPRA development. This Appendix also contains a parametric uncertainty analysis of the FPRA CDF results (including calculated uncertainty bounds)	Maintenance	This issue is primarily a documentation issue and therefore does not represent a methodology change. The Entergy PSA staff has performed a detailed review of the LERF results for both the internal events model and the Fire PRA. The detailed review included a review of the top cutsets for each sequence and some review of non-significant cutsets to ensure that the cutsets represent the as-build, as-operated plant. However, the internal events LERF review had not been included in the LERF documentation. The methods for reasonableness review for LERF are the same as the review for CDF.
FQ-E1-01	Reasonableness review	Closed	There has been no detailed review of reasonableness of CDF or LERF cutsets whether significant or non-significant outside of reducing high CDF cutsets. This was acknowledged by the Entergy team. The reasonableness review needs to be performed and documented.	Following completion of the quantifications, a series of Entergy review meetings was conducted to review the cutsets for selected fire initiating events. The results are documented in the Summary Report (0247070001.07, Revision 2), Section 2.14 and Appendix D.	Maintenance	Entergy was planning on updating the Fire PRA documentation to incorporate peer review comments. Therefore, some reviews were not documented at the time of the peer review. This has been done. The method for reviewing cutsets for Fire PRA is the same as the reasonableness review for internal events CDF and LERF. No new methodologies were employed.
FQ-E1-02	LERF Uncertainty	Closed	The LERF sources of model uncertainty and related assumptions have not been assessed at this time	Appendix D of the Summary Report (Report 0247070001.07, Revision 2) provides details on sources of uncertainty for each individual task in the FPRA development. This Appendix also contains a parametric uncertainty analysis of the FPRA CDF results (including calculated uncertainty bounds). Additionally, section 3.2 of the Summary Report includes a qualitative analysis of uncertainty associated with LERF.	Maintenance	LERF uncertainty for Fire PRA is included in the current Summary Report. The methodology for performing parameteric and modeling uncertainty for internal events and Fire PRA are identical and therefore does not represent a methodology change.
FSS-B2-01	Main Control Room abandonment modeling	Closed	Main Control Room (MCR) abandonment has been modeled with eleven scenarios (RAB1A CRA1M through CRA5M, CRA1S through CRA5S, and CRA5T). Fire modeling using CFAST was used to determine abandonment times. A CCDP of 0.1 is assumed for all of the abandonment scenarios. This is justified based on combination of the HEPs and random failures associated with the remaining plant capability following MCR abandonment and is judged to result in a relatively high CCDP. The non-suppression of fire in the MCR is also credited for these scenarios. This methodology is judged to result in bounding results. Bounding analysis rather than realistic analysis has been performed. Provide realistic rather than bounding analysis to meet Category 2.	The Waterford 3 Fire Probabilistic Risk Assessment Fire Scenarios Report (R0247070001.06, Revision 2) Sections 13.2.1 and 13.2.2 discuss the use of a 0.1 CCDP for MCR abandonment. A detailed human reliability analysis for shutdown outside of the MCR does not exist. Shutdown outside the MCR was judged to result in a relatively high CCDP. This judgment was due to the combination of the HFEs, random failures associated with the remaining plant capability, and the damage to other systems by fire. Applying a 0.1 CCDP for such cases is acceptable for addressing MCR abandonment and bound this scenario.	No Change	NUREG/CR-6850 allows for a conservative point estimate of CCDP for MCR abandonment. Since MCR abandonment cases were not dominant fire scenarios, Waterford used the conservative approach for MCR abandonment. A detailed MCR abandonment evaluation could be considered a PRA Upgrade if Waterford were to change from the point estimate for future revisions. See Table V-2 of the Waterford NFPA-805 LAR for the acceptability of CC-I for this Supporting Requirement.

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SR	**Topic**	**Status**	**Finding/Observation**	**Disposition**	**Classification of Change**	**Explanation**
FSS-C1-01 Other Affected SR FSS-C2, FSS-C3	Multi-Point Heat Release Rates	Closed	Two points or a range of heat release values were not assigned to the ignition sources. A lower overall CDF will likely be achieved by using a two point analysis or additional fire modeling to represent HRR profiles from ignition thru burnout and the corresponding probabilities of damage.	The use of multi-point heat release rates (to meet the Category II SR) has not been performed for Waterford 3. Category I is acceptable for the application. These results are comparable to the results of more detailed fire modeling. Section 14 of the Fire Scenarios Report discusses the use of generic fire modeling versus detailed fire modeling and	No Change	Waterford uses a generic fire modeling technique from Hughes and Associates that provides a slightly conservative fire damage assessment. Change to detailed fire modeling could be considered a PRA Upgrade and if done, may warrant a re-review. See Table V-2 of the Waterford NFPA-805 LAR for the acceptability of CC-I for this Supporting Requirement.
FSS-D7-01	Plant specific Non-suppression Probability	Closed	As noted in Section 8.0 or R024707001.06 Rev 0, when applied to a scenario NUREG-6850 non-suppression probability values were used in the analysis. To move from CC-I to CC-II, specific WSES maintenance history review to assess outlier behavior is to be documented.	Section 8.1 of the Fire Scenarios Report (R0247070001.06, Revision 2) documents a plant specific analysis of fire suppression system failure probabilities. This analysis includes a review of maintenance history and unavailability. This section provides adequate details to the meet the Category II SR requirements for FSS-D7.	Maintenance	Waterford reviewed the maintenance history of the automatic suppression systems credited in the Fire PSA. This review did not identify any excessive maintenance that would impact the generic values from NUREG/CR-6850. If the probabilities were significantly different, a Bayesian update could be performed similar to the methods for plant-specific data in the internal events PSA.
FSS-E3-01	Quantitative Uncertainty	Closed	Only qualitative discussions were provided with respect to the uncertainty intervals for the fire modeling parameters. Provide quantitative uncertainty intervals.	Complete discussion of uncertainty and sensitivity is included in the Summary Report (0247070001.07, Revision 2). However, consistent with industry discussions with ACRS, quantitative treatment of uncertainty intervals for fire modeling parameters is not required at this time.	No Change	Waterford is using generic fire modeling which provides a conservative assessment of fire damage. The NFPA-805 methods allow for qualitative uncertainty in the fire damage scenarios. See Table V-2 of the Waterford NFPA-805 LAR for the acceptability of CC-I for this Supporting Requirement.
FSS-F2-01 Other Affected SR FSS-F3	Structural Collapse Analysis	Closed	Criteria for structural collapse or non-collapse was not provided. Only judgment statements were provided and these statements do not appear to reflect reality. Re-perform the analysis to address the situation where a turbine building collapse occurs due to a large turbine lube oil fire. Revise the documents to eliminate the implication that failure of structural steel is not a credible event.	The Fire Scenarios Report (R0247070001.06, Revision 2) provides details on the potential for structural collapse. Section 10.3 of the report has been updated since the peer review with expanded discussion and a quantification screening value. The details provided in the listed document support a Category II/III classification for both FSS-F2 and FSS-F3.	Maintenance	This issue is primarily a documentation issue. Fire Scenario documentation was expanded to discuss structural collapse. The methodology and analysis were performed in accordance with NUREG/CR-6850.
FSS-H2-01	Plant specific damage criteria	Closed	Section 4.0 details damage criteria used in the Fire Scenario Report. No cases of where plant specific thresholds or damage mechanisms were used. Perform plant specific evaluations of the basis for target damage, including suppression considerations where fire sprinkler systems are installed.	Plant specific damage thresholds were not developed for the WSES FPRA. This is in line with the application of the Hughes generic fire modeling approach (no detailed fire modeling was done). The Waterford 3 FPRA is acceptable as a Category I SR for FSS-H2.	No Change	Waterford uses a generic fire modeling technique from Hughes and Associates. Change to detailed fire modeling could be considered a PRA Upgrade and if done in the future, may warrant a re-review.
FSS-H5-01 Other Affected SR FQ-E1	Fire Scenario Uncertainty	Closed	Documentation SR FSS-H5 requires analysis of parametric uncertainty for results of Fire Scenarios results. No documentation of this type of analysis exists.	The Waterford 3 FPRA uses generic fire modeling for individual fire scenarios. With this approach, the Waterford FPRA only meets Category I of SR FSS-H5. This approach is based on the Hughes generic fire modeling approach. Section 14 of the Fire Scenarios Report (R0247070001.06,	No Change	Waterford uses a generic fire modeling technique from Hughes and Associates. Change to detailed fire modeling could be considered a PRA Upgrade and if done in the future, may warrant a re-review. See Table V-2 of the Waterford NFPA-805 LAR for the acceptability of CC-I for this Supporting Requirement.

Table V-1 Fire PRA Peer Review – Findings and Observations						
SR	**Topic**	**Status**	**Finding/Observation**	**Disposition**	**Classification of Change**	**Explanation**
FSS-H10-01 Other Affected SR FSS-D10, FSS-D11	Walkdown Documentation	Closed	Walkdown documentation is weak. Many references are made in the reports to walkdowns, so a significant improvement in the walkdown documentation is highly recommended. Provide walkdown documentation that has been recorded using consistency in the level of detail, transcribed using a QC process, and verified as to accuracy.	The documentation of the walkdowns is provided in the Waterford 3 Fire Probabilistic Risk Assessment Plant Partitioning and Fire Ignition Frequency Development Report (R0247070001.01, Revision 1). This document includes specific walkdown summaries of ignition sources with an originator and reviewer including dates as transcribed from field notes. Additional detail on the methodology used for the walkdowns is also documented in Appendix A of the Fire Scenarios Report (R0247070001.06, Revision 2).	Maintenance	This issue is primarily a documentation issue and therefore does not represent a methodology change. Walkdown documentation was enhanced based on the peer review comment.
HRA-A2-01 Other Affected SR HRA-B2, HRA-D2	HRA Documentation	Closed	Section 5 of R0247070001.03 discusses the Human Reliability Analysis for the WSES fire PRA. As noted in 5.2.3, only one fire specific HFE was identified, RHFPUMPOFP. This is an action called out in procedure OP-901-524. This HFE had already been included in the Full Power Internal Events (FPIE) model with a screening value. However, no HRA calculation sheets could be located in the FPIE or in the FPRA documentation. Note that this issue was self-identified by WSES but they have not resolved it yet.	The Waterford 3 Fire Probabilistic Risk Assessment Quantification Model Preparation and Database Development (R0247070001.03, Revision 2) includes the HRA analysis for the Waterford 3 FPRA. This HRA analysis has been updated to include reevaluation of feasibility and specific calculations for credited HFEs. The updated document specifically includes details on RHFPUMPOFP development.	Maintenance	This issue is primarily a documentation issue. RHFPUMPOFP did not have a detailed HRA evaluation since it did not occur in internal event cutsets. The Fire PRA updated the probability this event based on fire. No other fire specific HRAs were needed for NFPA-805. The methodology used to develop this operator action and address fire impacts on other HRAs is consistent with the methodology used for the internal events HRA.
HRA-A4-01	Operator/Training Review of Credited HRAs	Closed	No documentation could be found (e.g., Operator Interview Sheets) that shows a review of the procedures associated with actions identified in SRs HRA-A1 and HRA-A2 has occurred with plant operations or training personnel to confirm that the interpretation is consistent with plant operational and training practices. Documentation of Operations review of applicable FPRA HFEs is necessary to assure proper application of HEP values. Document a review of the Fire PRA actions identified in SRs HRA-A1 and A2 has occurred with Operations and Training.	Documentation of HRA development has been updated to include interviews with plant operations personnel. Appendix E 'Operator Interview Results' has been added to the Waterford 3 Fire Probabilistic Risk Assessment Quantification Model Preparation and Database Development (R0247070001.03, Revision 2).	Maintenance	This issue is primarily a documentation issue. No fire-specific HRAs were identified. The impact of fires on operator actions had been discussed with operations but was not included in the Fire PRA reports. Closing this gap after the peer review does not affect the results for this application. The methodology used to update the HRA worksheets based on fire impacts is consistent with the internal events HRA.
HRA-C1-01	Fire Impacts on HFE Actions	Closed	The detailed analysis of the fire affected HFEs should be developed more addressing the fire effects on the action. Particular attention should be focused on the required instrumentation. Also, the screening of "EHFSTRBATP" states that SBO is not applicable to fires and sets the probability to "0" for the HFE. A fire induced SBO is applicable and the screening should be corrected. It is not clear if more instruments need to be cable traced and added to the model.	The FPRA HRA development was reviewed and updated to assure that sufficient cues are available for all credited operator actions (HFES). No new instruments were identified that need to be added. The Waterford 3 Fire Probabilistic Risk Assessment Quantification Model Preparation and Database Development (R0247070001.03, Revision 2) report provides the HFE development details. With respect to EHFSTRBATP, the event is not present in the portion of the PRA model used for the Fire PRA. As such, its probability has no impact on the results.	Maintenance	This issue involves an operator action that is not needed for the fire scenarios. Documentation was updated to clarify the HRAs required for fire scenarios and therefore does not represent a methodology change.
HRA-D1-01 Other Affected SR PRM-B11	HRA Feasibility	Closed	Table D-1 in R0247070001.03, Revision 0 lists five HFEs which had detailed analysis applied. Some of these HFEs have ex-main control room actions embedded. There is no evidence that a feasibility analysis has been performed on these actions. The demonstration of feasibility is a requirement of the ASME standard.	As part of the HRA review update (documented in the Waterford 3 Fire Probabilistic Risk Assessment Quantification Model Preparation and Database Development R0247070001.03, Revision 2) operator interviews were conducted to verify feasibility. HFEs were reviewed to identify embedded Actions. Appendix E of the documents contains the details of the operator interviews and Table E-2 documents the feasibility of each credited action.	Maintenance	This issue is primarily a documentation issue and therefore does not represent a methodology change. The feasibilities of the HRAs for fire had been performed before the peer review but had not been documented.

Table V-1 Fire PRA Peer Review – Findings and Observations						
SR	**Topic**	**Status**	**Finding/Observation**	**Disposition**	**Classification of Change**	**Explanation**
HRA-E1-01	Conflicting Documentation of HRA Methods	Closed	Documentation issues with R0247070001.03, Revision 0 section 5: Page 5-8 has a paragraph explaining that ex-mcr HFEs are set to true and then the risk significant HFEs are analyzed in more detail. If the HFE is set to true, then it would not show up in the cutsets. This paragraph needs a rewrite. Page 5-9 has a table explaining various treatments of HFEs in the model. Two of the columns conflict; one recommends a course of action and the resolution takes another course with no explanation of the differences. Also there should be some discussion about thermal hydraulic analysis on any new sequences.	The Waterford 3 Fire Probabilistic Risk Assessment Quantification Model Preparation and Database Development Report (R0247070001.03, Revision 2) has been updated (twice) since the peer review. The updated document provides a clearer description of the applied methodology for HFEs. Page 5-8 explains how screening HFEs are included in the model (and specifically how the FRANCs software uses them). The table on the following pages explains how specific HFE issues (not all HFEs) were treated.	Maintenance	This issue is primarily a documentation issue and therefore does not represent a methodology change. The write-up was not clear as to the method being performed. The actual method was discussed with the peer team, and they agreed that the method used was appropriate.
IGN-A10-01	Uncertainty Analysis	Closed	Documentation of sources of uncertainty covers uncertainties associated with NUREG/CR-6850 Bin elements, and uncertainties associated with the Bayesian update. No discussion on uncertainties associated with partitioning and weighting factor applications. The uncertainty analysis is incomplete. Provide either a numerical uncertainty analysis or qualitative discussion of other sources of uncertainty as required by the standard.	A detailed uncertainty evaluation is documented in Appendix D of the Summary Report (0247070001.07, Revision 2). This appendix provides adequate technical and qualitative detail to satisfy the Category III Supporting Requirement for IGN-A10. Documentation of weighting factor impact on uncertainty is not required by the standard. A discussion of partitioning impacts on uncertainty is included in Table D-1 in Appendix D.	Maintenance	This issue is primarily a documentation issue and therefore does not represent a methodology change. The preliminary uncertainty analysis had been performed but the documentation was not complete at the time of the peer review. The uncertainty associated with partitioning is limited based on the multi-compartment analysis, which found no unscreened MCA and HGL scenarios.
PP-A1-01 Other Affected SR PP-B1	Partitioning Element Selection and Definition	Closed	The station's switchyard, transformer yard, and Turbine building that houses switchyard relays, are in close proximity to each other with no defined fire barrier between them. There is little discussion concerning why these three areas should be separate. The Fire Hazard Analysis does not discuss the TBG, or either Yard boundaries as well.	The switchyard has been incorporated into the existing YARD physical analysis unit (PAU). The wall between the transformer yard (XFMR YARD) and the Turbine Building (TGB) Switchgear Room is of concrete construction and is rated for 2 hours (Ref Dwg G1370). There are no fixed ignition sources directly adjacent to the wall with the switchgear more than 8 feet away and	Maintenance	This issue is primarily a documentation issue. The bases for partitioning these areas was discussed but not included in the documentation. The partitioning methodology was performed consistent with NUREG/CR-6850.

Table V-1 Fire PRA Peer Review – Findings and Observations						
SR	**Topic**	**Status**	**Finding/Observation**	**Disposition**	**Classification of Change**	**Explanation**
PP-B7-01	PAU Barrier Verification Walkdowns	Closed	Appendix D of H0247000017.01, R1 contains copies of the PAU walkdown sheets. However, the walkdown which generated these sheets was ignition source counting and did not look at confirming the location and characterization of the credited barriers. Discussions with WSES personnel indicated that the barrier confirmation walkdowns had been conducted as part of the safe shutdown program development. Furthermore, there were inspection procedures that verified barrier conditions on a routine basis. However, neither was found to be referenced in H0247000017.01, R1. A check of the safe shutdown analyses did not immediately show documentation of the walkdowns of interest. WSES needs to directly reference any procedures that they are using as the basis for the conditions and characteristics of the credited partitioning elements. For example, ME-003-006 is the procedure for of inspection for penetrations. Equivalent procedures cover fire doors, dampers and other credited partitioning elements. These procedures and their results should be referenced.	Discussions of barrier observation were performed as part of the FPRA effort and are documented in the Partitioning Report (R0247070001.01, Revision 1). In addition, efforts completed as part of the Deterministic –NFPA-805 Transition work have been referenced (and added to reference section). Additional procedures for continuing inspection as part of plant operation have also been added to the reference section including that for Fire Rated Walls, Floors, and Ceilings, Fire Wrap Barriers, and Fire Dampers.	Maintenance	This issue is primarily a documentation issue and therefore does not represent a methodology change. The bases for PAUs has been updated to discuss the barriers used for defining the PAU. The procedures and methods used for establishing the PAUs was discussed with the peer team. The team acknowledged that the barriers were valid but the procedures needed to be included in the documentation.
UNC-A1-01	Uncertainty in Assumptions, CDF, & LERF Results	Closed	QU-E1 and QU-E2 requires identification of sources of model uncertainty and assumptions. In general, WSES had an assumption section in each report. However, a simple search on "assum" showed that there were many more assumptions than were listed in the assumption sections. At the CC-I level, QU-E3 requires estimation of the uncertainty interval of the overall CDF results. WSES does not provide an estimation of the uncertainty interval for CDF. QU-E4 requires that for each source of model uncertainty and related assumption identified in QU-E1 and QU-E2, respectively; IDENTIFY how the PRA model is affected. WSES only identifies how the model is impacted for some of the assumptions and sources of uncertainty. The Uncertainty and Sensitivity Matrix in Appendix D of R0247070001.07. Per LE-F2, WSES should review LERF contributors for reasonableness (e.g., to assure excessive conservatisms have not skewed the results, level of plant specificity is appropriate for significant contributors, etc.). There is no evidence that such a review was performed As a minimum, WSES needs to provide an estimate of the uncertainty bounds for the fire-induced CDF. WSES should also make an effort to capture all assumptions for each	Appendix D of the Summary Report (Report 0247070001.07, Revision 2) provides details on sources of uncertainty for each individual task in the FPRA development. This Appendix also contains a parametric uncertainty analysis of the FPRA CDF results (including calculated uncertainty bounds). Additionally, section 3.2 of the Summary Report includes a qualitative analysis of uncertainty associated with LERF results (i.e. a reasonableness review). Entergy concludes that the Waterford 3 FPRA contains sufficient details and analysis to address the uncertainty bounds for this fire induced CDF finding.	Maintenance	Limited uncertainty evaluations were performed for the Fire PRA at the time of the peer review. However, the method for determining the assumptions and sensitivity cases is similar to the internal events model. The method for identifying and performing uncertainties is consistent with the method reviewed by the peer team for internal events. Besides, this addition does not represent a methodology change.

Table V-2 Fire PRA– Category I Summary

SR	Topic	Status
FSS-B2	Main Control Room Abandonment	The Waterford 3 Fire Probabilistic Risk Assessment Fire Scenarios Report (PRA-W3-05-006, Revision 0) Sections 13.2.1 and 13.2.2 discuss the use of a 0.1 CCDP for MCR abandonment. A detailed human reliability analysis for shutdown outside of the MCR does not exist. Shutdown outside the MCR was judged to result in a relatively high CCDP. This judgment was due to the combination of the HFEs, random failures associated with the remaining plant capability, and the damage to other systems by fire. The approach for applying a bounding 0.1 CCDP for is judged to be appropriate for these cases. A Capability Category 1 is considered acceptable for the Fire PRA application.
FSS-C1	Use of Multi-point Heat Release Rate Treatment	Section 14 of the Fire Scenarios Report discusses the use of generic fire as opposed to more detailed fire modeling. Waterford 3 applied the Hughes Associates Generic Fire Modeling Treatment. This treatment offers a means for incorporation of fire modeling into the fire PRA in a manner that eliminates the need for separate scenario specific analyses. While the results are slightly more conservative, they are consistent with the results of the more detailed fire modeling. A Capability Category I is acceptable for this application.
FSS-C2	Peak Heat Release Rates Versus Time Dependent Fire Growth.	The use of fire growth curves are not part of the Generic Fire Modeling Treatments used at Waterford 3. Section 14 of the Fire Scenarios Report discusses the use of generic fire modeling versus detailed fire modeling and justifies the approach for the Waterford 3 Fire PRA application. A Capability Category I is considered acceptable for this application.
FSS-C3	Fire Development - Burnout/Growth/Decay	The use of fire growth curves are not part of the Generic Fire Modeling Treatments used at Waterford 3. Section 14 of the Fire Scenarios Report discusses the use of generic fire modeling versus detailed fire modeling and justifies the approach for the Waterford 3 Fire PRA application. A Capability Category I is considered acceptable for this application.
FSS-E3	Quantitative Uncertainty	Complete discussion of uncertainty and sensitivity is included in the Summary Report (PRA-W3-05-007, Revision 0). However, consistent with industry discussions with ACRS, quantitative treatment of uncertainty intervals for fire modeling parameters is not required at this time.
FSS-H2	Plant Specific Damage Criteria	Plant specific damage thresholds were not developed for the Waterford 3 FPRA. This is in line with the application of the Hughes generic fire modeling approach (no detailed fire modeling was done). A Capability Category I for FSS-H2 is considered acceptable for the FPRA application.
FSS-H5	Fire Scenario Uncertainty	The Waterford 3 FPRA uses generic fire modeling for individual fire scenarios. With this approach, the Waterford 3 FPRA only meets Category I of SR FSS-H5. Section 14 of the Fire Scenarios Report (PRA-W3-05-006, Revision 0) provides the basis for this approach and the justification for its use in the FPRA methodology. A Capability Category I for FSS-H5 is acceptable for the FPRA application.