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1CAN031602

March 25, 2016

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

SUBJECT: Response to PRA RAI 03
Adoption of National Fire Protection Association Standard NFPA 805
Arkansas Nuclear One, Unit 1
Docket No. 50-313
License No. DPR-51

Dear Sir or Madam:

By email dated February 3, 2016 (Reference 14), the NRC requested the final response to Probabilistic Risk Assessment (PRA) Request for Additional Information (RAI) 03, associated with the Entergy Operations, Inc. (Entergy) request to amend the Arkansas Nuclear One, Unit 1 (ANO-1) Technical Specifications (TS) and licensing bases to comply with the requirements in 10 CFR 50.48(a), 10 CFR 50.48(c), and the guidance in Regulatory Guide (RG) 1.205, "Risk-Informed Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants." The amendment request followed Nuclear Energy Institute (NEI) 04-02, "Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program under 10 CFR 50.48(c)." This submittal described the methodology used to demonstrate compliance with, and transition to, National Fire Protection Association (NFPA) 805, and included regulatory evaluations, PRAs, change evaluations, proposed modifications for non-compliances, and supporting attachments.

The Entergy response to PRA RAI 03 is discussed in Attachment 1 to this letter. The response also requires revisions to one or more attachments previously submitted to the NRC during this application process. Where revisions are significant, the entire attachment is resubmitted; otherwise, revised items are included in Attachment 1 of this letter. As this response is expected to resolve most, if not all, existing NRC review requirements, other updates unrelated to PRA RAI 03 are also discussed and included in Attachment 1 of this letter.

The information, as detailed in this letter, with respect to the original Entergy request (Reference 1) has been reviewed and Entergy has determined that the information does not invalidate the no significant hazards consideration included in the Reference 1 letter.

In accordance with 10 CFR 50.91(b)(1), a copy of this application is being provided to the designated Arkansas state official.

This letter contains no new commitments.

If you have any questions or require additional information, please contact Stephenie Pyle at 479-858-4704.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on March 25, 2016.

Sincerely,

ORIGINAL SIGNED BY JEREMY G. BROWNING

JGB/dbb

Attachments:

1. Response to PRA RAI 03 – ANO-1 Transition to NFPA 805
2. Updated Table 4-3 – Compliance with NFPA 805 Requirements
3. Updated Pages for Attachment C, Table B-3 – Fire Area Transition
4. Updated Attachment G, Table G-1 – Recovery Actions Transition
5. Updated Attachment J – Fire Modeling V&V
6. Updated Attachment S – Modifications and Implementation Items
7. Updated Attachment W – Fire PRA Insights
8. Updated Enclosure 2 – Proposed Operating License and Technical Specification Changes (mark-up)
9. Updated Enclosure 3 – Revised Operating License and Technical Specification Pages

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REFERENCES:

1. Entergy letter dated January 29, 2014, *License Amendment Request to Adopt NFPA-805 Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants (2001 Edition)* (1CAN011401) (ML14029A438)

2. NRC letter dated May 5, 2015, *Arkansas Nuclear One, Unit 1 – Request for Additional Information Regarding License Amendment Request to Adopt National Fire Protection Association Standard 805* (TAC No. MF3419) (1CNA051501) (ML15091A431)

3. Entergy letter dated May 19, 2015, *Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN051501) (ML15139A196)

4. Entergy letter dated June 16, 2015, *60-Day Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN061501) (ML15167A503)

5. Entergy letter dated July 21, 2015, *90-Day Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN071501) (ML15203A205)

REFERENCES (continued):

6. Entergy letter dated August 12, 2015, *120-Day Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN081501) (ML15224A729)

7. NRC email dated September 8, 2015, *Arkansas Nuclear One, Unit 1 – 2nd Round Request for Additional Information - ANO-1 NFPA 805 LAR (TAC No. MF3419)* (1CNA091501) (ML15251A220)

8. Entergy letter dated September 22, 2015, *Round 2 Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN091501) (ML15265A113)

9. NRC email dated October 6, 2015, *Arkansas Nuclear One, Unit 1 – 2nd Round Part 2 Request for Additional Information - ANO-1 NFPA 805 LAR (TAC No. MF3419)* (1CNA101501) (ML15280A114)

10. Entergy letter dated November 4, 2015, *Second Set of Round 2 Responses to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN111501) (ML15308A452)

11. Entergy letter dated November 17, 2015, *Clarification of Response to Round 2 Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN111502) (ML15321A076)

12. NRC email dated January 12, 2016, *Arkansas Nuclear One, Unit 1 – 3rd Round Request for Additional Information - ANO-1 NFPA 805 LAR (TAC No. MF3419)* (1CNA011601) (ML16012A049)

13. Entergy letter dated January 15, 2016, *Response to Round 3 Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN011601) (ML16015A421)

14. NRC email dated February 3, 2016, *Arkansas Nuclear One, Unit 1 – 3rd Round Request for Additional Information - ANO-1 NFPA 805 LAR (TAC No. MF3419)* (1CNA021601)

Attachment 1 to

1CAN031602

Response to PRA RAI 03
ANO-1 Transition to NFPA 805

RESPONSE TO PRA RAI 03
ANO-1 Transition to NFPA 805

By email dated February 3, 2016 (Reference 14), the NRC requested the final response to Probabilistic Risk Assessment (PRA) Request for Additional Information (RAI) 03, associated with the Entergy Operations, Inc. (Entergy) request to amend the Arkansas Nuclear One, Unit 1 (ANO-1) Technical Specifications (TS) and licensing bases to comply with the requirements in 10 CFR 50.48(a), 10 CFR 50.48(c), and the guidance in Regulatory Guide (RG) 1.205, "Risk-Informed Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants." The amendment request followed Nuclear Energy Institute (NEI) 04-02, "Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program under 10 CFR 50.48(c)." This submittal described the methodology used to demonstrate compliance with, and transition to, National Fire Protection Association (NFPA) 805, and included regulatory evaluations, PRAs, change evaluations, proposed modifications for non-compliances, and supporting attachments.

Entergy letter dated August 12, 2015 (Reference 6) provided the overall response to PRA RAI 03, but did not include quantitative results. PRA RAI 03, as issued by the NRC, is repeated below for completeness. The response which follows discusses any pertinent information relating to the quantitative results, which are provided in an updated Attachment W included with this letter.

In addition, the aforementioned initial response to PRA RAI 03 included a table of RAI responses tied to the subject quantitative results. This table was revised, with the final version submitted via Entergy letter dated January 15, 2016 (Reference 13). The January 15, 2016, version of the table is also copied in this response and updated to address resolution of the individual items.

A markup version of all changes included in this letter can be uploaded upon request for convenience of NRC review.

PRA RAI 03 – Integrated Analysis

Section 2.4.4.1 of NFPA-805 states that the change in public health risk arising from transition from the current fire protection program to an NFPA-805 based program, and all future plant changes to the program, shall be acceptable to the NRC. RG 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Revision 2, dated May 2011 (ADAMS Accession No. ML 100910006), provides quantitative guidelines on CDF and LERF, and identifies acceptable changes to these frequencies that result from proposed changes to the plant's licensing basis and describes a general framework to determine the acceptability of risk-informed changes. The NRC staff review of the information in the LAR has identified additional information that is required to fully characterize the risk estimates.

The PRA methods currently under review in the LAR include:

- PRA RAI 1.a regarding spatial separation
- PRA RAI 1.b regarding fire barriers
- PRA RAI 1.d regarding fire propagation from electrical cabinets

- PRA RAI 1.h regarding circuit failure likelihood analysis
- PRA RAI 1.j regarding modeling new fire Human Error Events
- PRA RAI 1.k regarding state of knowledge correlation (SOKC)
- PRA RAI 2.a regarding impact of phenomenological conditions
- PRA RAI 2.d regarding counting operational demands
- PRA RAI 2.e regarding counting failures
- PRA RAI 4 regarding reduced transient HRRs
- PRA RAI 5 regarding treatment of sensitive electronics
- PRA RAI 7 regarding propagation of fire from >440 V electrical cabinets
- PRA RAI 8 regarding use of the transient frequency adjustment factors
- PRA RAI 9 regarding fire propagation in the MCR
- PRA RAI 11 regarding crediting MCR abandonment
- PRA RAI 12 regarding multiple versus single cables
- PRA RAI 14 regarding large reduction credit for modifications
- FM RAI 1.k regarding evaluation of MCR abandonment times

Please provide the following information:

a) Results of an aggregate analysis that provides the integrated impact on the fire risk (i.e., the total transition CDF, LERF, ΔCDF, ΔLERF) of replacing specific methods identified above with alternative methods which are acceptable to the NRC. In this aggregate analysis, for those cases where the individual issues have a synergistic impact on the results, a simultaneous analysis must be performed. For those cases where no synergy exists, a one-at-a-time analysis may be done. For those cases that have a negligible impact, a qualitative evaluation may be done. It should be noted that this list may expand depending on NRC's review of the responses to other RAIs in this document.

b) For each method (i.e., each bullet) above, please explain how the issue will be addressed in 1) the final aggregate analysis results provided in support of the LAR, and 2) the PRA that will be used at the beginning of the self-approval of post-transition changes. In addition, provide a method to ensure that all changes will be made, that a focused-scope peer review will be performed on changes that are PRA upgrades as defined in the PRA standard, and that any findings will be resolved before self-approval of post-transition changes.

c) In the response, explain how the RG 1.205 risk acceptance guidelines are satisfied for the aggregate analysis. If applicable, include a description of any new modifications or operator actions being credited to reduce delta risk as well as a discussion of the associated impacts to the fire protection program.

d) If any unacceptable methods or weaknesses will be retained in the PRA that will be used to estimate the change in risk of post-transition changes to support self-approval, explain how the quantification results for each future change will account for the use of these unacceptable methods or weaknesses.

Response

In Entergy letter dated January 15, 2016 (Reference 13), a complete list of items associated with the final response to PRA RAI 03 was included in response to PRA RAI 03.b.01. This list of items is provided below with the status of ANO's response to each of the items. In some cases, the disposition was not affected by changes to the model. For those RAIs that were affected by model changes, the disposition response has been edited to reflect the current model of record and the corresponding results. Additionally, several items have been added to this table that are not in direct response to an RAI, but were included in the revised model to ensure completeness in communicating changes or additions to the information provided as part of the license amendment request (LAR).

RAI No. / Description	Disposition with respect to the final integrated analysis and the aggregated results provided in support of the LAR and associated RAI responses	Disposition with respect to the self-approval model for post-transition changes
PRA RAI 01.a regarding spatial separation	Spatial separation is not credited. The zone of influence is allowed to cross non-barrier boundaries. No change to the Fire PRA (FPRA) model is required.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 01.b regarding fire barriers	There are no active fire protection systems supporting the Multi-Compartment Analysis (MCA) fire barriers that require an actuation system (i.e., barrier features which credit systems that require signals from cables or a detection system) as part of any physical analysis unit (PAU) boundary at ANO-1 (e.g., water curtains). The MCA has been revised to sum the generic barrier failure probabilities for each type of barrier present between PAUs.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 01.c regarding fire propagation from electrical cabinets	The panel factor approach was eliminated prior to submitting the LAR. Severe and non-severe panel fires have been defined based on the zone of influence up to and excluding the nearest target. The methodology used is based on data provided in NUREG/CR-6850, Appendices E and H, and the methodology defined in the Generic Fire Modeling Treatments (GMFT).	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.

RAI No. / Description	Disposition with respect to the final integrated analysis and the aggregated results provided in support of the LAR and associated RAI responses	Disposition with respect to the self-approval model for post-transition changes
PRA RAI 01.e regarding circuit failure likelihood analysis / PRA RAI 01.e.d regarding spurious operation in other cable configurations	Circuit failure likelihood values used are consistent with the values specified in NUREG/CR-7150. The guidance from NUREG/CR-7150 regarding "other cable configurations" recommends the use of the aggregate spurious operation conditional probabilities for in-panel wiring and trunk cables. For instrument circuits, no spurious operation conditional probability will be credited. The guidance on "other cable configurations" has been incorporated into the ANO-1 FPRA in support of the integrated risk assessment PRA RAI 03.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 01.g regarding modeling new fire Human Error Events	The FPRA has incorporated the update to the Human Reliability Analysis (HRA) methodology that is consistent with developing detailed human error probabilities (HEPs) as outlined in NUREG-1921.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 01.h regarding state of knowledge correlation (SOKC)	A SOKC was applied to ignition frequencies, circuit failure probabilities, non-suppression probabilities, and HRA basic events. The SOKC has been addressed in the final FPRA documentation.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 02.a regarding impact of phenomenological conditions	The FPRA model has been revised to address the phenomenological issues as identified in response to PRA RAI 02.a.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 02.b regarding completion of Large Early Release Frequency (LERF) analysis	Spurious operation of the Atmospheric Dump Valves (ADVs) and Electromatic Relief Valve (ERV), which could impact Pressure-Induced Steam Generator Tube Rupture (SGTR) and Thermal-Induced SGTR (TI-SGTR), has been incorporated in the Integrated Analysis performed in response to PRA RAI 03.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.

RAI No. / Description	Disposition with respect to the final integrated analysis and the aggregated results provided in support of the LAR and associated RAI responses	Disposition with respect to the self-approval model for post-transition changes
PRA RAI 02.d regarding counting operational demands	The internal events model is not altered by the response to this RAI (see RAI response for basis). Therefore, the resolution of this RAI does not impact the PRA quantification.	Not applicable to the development of the post transition self-approval model, since this RAI did not impact the integrated analysis and the aggregated results provided in support of the LAR and associated RAI responses.
PRA RAI 02.e regarding counting failures	The internal events model is not altered by the response to this RAI (see RAI response for basis). Therefore, the resolution of this RAI does not impact the PRA quantification.	Not applicable to the development of the post transition self-approval model, since this RAI did not impact the integrated analysis and the aggregated results provided in support of the LAR and associated RAI responses.
PRA RAI 04 regarding reduced transient heat release rates (HRRs)	Reduced heat release rate values are used in distinct areas with restricted transient controls in the new fire protection program.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 05 regarding treatment of sensitive electronics	Sensitive electronics have been accounted for in the final FPRA quantification, consistent with the methodology outlined in FAQ 13-0004.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 07 regarding propagation of fire from > 440 V electrical cabinets	A review of the “well-sealed” panels that house circuits below 440 V has been completed. The “well-sealed” panels represent a small percentage of the total Bin 15 count and have been removed from the Bin 15 frequency allocation. Additionally, the FPRA has been revised to include fire propagation from sealed > 440 V panels, consistent with the guidance in Frequently Asked Question (FAQ) 14-0009.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.

RAI No. / Description	Disposition with respect to the final integrated analysis and the aggregated results provided in support of the LAR and associated RAI responses	Disposition with respect to the self-approval model for post-transition changes
PRA RAI 08 regarding use of the transient frequency adjustment factors	Transient Frequency Adjustment Factor of 0.1 has been removed from the analysis and replaced with a frequency adjustment that is consistent with FAQ 12-0064.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 09 regarding fire propagation in the MCR	Fire propagation in the Main Control Room (MCR) has been addressed consistent with the guidance of NUREG/CR-6850 Chapter 11 and Appendix S.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 11 regarding crediting MCR abandonment	The FPRA method for control room abandonment evaluation of the variant and compliant cases is addressed in the RAI response. No changes to this methodology were required. Additional information for PRA RAI 11.e has been included within this attachment using the results from the integrated analysis as an update to the values provided in the original RAI response.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 12 regarding multiple versus single cables	The updated quantification assumed the heat release rates associated with multi-bundle configuration for all MCR panels.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 14	See PRA RAI 15.	See PRA RAI 15.
PRA RAI 15 [corrected RAI number for this subject, original list incorrectly identified RAI as PRA RAI 14] regarding large reduction credit for modifications	The response to this RAI calculated the total risk increase associated with the unresolved variances from deterministic requirements (VFDRs) (i.e., VFDRs that are not associated with a plant modification and discuss the impact of important modeling assumptions contributing to the risk significant scenarios for fire areas in the compliant plant model). Additional information for the response to PRA RAI 15 has been included within this attachment using the results from the integrated analysis.	Not applicable to the development of the post transition self-approval model, since this RAI did not impact the integrated analysis and the aggregated results provided in support of the LAR and associated RAI responses.

RAI No. / Description	Disposition with respect to the final integrated analysis and the aggregated results provided in support of the LAR and associated RAI responses	Disposition with respect to the self-approval model for post-transition changes
FM RAI 01.k regarding evaluation of MCR abandonment times	The abandonment frequency has been updated as necessary to reflect the response provided for Fire Modeling (FM) RAI 01.k.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 18.01 – Minimum Joint HEP floor value	a) It is understood that the joint HEP value used in the FPRA below 1.0E-05 would include its own justification that demonstrates the inapplicability of the NUREG-1792 lower value guideline. b) The integrated analysis does not credit any joint HEP less than 1E-05.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
SSA RAI 11.01 Clarification – Inhibit Circuit Failure Probability	Inhibit circuits of valves associated with IN 92-18, "Potential for Loss of Remote Capability during a Control Room Fire" (ML031200481) discussed in response to Safe Shutdown Analysis (SSA) RAI 11.01 in Entergy letter dated November 4, 2015, has been modeled with failure probabilities as discussed in the RAI response of Entergy letter dated January 15, 2016. The aggregate risk results of the modeling are included in the final PRA results in response to PRA RAI 03.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 03.c – Explanation of how the RG 1.205 risk acceptance guidelines are satisfied for the aggregate analysis	A revision to ANO-1 LAR, Attachment W, is provided with the results of the integrated analysis.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.
PRA RAI 10.b – Discussion and range of Conditional Core Damage Probabilities (CCDPs) for MCR abandonment	Additional information associated with the response to RAI 10.b has been included within this attachment.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.

RAI No. / Description	Disposition with respect to the final integrated analysis and the aggregated results provided in support of the LAR and associated RAI responses	Disposition with respect to the self-approval model for post-transition changes
PRA RAI 10.c – Frequency of the MCR abandonment	The frequency of abandonment has been updated in order to address fire modeling RAIs associated with the calculation of MCR abandonment times. The final value is being provided as part of the response to PRA RAI 03. The updated MCR abandonment frequency is 7.24E-05 / rx-yr (sum of ANO-1 and ANO-2 fire contributions).	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses. Note that the incorporation of NUREG-2169 and NUREG-2178 will revise the frequency of MCR abandonment in the self-approval model for post-transition changes.
Fire ignition frequency sensitivity associated with the use of NUREG/CR-6850, Supplement 1	Revising the ignition frequencies to use the NUREG/CR-6850 frequencies (in lieu of the NUREG/CR-6850, Supplement 1, frequencies) in order to perform a sensitivity analysis for bins with an alpha term less than or equal to 1 resulted in total Core Damage Frequency (CDF) / LERF that slightly exceeds RG 1.174 criteria. However, defense-in-depth (DID) actions listed in Attachment G for control room fires, as well as fires in other high risk fire areas, are available in addition to the safety margin present in the overall system design that is not credited in the FPRA to offset the sensitivity results. Specifically, 85% of the risk increase in Fire Area G (Alternate Shutdown Area), was primarily associated with the MCR. A list of specific DID actions for control room (Alternate Shutdown Areas) fires is provided in LAR, Attachment G. Most of the DID actions would restore significant systems that are credited in the FPRA (e.g., emergency diesel generators, service water, high pressure injection). These DID actions are reasonably expected to offset the increase in risk for the NUREG/CR-6850 ignition frequency sensitivity analysis to a value within the guidelines of RG 1.174.	The self-approval model for post-transition changes will be reviewed against the latest frequency data endorsed by the AHJ, as required.

RAI No. / Description	Disposition with respect to the final integrated analysis and the aggregated results provided in support of the LAR and associated RAI responses	Disposition with respect to the self-approval model for post-transition changes
Dual unit alternate shutdown	The updated FPRA quantification, with results provided in LAR, Attachment W, incorporates a control room fire scenario associated with a fire in the ANO-2 control room which creates the potential for impacting sensitive electronics in the ANO-1 control room via hot gases spreading from ANO-2 to ANO-1. In this scenario (identified as scenario 129-F-BA in the FPRA), the potential exists for the need to abandon both control rooms. Given that the operator minimum manning for both control rooms does not support dual unit alternate shutdown, the impact of this case on ANO-1 is conservatively modeled as core damage. The frequency for such a scenario has been quantified as 6.85E-07 (ANO-2 control room fires that result in sensitive electronics hot gas layer damage in ANO-1). The calculated CDF for this scenario, conservatively assuming a CCDP of 1.0, is 6.27E-07/rx-yr. The critical reactor years per calendar year for ANO-1 of 9.16E-01 is applied to the scenario frequency, along with a CCDP of 1.0, resulting in the 6.27E-07/rx-yr CDF. This CDF represents 0.8% of the total ANO-1 CDF. The corresponding LERF contribution is 3% of the total ANO-1 LERF (2.25E-07/rx-yr). This conservative analysis, assuming a CCDP of 1.0 due to the potential for inadequate manpower for dual unit fire damage shutdown, is reflected in the total ANO-1 fire risk presented in the updated Attachment W tables.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.

RAI No. / Description	Disposition with respect to the final integrated analysis and the aggregated results provided in support of the LAR and associated RAI responses	Disposition with respect to the self-approval model for post-transition changes
Update to Attachment U	The initial responses to PRA RAI 02 a), d), and e) was provided to disposition the internal events Findings and Observations (F&Os) identified in Attachment U that have the potential to impact the FPRA results. While information was provided to address these specific Supporting Requirements (SRs) in the RAI, additional information is being provided to ensure that all pertinent information relating to internal events F&Os has been formally communicated. Supplemental information relating to Attachment U is found in the sections following this table.	Same approach as that used for the final integrated analysis provided in support of the LAR and associated RAI responses.

An updated Attachment W is included in this letter. This attachment addresses the final quantification results that were referenced in various NFPA 805 RAI responses. The changes in these quantification results are due to the analysis changes implemented to address the various RAIs as outlined in the RAI responses. These changes do not involve the implementation of methods that deviate from those used in the original LAR quantification.

In addition to the Attachment W updated quantification, several RAI responses required that additional information, beyond the results provided in Attachment W, be provided. These RAIs are specified below along with the supplemental information associated with the final FPRA quantification that was to be provided.

PRA RAI 11.e – Credit for MCR Abandonment for Loss of Control Scenarios

The range of CCDPs and Conditional Large Early Release Probabilities (CLERPs) for the variant and compliant cases for the MCR fire scenarios are provided below (updated from the original PRA RAI 11.e response to reflect the final FPRA quantification).

MAIN CONTROL ROOM ABANDONMENT CASE (using the ANO-1 Control Room fire results, the risk is quantified and the results are provided below (Fire Zone 129-F)):

VARIANT CASE		COMPLIANT CASE	
CCDP	2.69E-01	CCDP	5.96E-02
CLERP	1.45E-02	CLERP	1.83E-03

NON-ABANDONMENT CASE FOR MAIN CONTROL ROOM FIRES (Fire Zone 129-F):

	Minimum (Scenario with lowest value)	Maximum (Scenario with highest value)
VARIANT CASE		
CCDP	2.24E-05	8.09E-02
CLERP	1.14E-05	2.37E-02
COMPLIANT CASE		
CCDP	1.28E-05	3.81E-02
CLERP	1.01E-05	1.15E-02

PRA RAI 15 – Large Reduction Credit for Modifications

Two evaluations were performed to evaluate the negative delta risk resulting from the FPRA analyses.

1) Impact evaluation of the un-routed cables on the delta risk

   The assumption that all un-routed cables fail in every fire potentially overestimates the plant risk, which can overestimate the risk-decrease caused by risk reduction modifications. To address this concern, an evaluation was performed by estimating the greatest possible increase in the change-in-risk from the unknown cable routing by continuing to fail all unknown routed cables in the post-transition PRA, but not failing any of these cables in the compliant plant PRA. This overestimates the change in risk associated with unknown cable routing because some of the unknown cable routing cables, which are assumed available in the compliant case, would fail due to fire (the cables cannot physically be available in all fire scenarios). In addition, a sensitivity where the same assumption of not failing any unknown cable routing cables in both the compliant and post-transition PRA models was performed. The results of these evaluations are as follows.

   Delta Risk with unknown cable routing cables failed in both post transition plant and compliant cases (baseline NFPA 805 transition delta risk):

   ΔCDF: -6.74E-07/rx-yr

   ΔLERF: -1.25E-05/rx-yr

   Delta Risk with unknown cable routing cables failed in the post-transition plant case, but assumed available in all scenarios for the compliant case:

   ΔCDF: 1.21E-05/rx-yr

   ΔLERF: -7.11E-06/rx-yr

An additional sensitivity case was performed where the post-transition plant and the compliant cases both assumed unknown cable routing cable is not failed in any fire scenarios:

ΔCDF: -4.77E-06/rx-yr

ΔLERF: -4.01E-06/rx-yr

Based on the results of the variation of assumptions for unknown cable routing, the most conservative set of assumptions indicate a delta risk that is only slightly greater than the RG 1.174 limit. A more reasonable assumption that such cables are available in the compliant and post-transition plant configurations still yields a negative delta risk.

2) Evaluation of the compliant case risk with the NFPA 805 modifications incorporated into the compliant case

This evaluation separates the positive delta risk associated with the VFDRs from the negative delta risk associated with modifications. The delta risk for VFDRs is calculated by incorporating the NFPA 805 modifications into the compliant case to focus the delta risk on the VFDRs alone. This delta risk is determined to be:

ΔCDF: 3.71E-05/rx-yr

ΔLERF: 3.18E-06/rx-yr

The delta risk associated with the NPFA 805 modifications is then the difference between the above delta risk and the delta risk reported as the overall NFPA 805 transition risk:

ΔCDF: -3.78E-05/rx-yr

ΔLERF: -1.57E-05/rx-yr

Using the sensitivity described above, a comparison of the CCDPs provided an overview for which compliant case scenarios crediting the common feed water (CFW) pump had the most significant impact. A review of the compliant plant scenarios indicated the modifications had varying impact on CCDP values with respect to the post-transition baseline model. The primary differences are discussed below.

The scenarios for Fire Areas G (alternate shutdown area that includes scenarios in the MCR (Fire Zone 129-F) and cable spreading room (Fire Zone 97-R)) and Fire Area I-1 (emergency diesel corridor (Fire Zone 98-J)) are characteristically high risk given the significant amount of safety related cables contained within the zones. For the severe scenarios within these zones, the compliant plant model included a significant number of impacted safety related systems, but still remained compliant (e.g., one train damaged and the other train available). Conversely, the post-transition model also includes the same impacted safety related systems and also relies on an action for starting the new CFW system to satisfy the decay heat removal performance criteria. In these scenarios, an operator manual action is required to start and maintain level at the CFW control panels. Additionally, the post transition model requires operator actions inside and outside the MCR to maintain Reactor Coolant System (RCS) integrity, which are failures not mitigated by the CFW system. In these scenarios, the complaint plant model results in a positive delta risk since the Emergency Feedwater (EFW) system relies on auto-initiation through the normal plant design and the compliant plant scenario generally required less dependence on operator mitigation to maintain the RCS boundary integrity. As a result, for these types of scenarios, a positive delta risk is observed between the compliant and post-transition model.

In some scenarios the CFW pump provides redundancy and resulted in a negative delta risk between the compliant and post-transition models. The CFW system provides redundancy for random failures of the EFW systems and the respective power support systems. CFW provides redundancy throughout the plant, but notably in Fire Areas B1@BOFZ (contains zones such as the turbine building, 197-X), E (red train 4160 V switchgear room), B-8 (electrical equipment room), I-2 (green train 4160 V switchgear room) and B1@73-W (condensate demineralizer area). In some of these areas, the redundant power supply becomes significant in the delta risk calculation because the modification for the CFW pump will utilize an automatic bus transfer switch. The automatic bus transfer switch will be equipped with a unique power supply that would not be available in the compliant plant model, thereby resulting in a reduction in risk over the compliant scenario. The CFW system also provides a reduction in risk for scenarios that do not fail the credited EFW system in the compliant model. Thus, CFW would be added as a redundant system to the already available EFW system(s) in the post-transition baseline model, resulting in a reduction in risk.

In summary, a negative delta risk would be observed for the scenarios where the compliant plant model includes a loss of power or in cases where CFW provides a redundant system to EFW. A positive delta risk is observed for scenarios that involve large portions of significant systems that are damaged and that are dependent on operator actions, inside or outside the MCR, to maintain the RCS inventory in the post-transition model.

PRA RAI 10 – MCR Abandonment Scenarios due to Loss of Habitability

The initial response to PRA RAI 10 stated that once the updates to the FPRA model were completed, responses to RAI 10 b) and c) would be provided in the final response to RAI 03. Part b) is discussed below and the Part c) response was provided in the table above (see PRA RAI 10.c).

b) The large negative delta risk value for the ANO-1 FPRA due to the incorporation of significant modifications that are not required for a compliant plant will offset the most conservative estimate of the delta risk that can be obtained, one in which the compliant case risk is assumed to be zero (i.e., the MCR abandonment variant case CDF is expected to be less than the absolute value of the plant delta risk, which is a negative value). The final risk quantification values are provided as part of the response to PRA RAI 03.

The original LAR values, for the single MCR abandonment case, were conservative because it was based on the assumption that all cables in the control room are damaged and, therefore, included the failures that increase the likelihood of core damage. Since it could be inferred that this assumption could result in an over-estimation of risk, a sensitivity analysis was performed to remove the potential over-estimation of risk relating to the MCR compliant case. This was completed by removing the contribution of the MCR compliant case (single control room abandonment case only) from the delta risk calculation to determine the increase in the total plant risk.

The MCR abandonment scenario compliant case risk (CDF 4.27E-06, LERF 1.31E-07), if set to zero to eliminate potential overestimation of the MCR compliant case risk, would result in an increase in the plant delta risk to the following values:

ΔCDF: 3.6E-06 / rx-yr

ΔLERF: -1.24E-05 / rx-yr

The above conservative estimate of the total delta risk remains below the RG 1.174 limit.

PRA RAI 2 a), d) and e)

The initial responses to PRA RAI 02 a), d) and e) were provided to disposition the internal events F&Os identified in LAR, Attachment U, that have the potential to impact the FPRA results. While information was provided to address these specific SRs in the RAI, additional information is being provided here to ensure that all pertinent information relating to internal events F&Os has been formally communicated.

The method used to develop the ANO-1 Level 2 model is based on WCAP-16341-P, “Simplified Level 2 Modeling Guidelines,” Westinghouse Electric Company, November 2005, which is an extension of NUREG/CR-6595, “An Approach for Estimating the Frequencies of Various Containment Failure Modes and Bypass Events,” January, 1999. Although reliant on these reference documents, ANO-1 specific information is used throughout the model.

The ANO method is considered a simplified LERF modeling approach and is also considered to be bounding. From NUREG/CR-6595:

> “Risk analysts can use this revision as guidance for estimating LERF in support of risk-informed applications, consistent with RG 1.174 principles. This revision updates the full-power guidance with information from recent containment studies and the individual plant examination studies, and it provides additional guidance for low power and shutdown operation. The guidance is intended to encompass the likelihood of containment failure for most nuclear power plants. However, the simplified approach provided in this revision is somewhat bounding and should only be used as a first-step scoping study in estimating LERF. Less-bounding probabilities may be used for a particular plant given that sufficient justification is provided.”

The scope of the ANO-1 peer review conducted in 2009, was to evaluate the LERF SRs in relation to the criteria established in Capability Category (CC)-I since a site specific containment and phenomenological analysis was not performed to refine the sequences and take credit for mitigative actions. The bounding nature of the current analysis is considered adequate for applications.

The table below lists the SRs for LERF that contain more than one criterion for two or more capability categories. A comparison of the requirements to meet CC-I and CC-II/III was performed to relate the general conservatism of the requirements to meet CC-I (a more simplistic method) with respect to the more realistic values that would be obtained with a more rigorous containment and phenomenological analysis.

In conclusion, although the ANO-1 LERF model was not peer reviewed against the criteria for CC-II/CC-III, the model provides a bounding assessment of the LERF results and is adequate for the FPRA application.

LERF Index No.	CC-I (bounding)	CC-II/III (Realistic)	Expected Impact on NFPA 805
LE-B1		CC-II Met	N/A
LE-B2		CC-II Met	N/A
LE-C1	Containment event trees developed in NUREG/CR-6595 are acceptable.	Compare the Containment challenges analyzed in LE-B with the Containment structural capability analyzed in LE-D and identify accident progressions that have the potential for a Large early release. Justify any generic or plant-specific calculations or references used to categorize releases as non-LERF contributors based on release magnitude or timing.	Accident sequences and containment failure modes are developed from WCAP-16341-P, which includes at least all of the NUREG/CR-6595 considerations and is considered bounding
LE-C2	An acceptable conservative treatment of operator actions is provided in the event trees of NUREG/CR-6595.	Include realistic treatment of feasible operator actions.	Actions were limited to those that may impact LERF. The actions credited that impact LERF are the depressurization of the RCS, re-establishment of offsite power and "bumping" the pump. ANO-1 guidance to allow bumping the pump is an important contributor to LERF. Therefore, the results are bounding in respect to the treatment of additional operator actions for the LERF analysis.

LERF Index No.	CC-I (bounding)	CC-II/III (Realistic)	Expected Impact on NFPA 805
LE-C3	No requirement to repair.	Determine if repair of equipment can be credited.	No maintenance or operator actions are credited in this evaluation for recovering initially failed High Pressure Injection (HPI) or any other equipment that would be capable of recovering the core within the reactor vessel. The results are bounding with respect to repair of damaged equipment.
LE-C4	Containment event trees in NUREG/CR-6595 are acceptable.	Include mitigating actions by operations staff, effect of fission scrubbing, and expected beneficial failures in significant accident progression sequences.	ANO-1 Level 2 model is based on WCAP-16341-P. This WCAP-16341-P contains two event trees. One of the event trees corresponds to the accident progression after core damage of station blackout (SBO) sequences and the other event tree corresponds to the accident progression after core damage of non-SBO sequences. This logic is considered bounding.
LE-C5	Use appropriate conservative, generic analyses/ evaluations of system success criteria that are applicable to the plant.	Use appropriate realistic generic or plant-specific analyses for system success criteria for the significant accident progression sequences.	The success criteria for the systems are the same as Level 1. Additional success criteria are developed for Containment Isolation. The LERF success criteria are based upon WCAP-16341-P, which is an extension of NUREG/CR-6595 and is considered bounding.

LERF Index No.	CC-I (bounding)	CC-II/III (Realistic)	Expected Impact on NFPA 805
LE-C9	Do not take credit for continued equipment operation or operator actions in adverse environments.	Justify any credit given for equipment survivability or human actions under adverse environments.	Per WCAP-16679-P, "Accident Sequence Phenomena Considerations" the credit for equipment operability in beyond design basis conditions should be considered in the PRA model. Per the LERF analysis, an evaluation was performed and no deficiencies were noted that would require a change to the model. In relation to operator actions, all operator actions will be taken prior to the harsh conditions and no operator action contributing to Level 2 risk is affected by severe accident condition. The current approach taken is considered to be bounding.
LE-C10	No requirement; credit for equipment survivability or human actions in adverse environments is precluded by LE-C9.	Review significant accident progression sequences resulting in a large early release to determine if engineering analyses can support continued equipment operation or operator actions during accident progression that could reduce LERF.	As discussed in LE-C9, the approach taken in line with WCAP-16679-P. There are no CC-I requirements associated with this SR.
LE-C11	Do not take credit for continued operation of equipment and operator actions that could be impacted by containment failure.	Justify any credit given for equipment survivability or human actions that could be impacted by containment failure.	The current LERF analysis bounds this SR by assuming that all CD sequences with loss of containment isolation will result in a large early release. Actions taken to recover containment integrity are not considered. Thus, treatment of these sequences as LERF is considered a conservative position.

LERF Index No.	CC-I (bounding)	CC-II/III (Realistic)	Expected Impact on NFPA 805
LE-C12	No requirement; credit for post containment failure operability of equipment or operator actions is precluded by LE-C11.	Review significant accident progression sequences resulting in a large early release to determine if engineering analyses can support continued equipment operation or operator actions after containment failure that could reduce LERF.	As discussed in LE-C11, no credit is taken for actions to recover containment integrity. There are no CC-I requirements associated with this SR.
LE-C13	Treat containment bypass events in a conservative manner. Do not take credit for scrubbing.	Perform a containment bypass analysis in a realistic manner.	All core damage events involving a spontaneous SGTR, Pressure-Induced SGTR (PI-SGTR), or a TI-SGTR event were conservatively assumed to lead to a large early release. The additional fission product scrubbing provided by the containment sprays is not credited in this evaluation. Therefore, this SR is considered bounding.
LE-D1	Determine the containment ultimate capacity for the containment challenges that result in a large early release. Use a conservative containment capacity analysis for the significant containment challenges.	Determine the containment ultimate capacity for the containment challenges that result in a large early release. Perform a realistic containment capacity analysis for the significant containment challenges.	The LERF analysis for containment fragility is based upon NUREG/CR-6475. This evaluation is considered to be sufficient for the application, but does not meet the criteria for CC-II.

LERF Index No.	CC-I (bounding)	CC-II/III (Realistic)	Expected Impact on NFPA 805
LE-D2	Evaluate the impact of containment seals, penetrations, hatches, drywell heads (BWRs), and vent piping bellows and include as potential containment challenges, as required. An acceptable alternative is the approach in NUREG/CR-6595.	Evaluate the impact of containment seals, penetrations, hatches, drywell heads (BWRs), and vent piping bellows and include as potential containment challenges, as required. If generic analyses are used in support of the assessment, justify applicability to the plant being evaluated.	The current method for the LERF analysis simplifies the modeling by assuming that all CD sequences with loss of containment isolation will result in a large early release. WCAP-16341-P is used to categorize the remainder of the Level 2 end states. Thus, treatment of containment challenges is bounding.
LE-D3	Define failure location based on a conservative containment assessment.	Define failure location based on a realistic containment assessment.	The location of the containment failure is not specifically considered in the LERF model. This approach is considered bounding.
LE-D4	Use a conservative evaluation of interfacing system failure probability for significant accident progression sequences resulting in a large early release.	Perform a realistic interfacing system failure probability analysis for the significant accident progression sequences resulting in a large early release.	All inter-system loss of coolant accidents (ISLOCAs) included in the Level 1 PRA model are considered contributors to LERF. This approach is considered bounding.
LE-D5	Use a conservative evaluation of secondary side isolation capability for significant accident progression sequences caused by SG tube failure resulting in a large early release.	Perform a realistic secondary side isolation capability analysis for the significant accident progression sequences caused by SG tube failure resulting in a large early release.	The analysis has used a conservative evaluation of secondary side isolation capability for significant accident progression sequences. For most sequences secondary isolation is assumed to fail.

LERF Index No.	CC-I (bounding)	CC-II/III (Realistic)	Expected Impact on NFPA 805
LE-D6	Perform a conservative analysis of thermally induced SG tube rupture that includes plant specific procedures.	Perform an analysis of thermally induced SG tube rupture that includes plant specific procedures and design features and conditions that could impact tube failure.	All core damage events involving a spontaneous SGTR, PI-SGTR, or a TI-SGTR event were conservatively assumed to lead to a large early release. This approach is considered bounding.
LE-D7	Perform containment isolation analysis in a conservative manner.	Perform containment isolation analysis in a realistic manner.	Modeling of the Reactor Building Isolation system is modeled realistically. However, since the peer review only assessed the LERF against CC-I, CC-II was not considered.
LE-E2		CC-II Met	N/A
LE-E3		CC-II Met	N/A
LE-F1		CC-II Met	N/A
LE-G3*			

* Documentation and insights into the contributions to the LERF results. This SR does not have relevance to the calculation of the LERF results

<u>Other NFPA 805 LAR Updates</u>

Table 4-3 (NFPA 805 Compliance)

Table 4-3 includes fire detection systems in Fire Zone 1-E (Fire Area D) and Fire Zone 2-E (Fire Area H) that were included in the FPRA model. These two systems do not have an NFPA code evaluation as do the remaining area fire detection systems credited in the FPRA model. Both of these fire detection systems provide very limited risk benefit (less than 1E-10) and will be evaluated for removal from the FPRA during the NFPA 805 implementation phase. In addition, the localized Control Room cabinet fire detection systems do not have a separate NFPA code evaluation due to the localized configuration, but are credited in the FPRA model since this detection is maintained via site surveillance procedures.

Attachment C (Fire Area Transition)

Attachment C and Table 4-3 of the original LAR have been revised to remove the suppression and detections systems that had negligible risk benefit and add those systems which were credited in the Multi-Compartment Analysis / Hot Gas Layer.

Revisions to Attachment C also include the deletion of engineering evaluation CALC-85-E-0053-07, "Suppression System Evaluation for Rooms 96 and 111," from Fire Areas G, I-1, and I-3. This Engineering Report is obsolete and has been superseded by CALC-A-FP-2005-001, "Fire Protection Appendix R Detection & Suppression Evaluation, which evaluates the partial suppression in Fire Zone 98-J (Room 111)" and no longer credits suppression in the adjoining Fire Zone 112-I. Suppression is not credited for risk in Fire Zone 97-R and the evaluation performed in CALC-85-E-0053-07 is, therefore, no longer needed for Room 96 (Fire Zone 97-R).

Attachment G (Recovery Actions Transition)

As committed to in the response to SSA RAI 11.01 in Entergy's letter dated November 4, 2015, an additional defense-in-depth (DID) action to secure Load Center B-5, or its downstream breakers, has been included in main control room abandonment scenarios to remove power to red train valves associated with core damage frequency reduction. This has been added to Table G-1 of Attachment G, and Fire Area G was changed in Attachment C to reflect this new DID action.

Attachment J (Fire Modeling Verification and Validation)

Attachment J has been updated to match the documents that were used or created to address RAIs. Some documents were replaced because the methodologies were changed or the results were consolidated (as in the case of PRA-A1-05-011, for example). In another case, a new document was created after the original Attachment J was prepared that contained some fire modeling. The reference list has also been updated.

Attachment S (Plant Modifications and Implementation Items)

Attachment S, Table S-1, has been updated to refine the descriptions of the modifications based on completion of some modifications and a more detailed design of others. A new modification related to potential impacts to the Emergency Feedwater Initiation and Control (EFIC) Signal Conditioning Cabinet, C539, was also added to Attachment S as item S1-34. The need for this modification was identified in CR-ANO-C-2015-4976, which documents a concern with redundancy of post-event instrumentation. A fire watch has been posted as an interim compensatory measure until this condition is resolved.

In addition, Table S-2, Item S2-9 is revised, consistent with that of the Duane Arnold nuclear facility, to be more specific with respect to the intended verifications and the expected actions to drive resolution.

Operating License

The marked-up and revised Operating License pages submitted as Enclosures 3 and 4 of Reference 1 have been revised to include ANO-1 NFPA 805 correspondence history and to be consistent with that approved for ANO-2 in NRC Safety Evaluation dated February 18, 2015 (ML14356A227). Entergy requests the NRC replace the original Reference 1 Operating License pages with the updated Operating License pages included in this letter (Attachments 8 and 9).

<u>Conclusion</u>

With the exception of Attachment C, updated Versions to all aforementioned Attachments and/or Tables, including Attachment W (FPRA Risk Insights), are included in this letter. Entergy requests the NRC to replace the like Attachments and/or Tables in the original ANO-1 LAR (Reference 1) with these updated Attachments and/or Tables.

Due to the size of Attachment C (nearly 200 pages), only the revised pages are included in attachment to this letter. Entergy requests the NRC replace the like pages of Attachment C from the original ANO-1 LAR with those provided in this letter. The pages to be replaced are as follows:

<u>Attachment C Replacement Pages</u>

C-3, C-11, C-40, C-52, C-90, C-102 through C-108, C-111, C-114, C-117, C-120 through C-122, C-124, C-129, and C-138

REFERENCES:

1. Entergy letter dated January 29, 2014, *License Amendment Request to Adopt NFPA-805 Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants (2001 Edition)* (1CAN011401) (ML14029A438)

2. NRC letter dated May 5, 2015, *Arkansas Nuclear One, Unit 1 – Request for Additional Information Regarding License Amendment Request to Adopt National Fire Protection Association Standard 805* (TAC No. MF3419) (1CNA051501) (ML15091A431)

3. Entergy letter dated May 19, 2015, *Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN051501) (ML15139A196)

4. Entergy letter dated June 16, 2015, *60-Day Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN061501) (ML15167A503)

5. Entergy letter dated July 21, 2015, *90-Day Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN071501) (ML15203A205)

6. Entergy letter dated August 12, 2015, *120-Day Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN081501) (ML15224A729)

7. NRC email dated September 8, 2015, *Arkansas Nuclear One, Unit 1 – 2nd Round Request for Additional Information - ANO-1 NFPA 805 LAR (TAC No. MF3419)* (1CNA091501) (ML15251A220)

REFERENCES (continued):

8. Entergy letter dated September 22, 2015, *Round 2 Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN091501) (ML15265A113)

9. NRC email dated October 6, 2015, *Arkansas Nuclear One, Unit 1 – 2nd Round Part 2 Request for Additional Information - ANO-1 NFPA 805 LAR (TAC No. MF3419)* (1CNA101501) (ML15280A114)

10. Entergy letter dated November 4, 2015, *Second Set of Round 2 Responses to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN111501) (ML15308A452)

11. Entergy letter dated November 17, 2015, *Clarification of Response to Round 2 Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN111502) (ML15321A076)

12. NRC email dated January 12, 2016, *Arkansas Nuclear One, Unit 1 – 3rd Round Request for Additional Information - ANO-1 NFPA 805 LAR (TAC No. MF3419)* (1CNA011601)

13. Entergy letter dated January 15, 2016, *Response to Round 3 Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN011601) (ML16015A421)

14. NRC email dated February 3, 2016, *Arkansas Nuclear One, Unit 1 – 3rd Round Request for Additional Information - ANO-1 NFPA 805 LAR (TAC No. MF3419)* (1CNA021601)

Attachment 2 to

1CAN031602

Updated Table 4-3 – Compliance with NFPA 805 Requirements

Table 4-3 Summary of NFPA 805 Compliance Basis and Required Fire Protection Systems and Features

Fire Area	Fire Zone	Description	NFPA 805 Regulatory Basis	Required Suppression System (S, L, E, R, D)	Required Detection System (S, L, E, R, D)	Required Fire Protection Feature (S, L, E, R, D)	Required Fire Protection Feature and System Details
A		East Decay Heat Removal Pump Room					
A	10-EE	East Decay Heat Removal Pump Room	4.2.3.2	None	E, R	N/A	Detection
B-1		Unit 1 General Plant Multiple Elevations					
B-1@120	120-E	Boric Acid Addition Tank & Pump Room	4.2.4.2	D	None	N/A	Partial Suppression
B-1@120	125-E	Respirator Storage Room	4.2.4.2	D	None	N/A	Suppression
B-1@120	128-E	Controlled Access	4.2.4.2	E, D	R, D	N/A	Detection and Suppression
B-1@120	149-E	Upper North Elect Pen Rm, Hot Mech Shop, Decon Rm	4.2.4.2	E, R, D	E, R, D	N/A	Detection and Suppression
B-1@120	79-U	Upper North Piping Penetration Room	4.2.4.2	E, D	E, R, D	N/A	Detection and Partial Suppression
B-1@170-Z	170-Z	Steam Pipe Room (Penthouse)	4.2.4.2	None	None	N/A	None
B-1@40Y	40-Y	Pipeway Room (Under ICW coolers)	4.2.4.2	None	R, D	N/A	Detection
B-1@73-W	73-W	Condensate Demineralizer Room	4.2.4.2	E, D	E, R, D	N/A	Detection and Partial Suppression
B-1@BOFZ	157-B	Chemical Addition Room (Boric Acid Mix Tank)	4.2.4.2	None	None	N/A	None
B-1@BOFZ	159-B	Spent Fuel Room	4.2.4.2	None	E, R, D	N/A	Detection
B-1@BOFZ	160-B	Computer Room	4.2.4.2	None	E, D	N/A	Partial Detection
B-1@BOFZ	161-B	Ventilation Equipment Room	4.2.4.2	None	None	N/A	None
B-1@BOFZ	163-B	Reactor Building Purge Room	4.2.4.2	D	None	N/A	Partial Suppression
B-1@BOFZ	167-B	Computer Transformer Room	4.2.4.2	None	R, D	N/A	Detection
B-1@BOFZ	168-B	Transformer Room	4.2.4.2	None	None	N/A	None
B-1@BOFZ	175-CC	Lube Oil Storage Tank Room	4.2.4.2	D	D	N/A	Detection and Suppression
B-1@BOFZ	187-DD	Dirty & Clean Lube Oil Storage Tank Room	4.2.4.2	D	None	N/A	Suppression
B-1@BOFZ	197-X	Turbine Building (Balance of Fire Zone)	4.2.4.2	E, D	E, D	N/A	Partial Detection and Suppression
B-1@BOFZ	2026-Y	Drumming Station (Unit 1)	4.2.4.2	None	None	N/A	None
B-1@BOFZ	75-AA	Boiler Room, Ammonia Tank Room	4.2.4.2	E, D	D	N/A	Detection and Partial Suppression
B-1@BOFZ	78-BB	Gas Bottle Storage Room	4.2.4.2	None	None	N/A	None
B-1@WHD	197-X	Turbine Building (West Heater Deck)	4.2.4.2	None	E, D	N/A	Partial Detection
B-7		Aux Building Elev 317					
B-7	12-EE	Tendon Gallery Access Room	4.2.3.2	None	None	N/A	None
B-7	14-EE	West Decay Heat Removal Pump Room	4.2.3.2	None	E, R	N/A	Detection
B-7	4-EE	General Access Room	4.2.3.2	None	None	N/A	None

Table 4-3 Summary of NFPA 805 Compliance Basis and Required Fire Protection Systems and Features

Fire Area	Fire Zone	Description	NFPA 805 Regulatory Basis	Required Suppression System (S, L, E, R, D)	Required Detection System (S, L, E, R, D)	Required Fire Protection Feature (S, L, E, R, D)	Required Fire Protection Feature and System Details
B-8		Aux Bldg South Side					
B-8@SEPR	104-S	Electrical Equipment Room	4.2.4.2	None	E, R, D	N/A	Detection
B-8@SEPR	105-T	Lower South Electrical Penetration Room	4.2.4.2	E, R, D	E, R, D	N/A	Detection and Suppression
B-8@SEPR	144-D	Upper South Electrical Penetration Room	4.2.4.2	E, R, D	E, R, D	N/A	Detection and Suppression
B-8@SEPR	76-W	Compressor Room	4.2.4.2	None	R, D	N/A	Detection
B-8@SPPR	46-Y	Lower South Piping Penetration Room	4.2.4.2	None	E, R, D	N/A	Detection
B-8@SPPR	77-V	Upper South Piping Penetration Room	4.2.4.2	None	E, R, D	N/A	Detection
B-9		General Access Elev 354					
B-9	67-U	Lab & Demineralizer Access Room	4.2.4.2	E, D	E, R, D	N/A	Detection and Partial Suppression
B-9	68-P	Reactor Coolant Makeup Tank Room	4.2.4.2	None	R, D	N/A	Detection
B-9	88-Q	Communications Room	4.2.4.2	None	None	N/A	None
B-9	89-P	Controlled Access (stairwell)	4.2.4.2	None	None	N/A	None
B-10		Stairwell No.1					
B-10	162-A	Stairwell 1	4.2.4.2	None	None	N/A	None
C		General Area 335' Elevation					
C	20-Y	Radwaste Processing Room	4.2.4.2	D	E, R, D	N/A	Detection and Partial Suppression
C	31-Y	Purification Demineralizer Room	4.2.4.2	None	None	N/A	None
C	34-Y	Pipe Room	4.2.4.2	None	E, R, D	N/A	Detection
C	38-Y	Emergency Feedwater Pump Room	4.2.4.2	E, D	E, R, D	N/A	Detection and Partial Suppression
C	47-Y	Penetration Ventilation Room	4.2.4.2	None	E, R, D	N/A	Detection
C	53-Y	Lower North Piping Penetration Room	4.2.4.2	None	E, R, D	N/A	Detection
D		North Emergency Diesel Generator Room					
D	1-E	North Emergency Diesel Generator Exhaust Fans	4.2.3.2	None	E, R	N/A	Detection
D	86-G	North Emergency Diesel Generator Room	4.2.3.2	E, R	E, R	N/A	Detection and Suppression
E		South Switchgear Room					
E	100-N	South Switchgear Room	4.2.4.2	None	E, R, D	N/A	Detection
F		South Battery and DC Equipment Rooms					
F	110-L	South Battery Room	4.2.4.2	None	R, D	N/A	Detection

Table 4-3 Summary of NFPA 805 Compliance Basis and Required Fire Protection Systems and Features

Fire Area	Fire Zone	Description	NFPA 805 Regulatory Basis	Required Suppression System (S, L, E, R, D)	Required Detection System (S, L, E, R, D)	Required Fire Protection Feature (S, L, E, R, D)	Required Fire Protection Feature and System Details
G		Cable Spreading Room and Control Rooms					
G	97-R	Cable Spreading Room	4.2.4.2	E, D	E, R, D	N/A	Detection and Partial Suppression
G	129-F	Control Room	4.2.4.2	E, D	E, R, D	N/A	Detection and Partial Suppression
G	2098-C	CPC Room	4.2.4.2	R, D	R, D	N/A	Detection and Suppression
G	2098-L	Cable Spreading Room	4.2.4.2	R, D	R, D	N/A	Detection and Suppression
G	2119-H	CR Printer Room	4.2.4.2	None	R, D	N/A	Detection
G	2136-I	Health Physics Corridor	4.2.4.2	R, D	R, D	N/A	Detection and Partial Suppression
G	2137-I	USEP Room, Decon, Hot Instrument Shop	4.2.4.2	R, D	R, D	N/A	Detection and Suppression
G	2150-C	Old CPC Room	4.2.4.2	None	R, D	N/A	Detection
G	2199-G	Unit 2 Control Room	4.2.4.2	None	R, D	N/A	Detection
H		South Emergency Diesel Generator Room					
H	2-E	South Emergency Diesel Generator Exhaust Fans	4.2.3.2	None	E, R	N/A	Detection
H	87-H	South Emergency Diesel Generator Room	4.2.3.2	E, R	E, R	N/A	Detection and Suppression
I-1		Corridor					
I-1	98-J	Corridor	4.2.4.2	E, R, D	E, R, D	N/A	Detection and Partial Suppression
I-2		North Switchgear Room					
I-2	99-M	North Switchgear Room	4.2.4.2	None	E, R, D	N/A	Detection
I-3		Lower North Electrical Penetration Room					
I-3	112-I	Lower North Electrical Penetration Room	4.2.4.2	E, R, D	E, R, D	N/A	Detection and Suppression
J		Unit 1 Containment Building					
J-North	32-K	North Side Containment Building	4.2.4.2	N/R	E, R, D	N/A	Partial Detection
J-South	33-K	South Side Containment Building	4.2.4.2	N/R	E, R, D	N/A	Partial Detection
K		Tank Vaults					
K	16-Y	Clean Waste Receiver Tank Room	4.2.3.2	None	None	N/A	None
K	2020-JJ	Boron Holdup Tank Vault	4.2.3.2	None	None	N/A	None
L		Diesel Fuel Storage Vault Area					
L	TKVLT	Diesel Fuel Storage Vault	4.2.3.2	N/R	N/R	N/A	None
MH01		Between Aux Bldg and Intake Structure					
MH01	1MH01	Yard Manhole	4.2.3.2	None	None	N/A	None

Table 4-3 Summary of NFPA 805 Compliance Basis and Required Fire Protection Systems and Features

Fire Area	Fire Zone	Description	NFPA 805 Regulatory Basis	Required Suppression System (S, L, E, R, D)	Required Detection System (S, L, E, R, D)	Required Fire Protection Feature (S, L, E, R, D)	Required Fire Protection Feature and System Details
MH02		Between Aux Bldg and Intake Structure					
MH02	1MH02	Yard Manhole	4.2.3.2	None	None	N/A	None
MH03		Between Aux Bldg and Intake Structure					
MH03	1MH03	Yard Manhole	4.2.4.2	None	None	N/A	None
MH04		Between Aux Bldg and Intake Structure					
MH04	1MH04	Yard Manhole	4.2.3.2	None	None	N/A	None
MH05		Between Aux Bldg and Intake Structure					
MH05	1MH05	Yard Manhole	4.2.4.2	None	None	N/A	None
MH06		Between Aux Bldg and Intake Structure					
MH06	1MH06	Yard Manhole	4.2.3.2	None	None	N/A	None
MH09		Between Aux Bldg and Intake Structure					
MH09	1MH09	Yard Manhole	4.2.3.2	None	None	N/A	None
MH10		Between Aux Bldg and Intake Structure					
MH10	1MH10	Yard Manhole	4.2.3.2	None	None	N/A	None
N		Unit 1 Intake Structure					
N	INTAKE	Intake Structure (Unit 1)	4.2.4.2	N/R	D	N/A	Detection
O		North Battery Room					
O	95-O	North Battery Room	4.2.4.2	None	R, D	N/A	Detection
YD		Miscellaneous Yard Locations					
YD	DEGAS	Degas	4.2.3.2	None	None	N/A	None
YD	YARD	Miscellaneous Yard Locations	4.2.3.2	N/R	N/R	N/A	None
ADMIN		Administration Building					
ADMIN	ADMIN	Administration Building	4.2.3.2	N/R	N/R	N/A	None

Legend:

S – Credited Separation Criteria is derived from PRA in B-3 Table VFDRs.
L –NRC approved Licensing Action is derived from Attachment K and/or B-1 Table VFDRs.
E – EEEE Criteria: Credited Systems/Features are derived from B-1 Table and/or B-3 Table.
R – Risk Criteria is derived from PRA in B-3 Table.
D – Defense-in-depth Criteria is derived from PRA in B-3 Table.
N/R – System is operational in fire area, however it is Not Required.
Fire Protection Features are features required to meet NFPA 805 Chapter 3 requirements.
None – Fire protection feature is not present in the fire zone.

Attachment 3 to

1CAN031602

Updated Pages for Attachment C, Table B-3 – Fire Area Transition

Fire Area ID:	A – East Decay Heat Removal Pump Room
Compliance Basis:	NFPA 805 Section 4.2.3.2 – Deterministic Approach

Engineering Evaluation ID: CALC-ANO1-FP-09-00016 “Engineering Evaluation for Penetration Seals in Fire Area C”

Summary: Purpose: The purpose of this evaluation is to document the acceptability of ANO-1 penetrations in Fire Area C used in 3-hour rated fire area boundaries.

The seals reviewed by this evaluation are:

From Fire Area C (20-Y) to A (10-EE)

FB-0049-01-0001
FB-0049-01-0004

Basis for Acceptability: The penetrations listed are considered adequate for the hazards in the respective area based on:

- Acceptable combustible loading
- Smoke detection systems in Fire Zones 10-EE and 20-Y
- Full depth silicone foam for FB-0049-01-0001 and FB-0049-01-0004
- Response by the fire brigade team with manual firefighting equipment in the areas without automatic suppression

Engineering Evaluation ID: CALC-ANOC-FP-07-00003 “Watertight Fire Doors Evaluation”

Summary: Purpose: Evaluate watertight doors used in 3-hour rated fire barriers.

Basis for Acceptability: The watertight doors (DR-5, DR-30, DR-33, and DR-455) installed at ANO in 3-hour rated fire barriers have been determined to be acceptable for use based on the hazards in the areas. Although these doors are not 3-hour rated fire doors, they will provide the protection needed in the areas they are used.

Required Fire Protection Systems and Features

		Installed		Required?									
				Separation		LA		EEEE		Risk*		DID	
Fire Zone	Fire Zone Description	SUP	DET	SUP	DET	SUP	DET	SUP	DET	SUP	DET	SUP	DET
10-EE	East Decay Heat Removal Pump Room	No	Yes	No	No	No	No	No	Yes	No	Yes	No	No

* Suppression and/or detection credited in HGL/MCA
P – Indicates a partial system is installed
Separation - Required for Chapter 4 Separation Criteria
LA- Required for NRC-Approved Licensing Action
EEEE- Required for Existing Engineering Equivalency Evaluation
Risk - Required for Risk Significance
DID- Required to Maintain an Adequate Balance of Defense-in-Depth in a Change Evaluation or Fire Risk Evaluation

Fire Area ID: B-1@120-E, 125-E, 128-E, 149-E, and 79-U (North Auxiliary Building)
Compliance Basis: NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

Required Fire Protection Systems and Features

		Installed		Required?									
				Separation		LA		EEEE		Risk		DID	
Fire Zone	Fire Zone Description	SUP	DET	SUP	DET	SUP	DET	SUP	DET	SUP	DET	SUP	DET
120-E	Boric Acid Addition Tank and Pump Room	P	No	No	No	No	No	No	No	No	No	Yes	No
125-E	Respirator Storage Room	Yes	No	No	No	No	No	No	No	No	No	Yes	No
128-E	Controlled Access	Yes	Yes	No	No	No	No	Yes	No	No	Yes	Yes	Yes
149-E	Upper North Electrical Penetration Room Hot Mechanic Shop Decon Room	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
79-U	Upper North Piping Penetration Room	P	Yes	No	No	No	No	Yes	Yes	No	Yes	Yes	Yes

P – Indicates a partial system is installed
Separation - Required for Chapter 4 Separation Criteria
LA- Required for NRC-Approved Licensing Action
EEEE- Required for Existing Engineering Equivalency Evaluation
Risk - Required for Risk Significance
DID- Required to Maintain an Adequate Balance of Defense-in-Depth in a Change Evaluation or Fire Risk Evaluation

Fire Area ID: B-1@BOFZ
Compliance Basis: NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

Required Fire Protection Systems and Features

		Installed		Required?											
				Separation		LA		EEEE		Risk		DID			
Fire Zone	Fire Zone Description	SUP	DET	SUP	DET	SUP	DET	SUP	DET	SUP	DET	SUP	DET		
157-B	Chemical Addition Rm. (Boric Acid Mix Tank)	No	No	No	No	No	No	No	No	No	No	No	No		
159-B	Spent Fuel Room	No	Yes	No	No	No	No	No	Yes	No	Yes	No	Yes		
160-B	Computer Room	No	P	No	No	No	No	No	Yes	No	No	No	Yes		
161-B	Ventilation Equipment Room	No	No	No	No	No	No	No	No	No	No	No	No		
163-B	Reactor Building Purge Room	P	No	No	No	No	No	No	No	No	No	Yes	No		
167-B	Computer Transformer Room	No	Yes	No	No	No	No	No	No	No	Yes	No	Yes		
168-B	Transformer Room	No	No	No	No	No	No	No	No	No	No	No	No		
175-CC	Lube Oil Storage Tank Room	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes		
187-DD	Dirty and Clean Lube Oil Storage Tank Room	Yes	No	No	No	No	No	No	No	No	No	Yes	No		
197-X	Turbine Building	P	P	No	No	No	No	Yes	Yes	No	No	Yes	Yes		
2026-Y	Drumming Station (Unit 1)	No	No	No	No	No	No	No	No	No	No	No	No		
75-AA	Boiler De-aeration and Expansion Tanks Room Ammonia Tank Room	P	Yes	No	No	No	No	Yes	No	No	No	Yes	Yes		
78-BB	Gas Bottle Storage Room	No	No	No	No	No	No	No	No	No	No	No	No		

P – Indicates a partial system is installed
Separation - Required for Chapter 4 Separation Criteria
LA- Required for NRC-Approved Licensing Action
EEEE- Required for Existing Engineering Equivalency Evaluation
Risk - Required for Risk Significance
DID- Required to Maintain an Adequate Balance of Defense-in-Depth in a Change Evaluation or Fire Risk Evaluation

Fire Area ID: B-7 Aux Building Elev. 317’
Compliance Basis: NFPA 805 Section 4.2.3.2 – Deterministic Approach

Engineering Evaluation ID: CALC-ANO1-FP-09-00014 “Engineering Evaluation for Penetration Seals in Fire Area A”

Summary: Purpose: The purpose of this evaluation is to evaluate and document the acceptability of ANO-1 penetration FB-10-02-0008 used in a 3-hour rated fire area boundary based on the penetration seal considered adequate for the hazards in the area.

Basis for Acceptability: The bases for the acceptability are the low fire durations, the smoke detection system on the near side (Fire Zone 10-EE) that alarms in the unit control room, and the response by the fire brigade (with the manual firefighting equipment in the area).

Required Fire Protection Systems and Features

		Installed		Required?											
				Separation		LA		EEEE		Risk*		DID	
Fire Zone	Fire Zone Description	SUP	DET	SUP	DET	SUP	DET	SUP	DET	SUP	DET	SUP	DET
12-EE	Tendon Gallery Access Room	No	No	No	No	No	No	No	No	No	No	No	No
14-EE	West Decay Heat Removal Pump Room	No	Yes	No	No	No	No	No	Yes	No	Yes	No	No
4-EE	General Access Room	No	No	No	No	No	No	No	No	No	No	No	No

* Suppression and/or detection credited in HGL/MCA
P – Indicates a partial system is installed.
Separation - Required for Chapter 4 Separation Criteria
LA- Required for NRC-Approved Licensing Action
EEEE- Required for Existing Engineering Equivalency Evaluation
Risk - Required for Risk Significance
DID- Required to Maintain an Adequate Balance of Defense-in-Depth in a Change Evaluation or Fire Risk Evaluation

Risk Summary

This fire area complies with the deterministic requirements of Section 4.2.3.2 of NFPA 805 and a fire risk evaluation is not required.

VFDRS

This fire area is in deterministic compliance and has no VFDRs.

End of Fire Area B-7

Fire Area ID: D
Compliance Basis: NFPA 805 Section 4.2.3.2 – Deterministic Approach

Required Fire Protection Systems and Features

		Installed		Required?									
				Separation		LA		EEEE		Risk*		DID	
Fire Zone	Fire Zone Description	SUP	DET	SUP	DET	SUP	DET	SUP	DET	SUP	DET	SUP	DET
1-E	North EDG Exhaust Fans	No	Yes	No	No	No	No	No	Yes	No	Yes	No	No
86-G	North Emergency Diesel Generator Room	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	No	No

* Suppression and/or detection credited in HGL/MCA
P – Indicates a partial system is installed
Separation - Required for Chapter 4 Separation Criteria
LA- Required for NRC-Approved Licensing Action
EEEE- Required for Existing Engineering Equivalency Evaluation
Risk - Required for Risk Significance
DID- Required to Maintain an Adequate Balance of Defense-in-Depth in a Change Evaluation or Fire Risk Evaluation

Risk Summary

This fire area complies with the deterministic requirements of Section 4.2.3.2 of NFPA 805 and a fire risk evaluation is not required.

VFDRS

This fire area is in deterministic compliance and has no VFDRs.

End of Fire Area D

Fire Area ID: G – Control Room
Compliance Basis: NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

Reference Document
CALC-85-E-0086-01, SSCA Safe Shutdown Capability Assessment, Rev. 7, Attachment 8.19
CALC-85-E-0086-02, Manual Action Feasibility Methodology and Common Results, Rev. 4, Attachment 53

Fire Suppression Activities Effect on Nuclear Safety Performance Criteria

Safe and stable conditions can be achieved and maintained utilizing equipment and actions outside of this fire area. Automatic suppression in the ANO-1 fire area is limited to the cable spreading room. Propagation of any suppression water from the ANO-1 cable spreading room would go into the turbine building where the large open area of minimizes any ponding concerns. The ANO-2 fire zones with automatic suppression included in this area are either physically isolated or separated by fire doors that can be controlled to limit any excess flow into ANO-1 areas. Fire suppression activities will, therefore, not adversely affect the plant's ability to achieve the nuclear safety performance criteria.

Licensing Actions

Licensing Action: Appendix R Exemption 12, Not Meeting III.L Criteria, approval letter 1CNA058303 dated May 11, 1983.

Licensing Basis: This exemption is no longer required because NFPA 805 does not require 8-hour battery backed emergency lighting.

Engineering Evaluations

Engineering Evaluation ID: CALC-90-R-1014-01 “Penetration Seal Analysis for Penetration 0097-05-0001”

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire suppression and detection in Fire Zone 97-R, the limited combustible loading, and the equivalent penetration seal construction as compared to the tested configuration. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Engineering Evaluation ID: CALC-90-R-1014-03 “Penetration Seal Analysis for Penetration 0097-01-0037”

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire suppression in Fire Zone 97-R, detection on both sides of the seal, and the limited combustible loading. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Fire Area ID: G – Control Room
Compliance Basis: NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

Engineering Evaluation ID: CALC-90-R-1014-04 “Penetration Seal Analysis for Penetration 0097-01-0040”

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire suppression and detection in Fire Zone 97-R, the limited combustible loading, and the equivalent penetration seal construction as compared to the tested configuration. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Engineering Evaluation ID: CALC-90-R-1014-06 “Penetration Seal Analysis for Penetration 0097-01-0048”

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire suppression and detection in Fire Zone 97-R, the limited combustible loading, and the equivalent penetration seal construction as compared to the tested configuration. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Engineering Evaluation ID: CALC-90-R-1014-14 “Penetration Seal Analysis for Penetration 0129-05-0264”

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire suppression and detection in Fire Zone 129-F, and the limited combustible loading. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Engineering Evaluation ID: CALC-90-R-1014-38 “Penetration Seal Analysis for Penetration 0129-01-0734”

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire detection and suppression on both sides of the seal, the limited combustible loading, and the equivalent penetration seal construction as compared to the tested configuration. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Fire Area ID:	G – Control Room
Compliance Basis:	NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

Engineering Evaluation ID: CALC-90-R-1014-39 "Penetration Seal Analysis for Penetration 0129-01-0186"

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon equivalency of metal instrument tubing to electrical conduit. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Engineering Evaluation ID: CALC-90-R-1014-40 "Penetration Seal Analysis for Penetration 0129-01-0020"

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire detection and suppression on both sides of the seal, the limited combustible loading, and the equivalent penetration seal construction as compared to the tested configuration. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Engineering Evaluation ID: CALC-90-R-1014-41 "Penetration Seal Analysis for Penetration 0129-01-0023"

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire detection and suppression on both sides of the seal, the limited combustible loading, and the equivalent penetration seal construction as compared to the tested configuration. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Engineering Evaluation ID: CALC-90-R-1014-42 "Penetration Seal Analysis for Penetration 0129-01-0070"

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire detection and suppression on both sides of the seal, the limited combustible loading, and the equivalent penetration seal construction as compared to the tested configuration. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Fire Area ID:	G – Control Room
Compliance Basis:	NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

Engineering Evaluation ID: CALC-90-R-1014-43 “Penetration Seal Analysis for Penetration 0129-01-0082”

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire detection and suppression on both sides of the seal, the limited combustible loading, and the equivalent penetration seal construction as compared to the tested configuration. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Engineering Evaluation ID: CALC-90-R-1014-44 “Penetration Seal Analysis for Penetration 0129-01-0094”

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire detection and suppression on both sides of the seal, the limited combustible loading, and the equivalent penetration seal construction as compared to the tested configuration. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Engineering Evaluation ID: CALC-90-R-1014-45 “Penetration Seal Analysis for Penetration 0129-01-0161”

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire detection and suppression on both sides of the seal, the limited combustible loading, and the equivalent penetration seal construction as compared to the tested configuration. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Engineering Evaluation ID: CALC-90-R-1014-46 “Penetration Seal Analysis for Penetration 0129-01-0173”

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire detection and suppression on both sides of the seal, the limited combustible loading, and the equivalent penetration seal construction as compared to the tested configuration. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Fire Area ID:	G – Control Room
Compliance Basis:	NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

Engineering Evaluation ID: CALC-90-R-1014-47 "Penetration Seal Analysis for Penetration 0129-01-0192"

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire detection and suppression on both sides of the seal, the limited combustible loading, and the equivalent penetration seal construction as compared to the tested configuration. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Engineering Evaluation ID: CALC-90-R-1014-48 "Penetration Seal Analysis for Penetration 0129-01-0200"

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire detection and suppression on both sides of the seal, the limited combustible loading, and the equivalent penetration seal construction as compared to the tested configuration. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Engineering Evaluation ID: CALC-90-R-1014-49 "Penetration Seal Analysis for Penetration 0129-01-0212"

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon availability of fire detection and suppression on both sides of the seal, the limited combustible loading, and the equivalent penetration seal construction as compared to the tested configuration. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Engineering Evaluation ID: CALC-ANO1-FP-07-00001 "Penetration Seal Analysis for Penetration 0097-01-0045"

Summary: Purpose: Evaluate the penetration seal to determine if it is acceptable to utilize the seal in a three (3)-hour rated fire boundary since the seal deviates from the tested configuration.

Basis for Acceptability: The configuration of the installed seal is acceptable based upon equivalency of penetrating items, smaller penetration area, and less free space. This evaluation has determined the deviation from tested design as having negligible impact and is, therefore, acceptable.

Fire Area ID:	G – Control Room
Compliance Basis:	NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

Engineering Evaluation ID: CALC-ANO1-FP-09-00015 "Engineering Evaluation for Penetration Seals in Fire Area B-1"

Summary: Purpose: The purpose of this evaluation is to evaluate and document the acceptability of ANO-1 penetrations in Fire Area B-1 used in a 3-hour rated fire area boundary.

The seals reviewed by this evaluation are:

- FB-79-01-0057 (from Fire Zones 79-U to 53-Y)
- FB-73-01-0034 and 0063 (from Fire Zones 73-W to 31-Y, and 34-Y)
- FB-149-01-0055 (from Fire Zones 149-E to 112-I)
- FB-2026-04-0055 (from Fire Zones 2026-Y to 34-Y)
- FB-160-01-0366 (from Fire Zones 160-B to 129-F)
- FB-0074-01-0057 and FB-0074-01-0058 (from Fire Zones 197-X to 34-Y)

Basis for Acceptability: The acceptability is the installed penetrations are considered to be adequate for the hazards based on:

- Detection system in fire zones 34-Y, 53-Y, 73-W, 79-U, 112-I, 129-F, 149-E, and 160-B
- Suppression system in fire zones 73-W, 79-U, 112-I, 129-F, and 149-E
- Combustible loading and fire brigade response using manual suppression

Engineering Evaluation ID: CALC-87-E-0024-01 "Evaluation of Fire Seal Required at Doorway Elev. 386' ANO-1 CR to ANO-2 CR"

Summary: Purpose: Evaluate seal requirements at doorway between ANO-1 and ANO-2 control rooms.

Basis for Acceptability: The embedded steel plate located at the joint in the doorway between control rooms prevents a fire originating at areas outside Fire Area G from spreading into the control rooms.

Engineering Evaluation ID: CALC-ANOC-FP-09-00013 "Fire Protection Engineering Evaluation for Penetration Seals in Fire Area G"

Summary: Purpose: The purpose of this evaluation is to evaluate and document the acceptability of penetrations in Fire Area G used in a 3-hour rated fire area boundary.

Basis for Acceptability: The bases for the acceptability is the seal are considered to be adequate for the hazards in the area based on the combustible loading, smoke detection on both sides (97-R, 129-F, and 197-X), suppression system in Fire Zone 97-R, and the response by the fire brigade to suppress the fire in the early stage.

Engineering Evaluation ID: CALC-ANOC-FP-10-00001 "Fire Protection Engineering Evaluation for Penetration Seals in Fire Area G"

Summary: Purpose: The purpose of this evaluation is to evaluate and document the acceptability of penetrations in Fire Area G used in a 3-hour rated fire area boundary.

Basis for Acceptability: The seals are considered to be adequate for the hazards in the area based on the combustible loading, smoke detection system or line type heat detectors in Fire Zones 97-R and 129-F, suppression system in Fire Zones 97-R and 129-F, and the response by the fire brigade to suppress the fire and prevent significant damage (with firefighting equipment in the area).

Fire Area ID: G – Control Room
Compliance Basis: NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

Required Fire Protection Systems and Features

		Installed		Required?									
				Separation		LA		EEEE		Risk		DID	
Fire Zone	Fire Zone Description	SUP	DET	SUP	DET	SUP	DET	SUP	DET	SUP	DET	SUP	DET
97-R	Cable Spreading Room	P*	Yes	No	No	No	No	Yes	Yes	No	Yes	Yes	Yes
129-F	ANO-1 Control Room	P**	Yes	No	No	No	No	Yes	Yes	No	Yes	Yes	Yes
2098-C	CPC Room	Yes**	Yes	No	No	No	No	No	No	Yes	Yes	Yes	Yes
2098-L	Unit 2 Cable Spreading Rooms	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes	Yes
2119-H	Control Room Printer Room	No	Yes	No	No	No	No	No	No	No	Yes	No	Yes
2136-I	Health Physics Room	P	Yes	No	No	No	No	No	No	Yes	Yes	Yes	Yes
2137-I	Upper South Electrical Penetration Room	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes	Yes
2150-C	Core Protection Calculator Room (Old CPC Room)	No	Yes	No	No	No	No	No	No	No	Yes	No	Yes
2199-G	ANO-2 Control Room	No	Yes	No	No	No	No	No	No	No	Yes	No	Yes

* No suppression in Room 96 ICS Relay Room
** Halon suppression above control room false ceiling and below auxiliary control room floor. Halon in Fire Zone 2098-C
P – Indicates a partial system is installed
Separation - Required for Chapter 4 Separation Criteria
LA- Required for NRC-Approved Licensing Action
EEEE- Required for Existing Engineering Equivalency Evaluation
Risk - Required for Risk Significance
DID- Required to Maintain an Adequate Balance of Defense-in-Depth in a Change Evaluation or Fire Risk Evaluation

Fire Area ID:	G – Control Room
Compliance Basis:	NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

Risk Summary (continued)

FRE Calculation: CALC -10-E-0023-18 (continued)

DID Maintained: The VFDRs, the associated fire area risks (CDF), and consequences (CCDP) were evaluated to identify general defense-in-depth echelon imbalances. This review is documented in Table 6.2.3 of the FRE and shows no additional DID methods for echelon 1 (prevention) and echelon 2 (detection & suppression). Defense in depth recovery actions (echelon 3) are identified to protect selected green train equipment listed by verifying/performing the following.

Inventory and Pressure Control

- CV-1000 electromatic relief valve (ERV) isolation valve closed
- D-21 breakers 1, 3, 9, 29, and 32 opened to remove DC power to switchgear and fail RCS vent and drain paths closed.
- CV-1408 BWST outlet valve opened
- CV-1275 Makeup tank outlet valve closed
- CV-1227/CV-1228 HPI block valves opened
- CV-1206 RCP seal injection valve closed
- CV-1274 RCP seal bleed off closed
- P-36C HPI/makeup pump locally operated
- P-36B HPI/makeup pump locally operated

DHR (Steam Generator)

- K-2A and K-2B MFW pumps tripped
- K-1 main turbine tripped

Vital Auxiliaries

- CV-3807 SW valve to EDG #2 cooler opened
- CV-3643 ACW isolation valve closed
- P-4B/P-4C SW pumps aligned
- Load Center B-5 secured to isolate power
- Load Center B-6 manually controlled to align/isolate power as required
- K-4B (EDG #2 secured if output breaker A-408 is open
- Switchgear A-4 breaker A-409 open to isolate non-ES bus
- Switchgear A-410 verified open to prevent EDG2 overload
- 125 VDC Bus RA-2 breakers 3 and 4 opened to prevent spurious operation of P-4B and P-36B
- K-4B (EDG #2) locally operated

Protect Cold Shutdown Equipment/shed unnecessary loads

- P-35B reactor building (RB) spray pump is tripped
- P-34B low pressure injection (LPI) / decay heat removal (DHR) pump tripped

No procedural changes or modifications are needed for maintenance of DID for this fire area.

Safety Margin Maintained: All analyses and assessments have been performed utilizing accepted techniques and industry accepted standards and are specifically documented within the FRE calculation.

Comments: None

Fire Area ID:	G – Control Room
Compliance Basis:	NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

VFDR ID: G-02 (continued)

Disposition: This VFDR has been evaluated and it was determined that the risk, safety margin and defense-in-depth meet the acceptance criteria of NFPA 805, Section 4.2.4, with the following actions:

a) Modification with a defense in depth action to prevent spurious operation and a local recovery to close CV-1221
b) Defense in depth action for CV-1206
c) Modifications with defense in depth actions to prevent spurious opening of CV-1405 and CV-1406
d) Defense in depth action to open breaker D-2101 isolating DC control power and recovery actions to locally trip RCPs P-32A, P-32B, P-32C, and P-32D at the switchgear
e) Recovery action to trip P-36A, B, and C and with defense in depth actions to start P-36B or P-36C
f) No further action for P-35A and defense in depth action to locally trip P-35B
g) Defense in depth action to secure P-34B
h) No further action for CV-1407 and defense in depth action to open CV-1408
i) No further action for CV-1414 and CV-1415
j) No further action for CV-1284, CV-1285, and defense in depth actions to open CV-1227 or CV-1228
k) Defense in depth action to close CV-1275
l) Defense in depth action to open breaker D-2129 and fail close SV-1072, SV-1074, SV-1082, SV-1084, SV-1092, and SV-1094. No further action for SV-1071, SV-1073, SV-1077, SV-1079, SV-1081, SV 1083, SV-1091, and SV-1093
m) Defense in depth action to open breaker D-2132 and fail close SV-1270, SV-1271, SV-1272, and SV-1273
n) Defense in depth action to close CV-1274
o) No further action for CV-1300

Fire Area ID:	G – Control Room
Compliance Basis:	NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

VFDR ID: G-05

VFDR: Fire damage to control cables in the area may affect SW functions. SW provides cooling to the EDGs and lube oil coolers for the primary makeup pumps. In addition, the SW system provides an assured long-term source of feedwater to the SGs via its connection to the EFW system once depletion of condensate occurs. The control circuits affected result in the following:

a) Loss of control and spurious closure of sluice gate SG-2 and SG-4 depriving the SW pumps of a suction source
b) Loss of control capabilities to SW pump P-4C or swing pump P-4B resulting in a loss of Loop 2 SW
c) Loss of control for valve CV-3643 (IN 92-18) resulting in a diversion of SW to ACW
d) Loss of control and spurious closure of SW cross tie valves CV-3640 and CV-3642 if P-4C is OOS (out of service) and P-4B is aligned to Loop 2
e) Loss of control and spurious opening of CV-3644 if P-4B is aligned to Loop 2 and Loop 1 is to be isolated
f) Loss of control and spurious closure of CV-3807 (IN 92-18) resulting in a loss of EDG #2 jacket cooling
g) Loss of control of valve CV-3811 (IN 92-18) prevents isolation of SW Loop 2 from Loop 1
h) Loss of control of CV-3851 (IN 92-18) prevents opening to supply EFW pump P-7A with SW for long-term heat removal after depletion of condensate

Loss of these functions could challenge the Vital Auxiliaries (Service water) Performance Criterion. This condition represents a variance from the deterministic requirements of Section 4.2.3 of NFPA 805. This is a separation issue and evaluation of the additional risk is required in accordance with Section 4.2.4 of NFPA 805.

Disposition: This VFDR has been evaluated and it was determined that the risk, safety margin and defense-in-depth meet the acceptance criteria of NFPA 805, Section 4.2.4, with the following actions:

a) Modification and defense in depth actions to prevent spurious closure of sluice gates SG-1 through SG-4
b) Defense in depth actions to align P-4C or P-4B
c) Defense in depth action for CV-3643
d) No further action for CV-3640 and CV-3642
e) No further action for CV-3644
f) Defense in depth action for CV-3807
g) No further action for CV-3811
h) No further action for CV-3851

End of Fire Area G

Fire Area ID: H – South Emergency Diesel Generator Room
Compliance Basis: NFPA 805 Section 4.2.3.2 – Deterministic Approach

Engineering Evaluation ID: CALC-ANOC-FP-09-00001 "Ventilation Opening in Units 1 & 2 EDG Room"

Summary: Purpose: The purpose of this evaluation is to evaluate the lack of fire dampers in the ventilation openings for the EDG rooms.

Basis for Acceptability: The bases for the acceptability are the smoke and flame detection systems, and suppression system in the EDG room would detect and suppress a fire in the early stage and prevent its growth. The smoke detection system in the exhaust fan rooms (1-E & 2-E) would also detect a fire in the early stage and alert Operations personnel to the fire. Manual firefighting equipment is located in rooms adjacent to the EDG room and exhaust rooms. The configuration of the exhaust fan rooms would also prevent fire to propagate to the other exhaust fan room or EDG rooms.

Required Fire Protection Systems and Features

		Installed		Required?									
				Separation		LA		EEEE		Risk*		DID	
Fire Zone	Fire Zone Description	SUP	DET	SUP	DET	SUP	DET	SUP	DET	SUP	DET	SUP	DET
2-E	South EDG Exhaust Fans	No	Yes	No	No	No	No	No	Yes	No	Yes	No	No
87-H	South Emergency Diesel Generator Room	Yes	Yes	No	No	No	No	Yes	Yes	Yes	Yes	No	No

* Suppression and/or detection credited in HGL/MCA
P – Indicates a partial system is installed
Separation - Required for Chapter 4 Separation Criteria
LA- Required for NRC-Approved Licensing Action
EEEE- Required for Existing Engineering Equivalency Evaluation
Risk - Required for Risk Significance
DID- Required to Maintain an Adequate Balance of Defense-in-Depth in a Change Evaluation or Fire Risk Evaluation

Risk Summary

This fire area complies with the deterministic requirements of Section 4.2.3.2 of NFPA 805 and a fire risk evaluation is not required.

VFDRS

This fire area is in deterministic compliance and has no VFDRs.

End of Fire Area H

Fire Area ID: I-1 Corridor
Compliance Basis: NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

Fire Zone ID	**Description**
98-J	Corridor

Performance Goal	Method Of Accomplishment	Comments
1. Reactivity Control	Manual reactor trip from the control room for short-term reactivity control. Long-term reactivity control is by inventory addition to the RCS using borated water from the BWST.	
2. Inventory Control	Letdown is isolated and the RCPs secured to maintain seal integrity. The primary makeup pump P-36A or P-36B is available with feed from the BWST using the normal charging path to the RCS.	Variance from the deterministic requirements of NFPA 805 exists for this performance goal. A Fire Risk Evaluation is required.
3. Pressure Control	RCS vent paths are secured. Pressurizer heaters are de-energized, normal pressurizer spray secured (RCPs turned off), and auxiliary pressurizer spray path is secured. RCS pressure is maintained by inventory addition using the primary makeup pumps.	Variance from the deterministic requirements of NFPA 805 exists for this performance goal. A Fire Risk Evaluation is required.
4. Decay Heat Removal	Main steam isolated, normal feedwater secured, and steam release using main steam safety valves if atmospheric dump valves are not immediately available. The motor driven EFW pump P-7B is aligned to SG-A.	Variance from the deterministic requirements of NFPA 805 exists for this performance goal. A Fire Risk Evaluation is required.
5a. Vital Auxiliaries (Electrical)	Engineered safety feature 4.16KV switchgear A-3 is aligned to offsite power.	Variance from the deterministic requirements of NFPA 805 exists for this performance goal. A Fire Risk Evaluation is required.
5b. Vital Auxiliaries (SW)	SW pump P-4A or P-4B (swing pump) feed SW Loop 1. ACW can be isolated to prevent potential pump run-out conditions.	Variance from the deterministic requirements of NFPA 805 exists for this performance goal. A Fire Risk Evaluation is required.
5c. Vital Auxiliaries (HVAC)	ANO-1 shares a common control room envelope with ANO-2. The control room is cooled by air conditioning unit VUC-9, ANO-2 condensing units (2VE-1A and 2VE-1B) and the control room emergency recirculation units (2VUC-27A and 2VUC-27B).	
6. Process Monitoring	Instrumentation is available in the Control Room via SPDS to monitor neutron flux, pressurizer level, RCS pressure, RCS temperature, and credited SG level and pressure.	Variance from the deterministic requirements of NFPA 805 exists for this performance goal. A Fire Risk Evaluation is required.

Reference Document
CALC-85-E-0086-01, SSCA Safe Shutdown Capability Assessment, Rev. 7, Attachment 8.21
CALC-85-E-0086-02, Manual Action Feasibility Methodology and Common Results, Rev. 4, Attachment 55

Fire Area ID:	I-1 Corridor
Compliance Basis:	NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

Fire Suppression Activities Effect on Nuclear Safety Performance Criteria

Safe and stable conditions can be achieved and maintained utilizing equipment and actions outside of the area of fire suppression activity. This area has automatic suppression and ponding in the fire area is minimized by the presence of two floor drains. A curb plate leading to Fire Area I-2, Fire Zone 99-M, prevents propagation of fire water to electrical switchgear rooms, and propagation into Fire Area F is limited by Door 480. Equipment located in adjacent Fire Area O, Fire Zone 95-O, is above the anticipated ponding level. Excess water can propagate to the south EDG room (Fire Zone 87-H), but this equipment is not required due to offsite power being available. Fire suppression activities will, therefore, not adversely affect the plant's ability to achieve the nuclear safety performance criteria.

Licensing Actions

Licensing Action: No licensing actions are applicable to this fire area.

Licensing Basis: N/A

Engineering Evaluations

Engineering Evaluation ID: CALC-A-FP-2005-001 “Fire Protection Appendix R Suppression and Detection Partial 86-10 Evaluation”

Summary: Purpose: The purpose of this evaluation is to document the adequacy of partial suppression in Fire Area I-1, Fire Zone 98-J.

Basis for Acceptability: Based upon a review of applicable drawings, walk downs, and evaluation of potential fire hazards, it is determined that the installed fire suppression system will adequately protect cables in the area.

Engineering Evaluation ID: CALC-ANO1-FP-09-00009 “Unit 1 Structural Steel Fire Protection Evaluation”

Summary: Purpose: The purpose of this evaluation is to document the fire protection engineering evaluation for the lack of structural steel fire proofing in the following locations:

B-1 (79-U, 149-E); B-8 (46-Y, 77-V, 105-T, 144-D); C (20-Y, 47-Y, 53-Y); I-1 (98-J); I-3 (112-I)

Basis for Acceptability: These rooms are protected by smoke detection systems that alarm in the control room (and suppression systems in the electrical penetration rooms) and the prompt response by the fire brigade with access to manual firefighting equipment should prevent any fire (in the unlikely event one does occur) from damaging the structural steel.

Fire Area ID:	I-1 Corridor
Compliance Basis:	NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

Risk Summary

FRE Calculation: CALC - 10-E-0023-20

Title: ANO-1 Fire Area I-1 Risk Evaluation

Summary: The fire risk evaluation has determined that the variances identified for this fire area are acceptable based upon the measured change in CDF and LERF, adequate defense in depth, and maintenance of safety margins with the identified recovery. In addition, there are global modifications credited to reduce CDF and LERF in all ANO-1 fire areas. This fire area is compliant with the risk-informed, performance-based approach as the results of this fire risk evaluation meet the requirements of NFPA 805 and the guidance of Regulatory Guide 1.205.

Credited Recovery Actions

- There are no recovery actions credited in this fire area to reduce the area risk or mitigate the risk of VFDRs.

Credited Modifications

Listed below are plant modifications that are credited globally to reduce the area CDF and LERF for all Fire PRA scenarios:

- A new AFW pump with controls independent of the existing EFW pumps.
- A redundant DC control power supply to switchgear A-1, A-2, H-1(VFDR I1-04), and H-2 (VFDR I1-04) will be installed to eliminate loss of switchgear due to loss of normal DC control power. This modification is credited in the compliant and variant case.
- Sluice gates SG-1, SG-2, SG-3, and SG-4 have a proposed modification to remove spurious operation that could close these valves. The sluice gates will remain open in all Fire PRA scenarios and are credited in both the compliant and variant case.
- CV-1405 and CV-1406 (VFDR I1-03-c) have a proposed modification to remove spurious operation that could open these valves. This modification is credited in the compliant and variant case.
- C539 (VFDR I1-05-a) has a proposed modification to eliminate a circuit impact associated with panel RS-1 that could result in a loss of instrumentation.

IN-92-18 Concerns

There are no recovery actions credited in this fire area to manually position motor operated valves that may have spuriously operated and failed in a non-recoverable position.

Additional Fire Area Considerations

The suppression and detection system for this fire area was credited in the ANO-1 HGL and MCA. The detection system is required to support fire brigade response to mitigate the formation of a hot gas layer.

Δ CDF: Refer to Attachment W “Fire PRA Insights”

Δ LERF: Refer to Attachment W “Fire PRA Insights”

Fire Area ID:	I-1 Corridor
Compliance Basis:	NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

VFDR ID: I1-04

VFDR: Fire damage to cables in the area may impact pressure and inventory control functions resulting in the following:

a) Loss of the control room trip capability of RCPs P-32A, P-32B, P-32C, and P-32D. Securing the pumps is required to assure normal pressurizer spray is secured and prevent potential RCP seal damage. Tripping the RCPs for a fire in this location also assures that a fault on the RCP P-32C and P-32D power cables cannot propagate back to transformer X-03 and cause a loss of off-site power.

Loss of these functions could challenge the Pressure and Inventory Control Performance Criterion. This condition represents a variance from the deterministic requirements of Section 4.2.3 of NFPA 805. This is a separation issue and evaluation of the additional risk is required in accordance with Section 4.2.4 of NFPA 805.

Disposition: This VFDR has been evaluated and it was determined that the risk, safety margin, and defense-in-depth meet the acceptance criteria of NFPA 805, Section 4.2.4, with modification to supply H-1 & H-2 with redundant DC control power.

VFDR ID: I1-05

VFDR: Fire damage to cables in the area may impact vital auxiliary functions. The circuits impacted result in the following:

a) Loss of the power supply to distribution panels RS-1, RS-2, RS-3, and RS-4.

Loss of this function could challenge the Vital Auxiliaries (Electrical) Performance Criterion. A loss of RS-1 results in a loss of power to instrumentation power supply and signal conditioning panel C539. This condition represents a variance from the deterministic requirements of Section 4.2.3 of NFPA 805. This is a separation issue and evaluation of the additional risk is required in accordance with Section 4.2.4 of NFPA 805.

Disposition: This VFDR has been evaluated and it was determined that the risk, safety margin, and defense-in-depth meet the acceptance criteria of NFPA 805, Section 4.2.4, with a modification of RS-1 circuits impacting instrumentation and no further actions for panels RS-2, RS-3, and RS-4.

End of Fire Area I-1

Fire Area ID:	I-3 Lower North Electrical Penetration Room
Compliance Basis:	NFPA 805 Section 4.2.4.2 – Performance Based – Fire Risk Evaluation

Fire Suppression Activities Effect on Nuclear Safety Performance Criteria

Safe and stable conditions can be achieved and maintained utilizing equipment and actions outside of the area of fire suppression activity. This fire area has automatic suppression system and one entrance from Fire Zone 98-J where excess fire water will propagate. Corridor 98-J is equipped with two large floor drains to minimize any ponding concerns. Fire suppression activities will therefore not adversely affect the plant's ability to achieve the nuclear safety performance criteria.

Licensing Actions

Licensing Action: No licensing actions are applicable to this fire area.

Licensing Basis: N/A

Engineering Evaluations

Engineering Evaluation ID: CALC-ANO1-FP-09-00009 “Unit 1 Structural Steel Fire Protection Evaluation”

Summary: Purpose: The purpose of this evaluation is to document the fire protection engineering evaluation for the lack of structural steel fire proofing in the following locations:

B-1 (79-U, 149-E); B-8 (46-Y, 77-V, 105-T, 144-D); C (20-Y, 47-Y, 53-Y); I-1 (98-J); I-3 (112-I)

Basis for Acceptability: These rooms are protected by smoke detection systems that alarm in the control room (and suppression systems in the electrical penetration rooms) and the prompt response by the fire brigade with access to manual firefighting equipment should prevent any fire (in the unlikely event one does occur) from damaging the structural steel.

Attachment 4 to

1CAN031602

Updated Attachment G, Table G-1 – Recovery Actions Transition

Table G-1 – Recovery Actions and Activities

Fire Area	Component	Component Description	Actions	VFDR	RA/PCS
B-1@BOFZ	P-32A/B/C/D	Reactor Coolant Pumps (RCPs)	Manually trip load breakers (H-11, H-22, H-12, H-21) and trip RCPs. For fire at switchgear H1/H2/A1/A2, the DC modification design maintains trip capability of the RCPs.	B-1@BOFZ-04	RA
G	CV-1221	Letdown Coolers Outlet	De-energize CV-1221 at panel B-61, breaker B-6154, located in Fire Area B-1, Fire Zone 149-E. Verify closed / manually close CV-1221 in Fire Area B-1, Fire Zone 79-U.	G-02	RA
G	P-32A	RCP	Manually open H-1 and H-2 feeder breakers to trip RCPs following fire damage to control circuits.	G-02	RA
G	P-32B	RCP	Manually open H-1 and H-2 feeder breakers to trip RCPs following fire damage to control circuits.	G-02	RA
G	P-32C	RCP	Manually open H-1 and H-2 feeder breakers to trip RCPs following fire damage to control circuits.	G-02	RA
G	P-32D	RCP	Manually open H-1 and H-2 feeder breakers to trip RCPs following fire damage to control circuits.	G-02	RA
G	P-36A	Primary Makeup Pump	De-energize DC control power to P-36A at D-11, D-1104, located in Fire Area F, Fire Zone 110-L. Verify tripped / manually trip A-306 in Fire Area E, Fire Zone 100-N.	G-02	RA
G	P-36B	Primary Makeup Pump	De-energize DC control power to P-36B(C) at RA-2, RA-204, located in Fire Area I-1, Fire Zone 98-J. Verify closed / manually close A-801 in Fire Area B-8, Fire Zone 104-S. De-energize DC control power to P-36B at A-4, A-407, located in Fire Area I-2, Fire Zone 99-M. Verify tripped / manually trip A-407, in Fire Area I-2, Fire Zone 99-M.	G-02	RA
G	P-36C	Primary Makeup Pump	De-energize DC control power to P-36C at A-4, A-406, located in Fire Area I-2, Fire Zone 99-M. Verify tripped / manually trip A-406 in Fire Area I-2, Fire Zone 99-M.	G-02	RA
G	P-75B**	New Auxiliary Feedwater (AFW) Pump	Manually start and align AFW pump to establish primary to secondary heat removal.	G-03, -04, -05	RA
G	PSV-1000	Pressurizer ERV	Manually disable PSV-1000 at breaker D-1124, local panel D-11 in Fire Area I-1, Fire Zone 98-J.	G-01	RA
G	A-4	4160V Vital Power Switchgear	Verify breaker A-409 open and open DC control power breaker.	N/A	RA*

Table G-1 – Recovery Actions and Activities

Fire Area	Component	Component Description	Actions	VFDR	RA/PCS
G	A-410	Vital Power Switchgear A4-A3 Crosstie	Verify breaker open and open DC control power breaker.	N/A	RA*
G	B-5	480V Vital Power	De-energize B-5 locally by removing DC control power to A-301 and opening the switchgear breaker.	N/A	RA*
G	B-6	480V Vital Power	De-energize B6 locally by opening A-401 and open DC control power when Electromatic Relief Valve (ERV) isolation valve position verified.	N/A	RA*
G	CV-1000	ERV Isolation Valve	Remotely close valve.	N/A	RA*
G	CV-1206	RCP Seal Injection Valve	Verify valve closed.	N/A	RA*
G	CV-1227 CV-1228	High Pressure Injection (HPI) Block Valves	Verify valves open.	N/A	RA*
G	CV-1274	RCP Seal Bleed Off Isolation Valve	Verify valve closed.	N/A	RA*
G	CV-1275	Makeup Tank Outlet Valve	Verify valve closed.	N/A	RA*
G	CV-1408	Borated Water Storage Tank (BWST) Outlet Valve	Manually open CV-1408 while monitoring flow.	N/A	RA*
G	CV-3643	Auxiliary Cooling Water (ACW) Isolation Valve	Verify valve closed.	N/A	RA*
G	CV-3807	Service Water (SW) to Emergency Diesel Generator #2 (EDG2) Coolers	Verify valve open.	N/A	RA*
G	D21-1, -3, -9, -29 and -32	DC Power To Various Equipment	Open breakers to remove DC power to switchgear H2 and A2, and load center B-6 (RCP seal return to Quench Tank and High Point Vents).	N/A	RA*
G	K-1	Main Turbine	Manually trip Main Turbine with TRIP lever at front standard.	N/A	RA*
G	K-2A, K-2B	Main Feed Pumps	Manually trip both Main Feedwater Pumps locally.	N/A	RA*
G	K-4B	EDG2	If EDG2 output breaker (A-408) is open, then secure EDG by opening EDG2 Engine Control Power breaker (D-2114A) inside Control Panel C-108.	N/A	RA*

Table G-1 – Recovery Actions and Activities

Fire Area	Component	Component Description	Actions	VFDR	RA/PCS
G	K-4B	EDG2	Place EDG2 in *no DC* override condition to start or maintain operating if running.	N/A	RA*
G	P-34B	Low Pressure Injection / Decay Heat Removal (LPI/DHR) Pump	Verify breaker A-405 open and open DC control power breaker.	N/A	RA*
G	P-35B	Reactor Building Spray Pump	Verify breaker A-404 open and open DC control power breaker.	N/A	RA*
G	P-36B	Primary Makeup Pump	Manually start P-36B(G) at A-4, breaker A-407, located in Fire Area I-2, Fire Zone 99-M.	N/A	RA*
G	P-36C	Primary Makeup Pump	Manually start P-36C at A-4, breaker A-406, located in Fire Area I-2, Fire Zone 99-M.	N/A	RA*
G	P-4B, P-4C	SW Pump	Align Loop 2 SW.	N/A	RA*
G	RA2-3 and -4	SW Pump P-4B and Primary Makeup Pump P-36B MOD control power	Open breakers RA2-3 and 4.	N/A	RA*

** Tentative Component Number

RA – Recovery Action PCS – Primary Control Station RA* – Defense in Depth Recovery Action

Attachment 5 to

1CAN031602

Updated Attachment J – Fire Modeling V&V

J. Fire Modeling Verification and Validation (V&V)

This attachment documents the Verification and Validation (V&V) basis for the Arkansas Nuclear One, Unit 1 (ANO-1) Fire Probabilistic Risk Assessment (FPRA) fire modeling applications. Plant specific fire modeling used to support the ANO-1 FPRA consists of the following:

- The calculation of the Main Control Room (MCR) operator abandonment times (CALC-ANO1-FP-09-00011);
- The use of generic fire modeling treatments and associated supplements as applicable to develop Zones of Influence (ZOI) (PRA-A1-05-004);
- A detailed assessment of fire scenarios involving secondary cable tray combustibles (PRA-A2-05-017 and PRA-A2-05-18);
- A screening calculation for minor quantities of secondary combustibles (CALC-ANOC-FP-15-00001);
- An assessment of the fire resistance of embedded conduit used as a basis for excluding such conduit from fire zones (EC-494); and
- Administrative and Turbine Building separation analysis (CALC-ANO1-FP-08-00003).

Main Control Room Abandonment Report

The goal of the MCR abandonment report, "Evaluation of Unit 1 Control Room Abandonment Times at ANO Facility" (CALC-ANO1-FP-00011), is to compute the time operators would abandon the ANO-1 MCR given a fire in either the ANO-1 or ANO-2 MCR. The abandonment times are assessed for various electronic equipment fires and for ordinary combustible fires as defined by the discretized heat release rate conditional probability distributions presented in NUREG/CR-6850. The abandonment time in the main control room is estimated by calculating the time to reach threshold values for temperature and visibility as identified by NUREG/CR-6850.

The focus of the MCR abandonment evaluation is on the first twenty-five minutes after ignition because the non-suppression probability (NSP) decreases to 0.001 at 20.9 minutes (NUREG/CR-6850, NUREG/CR-6850, Supplement 1). The abandonment calculations are performed using the zone fire model Consolidated Fire and Smoke Transport (CFAST), Version 6.1.1 (National Institute of Standards and Technology (NIST) Special Publication (SP) 1026 and NIST SP 1041).

The MCR area geometry and fire parameters for the simulations fall within the model limits listed in NIST SP 1026 and NIST SP 1041. Specifically, the vent area to enclosure volume ratio is less than two and the aspect ratio of the enclosures is less than five (for the true geometry). The physical input dimensions are adjusted to account for obstructions and boundary heat losses and the resulting model geometry has a length-to-width aspect ratio greater than five for some spaces. However, the input geometry conserves the boundary area, room volume, and enclosure height. Therefore, a corridor flow model is intentionally avoided because the true geometry has an aspect ratio that is within the model limitations.

The verification for the CFAST model (Version 6.0.5) is provided in NUREG-1824, Volume 5. Supplemental verification for CFAST, Version 6.1.1 is provided as an appendix to CALC-ANO1-FP-09-00011 as well as in NIST SP 1086.

The validation basis for the CFAST, Version 6.1.1 applications in the ANO-1 and ANO-2 MCR is provided in Appendix D of CALC-ANO1-FP-09-00011. The validation basis provided in Appendix D follows the guidance provided in NUREG-1934, which uses the NUREG-1824 verification and validation report. The process described in NUREG-1934 involves the comparison of various model non-dimensional parameters to the test values listed in NUREG-1824. The non-dimensional parameters that affect the model results as documented in NUREG-1824, Volumes 1 and 5, and NUREG-1934 include the model geometry, the global equivalence ratio, the fire Froude Number, and the flame length ratio. Non-dimensional parameters that relate to target exposure conditions (heat flux) and sprinkler actuation (ceiling jet) are not applicable to the calculation because these output parameters are not used.

Given the large number of CFAST simulations conducted as part of this effort (~2,000 baseline simulations, ~1,000 sensitivity simulations, and many additional scoping or alternate configuration simulations), it was not practical to document the status of each CFAST case with respect to the non-dimensional parameters. However, considering the range of fire sizes, space volumes, and ventilation fractions involved, some simulations fall entirely within the NUREG-1824, Volume 1, validation parameter space, and some fall partially within the parameter space.

Additional V&V studies are contained in NIST SP 1086 and NRL/MR/6180-04-8746. These studies have a broader parameter validation space than NUREG-1824, Volume 1. NIST SP 1086 is based in part on the methods of American Society for Testing and Materials (ASTM) E1355. NRL/MR/6180-04-8746 provides a Navy specific V&V study, which includes an assessment of CFAST, Version 3.1.7, predictions in multiple enclosures, and multiple elevation configurations. These additional V&V studies extend the range of the validation space to include configurations and conditions applicable to the MCR abandonment sensitivity analysis in Appendix B of CALC-ANO1-FP-09-00011.

The MCR abandonment report also provides benchmark and validation simulations for CFAST, Version 6.1.1 as applicable to the ANO-1 MCR area. In particular, the control room tests documented in NUREG/CR-4527, Volume 2, are used to provide additional validation basis for control room application of CFAST. Table J-1 provides a summary of the validation and verification basis for CFAST, Version 6.1.1, as applied in the MCR abandonment report.

Overall, it is concluded in Appendix D of CALC-ANO1-FP-09-00011 that the application of CFAST, Version 6.1.1, in the ANO-1 control room falls entirely within the NUREG-1824, Volume 1, V&V parameter space for applicable parameter for all times up to the predicted abandonment time, or would generate a conservative result relative to a case that fell within the NUREG-1824, Volume 1, V&V parameter space. The results after abandonment is predicted may be based on an application outside the NUREG-1824, Volume 1, V&V parameter space, but the results are not directly used in the FPRA.

Generic Fire Modeling Treatments

The "Generic Fire Modeling Treatments," (Hughes Associates) document is used to establish zones of influence for specific classes of ignition sources and primarily serves as a screening calculation in the FPRA under NUREG/CR-6850, Sections 8 and 11. The "Generic Fire Modeling Treatments" document (Hughes Associates) has two fundamental uses within the FPRA:

- Determine the ZOI inside which a particular ignition source is postulated to damage targets or ignite secondary combustible materials; and

- Determine the potential of the ignition sources to generate a hot gas layer within an enclosure that can either lead to full room burnout or invalidate the generic treatment ZOIs for a particular class of combustible materials.

The ZOI is determined using a collection of empirical and algebraic models and correlations. The potential for a hot gas layer having a specified temperature to form within an enclosure is determined using the zone model CFAST, Version 6.0.10 (NIST SP 1026, NIST SP 1041).

Wall and corner configurations are addressed using the 'Image' Method in which the source heat release rate and area are doubled for a wall configuration and quadrupled for a corner configuration. The enclosure boundary surface area and ventilation are also doubled and quadrupled for wall and corner configurations, respectively. This treatment takes advantage of the proportionality of the entrainment to the fire perimeter and the constant plume angle (Beyler, 1986; SFPE Handbook of Fire Protection Engineering, Section 2-1, 2008; Thomas et al. 1963; NIST-GCR-90-580) and results in more adverse conditions when the entrainment/fire perimeter ratio is reduced. However, explicit scenarios are not generated; rather, alternate scenarios are selected that have characteristics that are consistent with the 'Image' method adjustments.

Verification

The calculation development and review process in place at the time the "Generic Fire Modeling Treatments" document was prepared included contributions from a calculation preparer, a calculation reviewer, and a calculation approver. The responsibilities for each are as follows:

- The calculation preparer develops and prepares the calculation using appropriate methods.
- The calculation reviewer provides a detailed review of the report and supporting calculations, including spreadsheets and fire model input files. The reviewer provides comments to the preparer for resolution.
- Calculation approver provides a reasonableness review of the report and approves the document for release.

The calculation preparation occurred over a two year period ending in 2007. The review stage was conducted in 2007 at the completion of the preparation stage. The calculation was approved January 23, 2008. The approved document, the signature page, and an affidavit were transmitted to the Document Control Desk at the Nuclear Regulatory Commission in Washington, D. C., on January 23, 2008.

In the case of the empirical equations/correlations that form part of the basis of the "Generic Fire Modeling Treatments" document, a considerable amount of verification was performed during the preparation stage by the preparer. The empirical equations/correlations were solved using Excel® spreadsheets using either direct cell solutions (algebraic manipulation) or Visual Basic macros. All direct cell solutions were validated by the preparer through the use of alternate calculation. For simple equations, this entailed matching spreadsheet solution to the solution obtained using a hand calculator. For more complex solutions, the alternate calculation verification entailed either subdividing the problem into many sub-components and matching the solution using a hand calculator or matching the solution to a verified solution (i.e., the NUREG-1805 Solid Flame Heat Flux models). The verification of the Visual Basic macros also depended on the type of macro. In situations where the macro is used to perform multiple direct computations, the macro results were verified against the verified spreadsheet solutions that were verified through alternate calculation. In cases where the macro is used to find a root, the root was verified to be a zero by direct substitution into an alternate form of the solved equation.

The empirical equations/correlations were further verified by the reviewer using a Design Review method as indicated in the signature sheet. An independent reviewer was provided access to the draft report and all supporting calculation materials in late 2007. The reviewer conducted a detailed review of the implementation of the equations within the spreadsheets and the reporting of the equation result in the draft report. Comments and insights were provided to the preparer over the review period and were addressed to the satisfaction of the reviewer. Upon the completion of the review, a revised draft was prepared for review by the approver. The approver provided a higher level reasonableness check of the methods, approach, and the results. Comments and insights that were provided by the approver were addressed to the satisfaction of the reviewer and Revision 0 of the report was prepared and approved on January 23, 2008.

The verification for the CFAST model (Version 6.0.5) is provided in NUREG-1824, Volume 5. Supplemental verification for CFAST, Version 6.0.10, is provided as an appendix to the CALC-ANO1-FP-09-00011 as well as in NIST SP 1086.

Validation

The empirical equations and correlations are drawn from a variety of sources that are documented in various chapters of the Society of Fire Protection Engineers (SFPE) *Handbook of Fire Protection Engineering,* peer reviewed journals (e.g., the *Fire Safety Journal*), or engineering textbooks. The empirical models primarily fall into three groups:

- Flame height;
- Plume temperatures; and
- Heat fluxes (at a target location).

Table J-2 of this attachment identifies the empirical models that are used either directly or indirectly in the “Generic Fire Modeling Treatments” report. The table also identifies the original correlation source documentation and the correlation range in terms of non-dimensional parameters. The table also provides where applicable supplemental validation work that may have been performed on the correlations and provides limits applied in the “Generic Fire Modeling Treatments” report as applicable.

Except for the cable tray ZOI calculation, the flame height calculation is used only as a means of placing a limit on the applicability of the ZOI tables, which are based on the plume temperature and thermal radiation heat flux. The flame height calculation for axisymmetric source fires is robust and has considerable pedigree. The original documentation and basis of the flame height correlation is Heskestad (1981) as noted in Table J-2 of this attachment. Although there are earlier forms of the flame height equation, Heskestad provides a link between the flame height and plume centerline temperature calculation and identifies the range over which the plume equations are applicable. Because the flame height and plume centerline temperature equations are linked, the plume centerline range cited by Heskestad applies to the flame height calculation as well. The plume centerline temperature equations, and thus the flame height correlation, are applicable over the following range as noted in Table J-2 (Heskestad, 1981; Heskestad , 1984):

$$-5 \lesssim \log_{10}\left[\left[\frac{c_p T_\infty}{g\rho_\infty(\Delta H_{c/r})^3}\right]\frac{\dot{Q}^2}{D^5}\right] \lesssim 5$$

(J-1)

where c_p is the heat capacity of ambient air (kJ/kg-K [Btu/lb-°R]), T_∞ is the ambient temperature (K [°R]), g is the acceleration of gravity (m/s^2 [ft/s^2]), ρ_∞ the ambient air density (kg/m^3 [lb/ft^3]), $\dot{Q}$ is the fire heat release rate (kW [Btu/s]), r is the stoichiometric fuel to air mass ratio, D is the fire diameter (m [ft]), and ΔH_c is the heat of combustion of the fuel (kJ/kg [Btu/lb]). Application of Equation (J–1) depends on the fuel as well as a non-dimensional form of the fire heat release rate (fire Froude Number). In practice, the heat of combustion to air fuel ratio for most fuels will fall between 2,900 – 3,200 kJ/kg (1,250 – 1,380 Btu/lb), and for typical ambient conditions the $\dot{Q}^{2/5}/D$ ratio, for which the plume equations have validation basis, is between 7 – 700 kW$^{2/5}$/m (2.1 – 208 Btu$^{2/5}$/s-ft) (Heskestad , 1984). For fire sizes on the order of 25 kW (24 Btu/s) or greater, this means that the plume centerline equation is valid for heat release rates of 100 kW/m^2 (8.81 Btu/s-ft^2) to well over 3,000 kW/m^2 (264 Btu/s-ft^2). For weaker fires (heat release rates less than 100 kW/m^2 (8.81 Btu/s-ft^2), the tendency of the model is clearly to over-predict the temperature and flame height; thus for applications outside the range, but below the lower limit, the result will be conservative. The concern is therefore entirely on the upper range of the empirical model. The tables in the “Generic Fire Modeling Treatments” report are specifically developed with transient, lubricant spill fires, and electrical panel fires with a heat release rate per unit area within the validation range. When the heat release rate per unit area falls outside the applicable range, the table entry is not provided and it is noted that the source heat release rate per unit area is greater than the applicable range for the correlations. This applies to the flame height and the plume temperature for axisymmetric source fires.

The flame height and plume centerline temperature for line type fires (fires having a large aspect ratio) are applied only to cable tray fires. The correlation used has pedigree and has existed in its general form since at least Yokoi. Most recently, Yuan et al. provided a basis for the empirical constant using experimental data with source fires having a width of 0.015 m – 0.05 m (0.05 – 0.16 ft) and a length of 0.2 – 0.5 m (0.7 – 1.64 ft). When normalized, the applicable height to heat release rate per unit length range ($Z/\dot{Q}'$) for the correlations based on the experiments of Yuan et al. is between 0.002 and 0.6. This range includes the flame height as well as the elevation at which the temperature is between 204 – 329 °C (400 – 625 °F), the temperature at which cable targets are considered to be damaged under steady state exposure conditions. Yuan et al. also provide a tabular comparison of the empirical constant against seven preceding line fire test series, which include a broader range of physical fire sizes and dimensions. The Yuan et al. constant is greater than the other seven and thus the temperatures and flame heights are more conservatively predicted using the Yuan et al. data. The application of the Yuan et al. correlation in the “Generic Fire Modeling Treatments” document falls within the normalized applicability range reported by Yuan et al.

Four flame heat flux models are used in the “Generic Fire Modeling Treatments” document as described in Table J-2 of this attachment: the Point Source Model, the Simple Method of Shokri and Beyler, the Method of Mudan and Croce, and the Detailed Method of Shokri and Beyler. The former two are simple algebraic models using the heat release rate, separation distance, and the fire diameter. The latter two are considered detailed radiant models that account for the emissivity of the fire and the shape of the flame. Due to limitations in the target placement, the

(Simple) Method of Shokri and Beyler are shown to be inapplicable for calculating the ZOI dimensions. Similarly, for the fuels considered, it is shown that the Method of Mudan and Croce produces a net heat flux that exceeds the fire size. The ZOIs are therefore determined using the Point Source Model and the Detailed Method of Shokri and Beyler. The method that produces the largest ZOI dimension is used for each fuel and fire size bin.

The Point Source Model and the Method of Shokri and Beyler have been shown in the NUREG-1824, Volume 3, verification and validation study to provide reasonably accurate predictions when the target separation to fire diameter (R/D_f) ratio is between 2.2 and 5.7 (NUREG-1824, Volume 1). Furthermore, the fire size ranges considered in the "Generic Fire Modeling Treatments" report are between about 25 – 12,000 kW (24 – 11,400 Btu/s) and the heat release rates per unit area range between about 100 – 3,000 kW/m^2 (8.8 – 264 Btu/s-ft^2) for all fuels and fire size bins.

Using this information, the following table may be assembled for the applicable target heat flux range, based on the NUREG-1824, Volume 1, validation range:

Fire Size KW (Btu/s)	Heat Release Rate Per Unit Area, KW/m^2 (Btu/s-ft^2)	Fire Diameter, m (ft)	Point Source Model Heat Flux Range, KW/m^2 (Btu/s-ft^2)	Shokri and Beyler Heat Flux Range, KW/m^2 (Btu/s-ft^2)
25 (24)	100 (8.8)	0.56 (1.9)	0.07 – 0.45 (0.006 – 0.04)	0.36 – 3.8 (0.03 – 0.4)
25 (24)	3,000 (264)	0.1 (0.3)	2 – 13.6 (0.2 – 1.2)	2.84 – 10 (0.3 – 0.9)
12,000 (11,400)	100 (8.8)	12.4 (41)	0.07 – 0.45 (0.006 – 0.04)	0.55 – 5 (0.05 – 0.4)
12,000 (11,400)	3,000 (264)	2.3 (7.4)	2 – 13.6 (0.2 – 1.2)	0.45 – 4.6 (0.04 – 0.4)

The threshold heat fluxes that define the steady state ZOI dimensions range from 5.7 - 11.4 kW/m^2 (0.5 – 1 Btu/s-ft^2). Transient ZOI dimensions, addressed in the "Supplemental Generic Fire Modeling Treatments: Transient Ignition Source Strength" may approach 16 - 18 kW/m^2 (1.4 – 1.6 Btu/s-ft^2). Clearly, the steady state ZOI dimensions based on critical heat fluxes of 5.7 – 11.4 kW/m^2 (0.5 – 1 Btu/s-ft^2) overlay with the range of valid predicted heat fluxes identified in NUREG-1824, Volume 1. Fuels that identify the most conservative value over a range of heat release rates per unit area (transient and electrical panels) will thus include at least one point within the validation range (i.e., 5.7 kW/m^2 [0.5 Btu/s-ft^2]). Since the algorithm searches for the most adverse value, the result will be at least as conservative as the value obtained within the model validation range.

There are combinations of fuels and source strength ranges that do not produce heat fluxes that fall within the validation range. This is especially true for the higher target heat flux values (11.4 kW/m^2 [1 Btu/s-ft^2] and higher) combined with the lower transient fuel package heat release per unit area range (200 – 1,000 kW/m^2 [17.6 – 88.1 Btu/s-ft^2]). This is addressed through an extended validation range of the heat flux models provide by the SFPE (1999). As noted in Table J-2 of this attachment, the SFPE assessed the predictive capabilities of the Point Source Model and the Detailed Method of Shokri and Beyler against available pool fire data. The pool diameters ranged from 1 – 80 m (3.3 – 262 ft). The conclusion was that the Point Source Model was conservative, but not necessarily bounding, when the predicted heat flux is less than 5 kW/m^2 (0.44 Btu/s-ft^2) and the empirical constant (radiant fraction) is 0.21. The method is bounding when a safety factor of two is applied to the predicted heat flux. The application in the "Generic Fire Modeling Treatments" report uses an empirical constant (radiant fraction) of 0.35, indicating the application is essentially bounding. Similarly, it was concluded that that Method of Shokri and Beyler is conservative when the predicted heat flux is greater than 5 kW/m^2 (0.44 Btu/s-ft^2) and the method is bounding when a safety factor of two is applied to the predicted heat flux. The implementation in the “Generic Fire Modeling Treatments” report is conservative, though not bounding. Although the SFPE considered fire diameters greater than about 1 m (3.3 ft), smaller diameter pool fires are not optically thick and have a lower emissive power (SFPE Handbook of Fire Protection Engineering, Section 3.1). Thus, the use of the methods for smaller fires is conservative though outside the SFPE validation range.

The use of the heat flux models largely falls within the NUREG-1824, Volume 1, validation parameter space range; however there are cases where this is not so. For larger diameter fires, the SFPE provides comprehensive validation against full scale test data of the methods applied. The application in the “Generic Fire Modeling Treatments” report and the applicable supplements necessarily fall within the validation range or are more conservative because the solution algorithm identifies the most adverse solution among the methods. Smaller fires may fall outside the validation range of both studies, but such fires have a lower emissive power and are conservatively treated using the methods designed for high emissive power source fires.

A number of other empirical models that appear in the generic fire modeling treatments are applied within the stated range of the models or the data for which the models were developed. For example, the cable heat release rate per unit area model is based on cables that have a small scale heat release rate that ranges between 100 – 1,000 kW/m^2 (8.8 – 88.1 Btu/s-ft^2). The solution tables are provided for this range. The unconfined spill fire model (heat release rate reduction factor) is based on observations of pool fires having a diameter between 1 – 10 m (3.3 – 33 ft). The diameter range for which ZOI data is provided is 0.7 – 5 m (2.2 – 17 ft). The lower range value is less of a concern due the reduction in the optical thickness of the fire when the diameter falls below 1 m (3.3 ft). The upper range is maintained in the ZOI solutions. The offset distance for flame extensions outside a burning panel have an upper observational limit of about 1,000 kW (950 Btu/s), though it is applied in a normalized form (extension to panel height ratio). The ratio is applied as determined from the test data.

The CFAST applications in the “Generic Fire Modeling Treatments” report consist of simple geometries with a single natural vent path connected to an ambient boundary condition. The simulations are used to determine the time after the start of the fire that the hot gas layer temperature reaches a predetermined critical temperature. No consideration for the hot gas layer depth is made; if the hot gas layer temperature reaches the critical temperature at any time, then this time is the sole output parameter used in the “Generic Fire Modeling Treatments” report. The enclosure geometry is specified as a function of the volume in such a way as to minimize the heat losses to the boundary. Three vent configurations are evaluated for each volume-room geometry-vent fraction; the most adverse result among the three vent configurations is used.

The room geometry and fire parameters for the “Generic Fire Modeling Treatments” simulations fall within the model limits listed in NIST SP 1026 and NIST SP 1041. Specifically, the vent area to enclosure volume ratio is less than two and the aspect ratios of the enclosures are less than five.

The non-dimensional parameters that affect the model results as documented in NUREG-1824, Volumes 1 and 5, and NUREG-1934 include the model geometry, the global equivalence ratio, the fire Froude Number, and the flame length ratio. The non-dimensional parameters that relate to target exposure conditions (heat flux) and sprinkler actuation (ceiling jet) are not applicable to this calculation because these output parameters are not used. The non-dimensional geometry parameters (length-to-height and width-to-height, which range from 3.3 – 4.3) fall within the NUREG-1824, Volume 1, validation range (0.6 – 5.7). As previously noted, CFAST does not use a fire diameter; therefore, it is possible to specify a fire that falls within the range of fire

Froude numbers considered in the NUREG-1824, Volumes 1 and 5, validation documentation. The source fires considered are consistent with those described in NUREG/CR-6850 and subsequently those that are the subject of the NUREG-1824, Volume 1, validation effort. The global equivalence ratio does exceed the ratio validated in NUREG-1824, Volume 1, in some cases by a significant margin. Large fires in very small volumes with low ventilation could effectively result in equivalence ratios that even exceed the maximum values observed in fully developed fires (3 – 5) (SFPE Handbook of Fire Protection Engineering, Sections 2-5 and 3-4, 2008). However, the limiting oxygen index used in the model is zero, which forces the combustion process to use all available oxygen within the enclosure and the heat release rate to decrease to a value set by the natural ventilation oxygen inflow. The maximum temperature over the course of the fire occurs at some time prior to the oxygen being consumed in the enclosure, thus the global equivalence ratio for the data reported is based on a condition where it is less than unity and within the validation basis of NUREG-1824, Volume 1. Further, for a given volume and fire size, an optimum ventilation condition will occur over the vent range considered. Because of potential variations in a ventilation condition, the FPRA uses the most adverse time over the reported range and effectively performs an optimization on this parameter.

Finally, the flame length ratio is not always met, especially for large fires postulated in small enclosures. Because sprinkler actuation and thermal radiation to targets are not computed with the CFAST model, this parameter is not an applicable metric. Rather, the plume entrainment below the hot gas layer controls the layer decent time and the concentration of soot products in the layer. This aspect of the model is not affected by the flame height to ceiling height ratio. Consequently, the application of CFAST in the "Generic Fire Modeling Treatments" document falls within the NUREG-1824, Volume 1, validation parameter space.

Additional V&V studies, which are useful for extending the range of applicability of the model, are contained in NIST SP 1086 and NRL/MR/6180-04-8746. These studies have a broader parameter validation space than NUREG-1824, Volume 1. NIST SP 1086 is based in part on the methods of ASTM E1355. NRL/MR/6180-04-8746 provides a Navy specific V&V study, which includes an assessment of CFAST, Version 3.1.7, predictions in multiple enclosures and multiple elevation configurations. These additional V&V studies extend the range of the validation parameter space to include configurations and conditions presented in Appendix B of the "Generic Fire Modeling Treatments" report.

Appendix B of the "Generic Fire Modeling Treatments" report provides an in depth analysis of the parameters used as input and Table B-2 indicates the basis for the input parameter selection. The parameters are either selected as absolutely bounding over the credible range or establish an application limit (e.g., elevated temperature environment and boundary thermal properties).

A summary of the validation basis for both the CFAST and the empirical models is provided in Tables J-1 and J-2 of this attachment. Based on the information in the tables and the preceding discussion, it is shown that that the empirical fire model applications in the "Generic Fire Modeling Treatments" either fall within the original correlation bounds or they are outside the bounds, but used in a way that is demonstrably conservative. Likewise, CFAST is used within the model limitations described in the User's Guide (NIST SP 1041) and the Technical Reference Guide (NIST SP 1026). The results as reported in the "Generic Fire Modeling Treatments" document are based on conditions that meet the NUREG-1824, Volumes 1 and 5, validation space, although there are input specifications that fall outside this range. The use of the "Generic Fire Modeling Treatments" report in the FPRA performs an optimization over the ventilation fraction and necessarily is based on a condition that falls within the NUREG-1824, Volumes 1 and 5, validation space for the global equivalence ratio. Given these considerations, it is concluded that the CFAST application in the "Generic Fire Modeling Treatments" document has a validation and verification basis that meets the requirements of NFPA 805, Section 2.4.1.2.3.

Generic Fire Modeling Treatments Supplements

There are five supplements to the "Generic Fire Modeling Treatments", one of which is used by the ANO-1 FPRA (PRA-A1-05-004; PRA-A1-05-009):

- Supplement 3: "Supplemental Generic Fire Modeling Treatments: Transient Fuel Package Ignition Source Characteristics" (PRA-ES-05-006).

Supplement 1, "Supplemental Generic Fire Modeling Treatments: Closed Electrical Panels," Supplement 2, "Evaluation of the Development and Timing of Hot Gas Layer Conditions in Generic ANO-1 Fire Compartments," Supplement 4, "Supplemental Generic Fire Modeling Treatments: Transient Target Response to transient Ignition Source Fire Exposures," and Supplement 5, "Supplemental Generic Fire Modeling Treatments: Solid State Control Component ZOI and Hot Gas Layer Tables" are not used by the ANO-1 FPRA (PRA-A1-05-004; PRA-A1-05-009).

Supplement 3

The focus of Generic Fire Modeling Treatments, Supplement 3, "Supplemental Generic Fire Modeling Treatments: Transient Fuel Package Ignition Source Characteristics" (PRA-ES-05-006), is to provide an analysis of and basis for the transient ignition source heat release rate per unit area, the fire duration, and flame height. The analysis uses the original transient fire test data referenced in NUREG/CR-6850 to estimate the transient ignition source characteristics of interest in order to provide a narrower range of input parameters for the ZOI. Wall and corner effects are evaluated explicitly using the 'Image' method as previously described.

Supplement 3 is primarily an analysis of test data; however, several revised ZOI tables using the results of the analysis are provided. The ZOI tables determined using the same processes and fire models used to generate the original ZOI tables in the "Generic Fire Modeling Treatments" report. The validation and verification developed for the "Generic Fire Modeling Treatments" report for the model is thus applicable to this supplement.

Detailed Fire Modeling Calculations

The detailed fire modeling calculations as documented in PRA-A2-05-017 and PRA-A2-05-018 assess the potential for hot gas layers to exceed certain critical temperature thresholds when secondary combustibles are involved and the effect on the ZOI when the secondary combustibles ignite. The calculations provide detailed calculations for approximately eleven ignition sources, eight secondary combustible configurations, and three location factors.

PRA-A2-05-017 uses the following fire models or calculation methods:

- FLASH-CAT, as incorporated in Excel spreadsheets (PRA-A2-05-017; NUREG/CR-7010, Volume 1);
- The Heskestad flame height model (SFPE Handbook of Fire Protection Engineering, Section 2-1, 2008);

- Shokri and Beyler detailed thermal radiation model (SFPE Engineering Guide for Assessing Flame Radiation to External Targets from Pool Fires, 1999); and
- The Point Source Radiation model (SFPE Engineering Guide for Assessing Flame Radiation to External Targets from Pool Fires, 1999).

The FLASH-CAT calculation method (NUREG/CR-7010, Volume 1), which essentially involves a group of recommended heat release rate and flame spread parameters for cables in cable trays, is used in PRA-A2-05-017 to generate the heat release rate contribution from secondary combustibles. The remaining calculation methods are used to define the horizontal and vertical components of the ZOI. The verification and validation basis for these applications is described in Attachments 1 and 3 of PRA-A2-05-017. Except for the FLASH-CAT calculation, the methods are the same as those described in the Generic Fire Modeling Treatments Report. Accordingly, the validation discussion provided for the Generic Fire Modeling Treatments Report is applicable to PRA-A2-05-017 as well.

PRA-A2-05-018 uses two different fire models or calculation methods:

- FLASH-CAT, as incorporated in plant specific Excel spreadsheets (PRA-A2-05-018; NUREG/CR-7010, Volume 1); and
- CFAST, Version 6.1.1 (NIST SP 1026; NIST SP 1041).

The FLASH-CAT calculation method (NUREG/CR-7010, Volume 1) is used in PRA-A2-05-018 to generate the heat release rate contribution from secondary combustibles. The zone computer model CFAST, Version 6.1.1, is used to generate hot gas layer tables for specific plant spaces and source fire configurations. The CFAST results are evaluated over a range of natural ventilation conditions (0.001 – 10 percent of the boundary). The large natural ventilation range considered in the analysis readily encompasses the ability of a forced ventilation system to provide oxygen while conservatively ignoring the mixing or diluting aspects of such systems. In other words, a forced ventilation system is not postulated to provide more oxygen than is already assumed over the range of natural ventilation conditions and the system would tend to improve the result when dilution of the hot gas layer is considered.

FLASH-CAT

The FLASH-CAT applications in PRA-A2-05-017 and PRA-A2-05-018 are used to generate the temporal heat release rate for specific cable tray arrangements. The input parameters used are those recommended in NUREG/CR-7010, Volume 1, and the initial conditions (initial area and ignition criteria) are those recommended in NUREG/CR-6850. The calculation itself is performed using an Excel™ spreadsheet.

The verification basis for the FLASH-CAT model as incorporated in the Excel™ spreadsheet involves numerical comparisons against results presented in NUREG/CR- 7010, Volume 1. These comparisons are provided with the detailed fire modeling reports (PRA-A2-05-017 and PRA-A2-05-018) and serve as the verification that the model is correctly implemented as an Excel™ spreadsheet. The validation for the FLASH-CAT model is provided in NUREG/CR-7010, Volume 1, using about thirty different cable samples. The samples include cables having the same or similar materials as the predominant cable types used at ANO-1 (e.g., chlorosulfonated polyethylene per CALC-ANOC-FP-09-00019) such that the results and conclusions are applicable. An added measure of conservatism is provided in the FLASH-CAT analysis by assuming thermoplastic cable flame spread and propagation properties.

There is no validation range per se specified for the FLASH-CAT model (NUREG/CR- 7010, Volume 1). Rather, it may be inferred that if the configuration is similar (i.e., horizontal cable tray stacks) and the cable composition is similar, the results are applicable and NUREG/CR-7010, Volume 1, serves as the validation basis. The FLASH-CAT applications described in PRA-A2-05-017 and PRA-A2-05-018 involve horizontal cable tray stacks with some vertical or vertically sloped segments involving materials that are among those tested. The horizontal segments conform to the NUREG/CR-7010, Volume 1, test configuration, but the vertical segments do not. However, the vertical segments are conservatively assumed to propagate at a faster rate as recommended in NUREG/CR-6850. Therefore, the FLASH-CAT application has a validation and verification basis that meets the requirements of NFPA 805, Section 2.4.1.2.3.

CFAST

CFAST, Version 6.1.1 (NIST SP 1026; NIST SP 1041), is used to generate hot gas layer tables that provide the time various temperature thresholds are reached in the specific spaces using the FLASH-CAT temporal heat release rates. The CFAST application is identical to the approach adopted in the "Generic Fire Modeling Treatments" with the following exceptions:

- The height of the specific space is used in lieu of a generic room shape.
- The room volume is used rather than the generic room volumes. The length and width of the space are determined by minimizing the surface area given a height and volume.
- The fire heights are set based on the particular fuel packages examined. Thus, panel fires are modeled at the top of the panel and transient fuel packages are modeled 0.6 m (2 ft) above the floor.

The CFAST analysis assesses the time the hot gas layer temperature reaches threshold values over a range of ventilation conditions (0.001 – 10 percent of the boundary area). The ventilation condition that results in the most adverse time for a given scenario is used in the FPRA (PRA-A1-05-004).

The verification for the CFAST model (Version 6.0.5) is provided in NUREG-1824, Volume 5. Supplemental verification for CFAST, Version 6.1.1, is provided as an attachment to the PRA-A2-05-018 report as well as in NIST SP 1086.

The validation for CFAST described for the original "Generic Fire Modeling Treatments" report applies, except as follows:

- The equivalence ratio for some ventilation cases will fall outside the NUREG-1824 validation parameter space. However, at least one ventilation condition will be within this range, and the results are thus no less conservative than a case that falls within the NUREG-1824, Volume 1, validation parameter space. In general, the most adverse results will be predicted when the equivalence ratio is near unity (optimum burning conditions). Validation work has been performed for CFAST at these equivalence ratios (e.g., NIST SP 1086, NRL/MR/6180-04-8746) and applies to the ANO-1 calculation.
- The geometry for some volume-height combinations exceeds the length-width or length-height ratio for the NUREG-1824, Volume 1, validation cases. The procedure adopted in this analysis is to truncate the room dimensions (and volume) such that the ratio falls within the validation range for NUREG-1824, Volume 1, consistent with the guidelines provided in NUREG-1934.

Based on these considerations, it is concluded that the V&V basis for the CFAST application analysis meets the NFPA 805, Section 2.4.1.2.3, requirements.

Empirical Plume and Heat Flux Models

Refer to the discussion in the Generic Fire Modeling Treatments as well as Attachment 3 of PRA-A2-05-17.

Combustible Screening Calculation

The combustible screening calculation (CALC-ANOC-FP-15-00001) is a report using a graded approach that may be appropriate as a procedure to determine if a secondary combustible could significantly affect the ZOI of an ignition source. The report does not perform fire modeling calculations, per se, but provides equations that may be used to estimate the change in the ignition source ZOI if a small quantity of combustible materials were ignited. The equations involve the following empirical models:

- Point Source Model (SFPE Engineering Guide for Assessing Flame Radiation to External Targets from Pool Fires, 1999);
- Line fire flame height and thermal plume temperature (Yuan et al., 1996);
- Radiation heat flux from a line fire source (SFPE Handbook of Fire Protection Engineering, Section 1-4, 2008); and
- Burning duration computation (Drysdale, 1999).

The methods described are identical to those contained in the Generic Fire Modeling Treatments document (1SPH2902.030) since the procedure involves calculating the relative percent change in the ZOI as would be computed using the Generic Fire Modeling Treatments (1SPH02902.030, CALC-ANOC-FP-15-00001). Accordingly, the validation basis is the same. The report provides several tables of minimal quantities of secondary combustibles for different ignition sources for ease of use. These quantities were directly computed using the equations listed in the report and the results were verified as part of the technical review process under the applicable Quality Assurance program for preparing the calculation.

Embedded Conduit Fire Resistance

The fire resistance for conduit embedded in concrete boundaries is determined in CALC-ANOC-FP-07-00001. This calculation serves as part of the basis for excluding raceways from the adjoining fire zone(s) (EC-494) and is therefore implicitly credited in the FPRA.

The fire resistance of concrete embedded conduit is calculated using the finite difference conduction heat transfer model HEATING, Version 7.3 (Technical Report PSR-199), for various types and sized conduits and conduit embed depths. HEATING, Version 7.3, was developed at the Oak Ridge National Laboratories as a general purpose finite difference heat transfer model for use in the commercial and government nuclear industries. There are a number of validation and verification reports and benchmark solution cases for general applications of the HEATING model (e.g., Technical Report K/CSD/INF-89/4, Technical Report K/CSD/TM-61, Technical Report ORNL/NUREG/CSD-2/V2/R3). A verification and validation study for fire related applications is documented in NRL/MR/6180-04-8746. The model verification summarized in NRL/MR/6180-04-8746 is based on the methodology developed by Wickström (Wickström, 1999; Wickström et al., 1999; Pålsson et al., 2000) for which the solutions of eight fire exposure configurations of increasing complexity are provided. The simplest cases have exact analytic solutions whereas the more complex cases involve a comparison against a baseline heat transfer solution generated by the conduction finite element model TASEF (Sterner et al.). The model validation documented by NRL/MR/6180-04-8746 is based on eight test cases of increasing complexity for which measured data is available, one of which includes steel embedded in concrete. These sixteen V&V cases are consistent with the ASTM E1355 procedure for providing fire model V&V and thus meet the NFPA 805, Section 2.4.1.2.3, requirement for using a fire model that has undergone a V&V process and is applied within its limitations.

The embedded conduit calculation (CALC-ANOC-FP-07-00001) provides a detailed description of the Wickström et al. verification case involving a convection fire exposure to a two-dimensional concrete slab as documented in NRL/MR/6180-04-8746, a similar configuration to the concrete embedded conduit evaluated at ANO-1. This verification case has an analytic solution and serves as the model benchmark for the calculation and serves as a demonstration that the application is within the model limitations. A parameter sensitivity analysis is provided in the embedded concrete calculation, including material property uncertainty, boundary condition uncertainty, and mesh dependencies. Table J-1 provides a summary of the validation and verification basis for HEATING, Version 7.3, as applied in the embedded conduit calculation.

<u>Building Separation Calculation</u>

The purpose of the building separation calculation (CALC-ANO1-FP-08-00003) is to assess whether there is adequate separation between the Administration Building and the ANO-1 Turbine Building. A site review of the building separation concluded that the Administration Building and the ANO-1 Turbine Building do not meet the separation requirements of NFPA 80A and thus a fire involving one building could affect the other. CALC-ANO1-FP-08-00003 assesses the adequacy of the building separation through the use of two radiant heat transfer models as contained in the FDT^S model (NUREG-1805). Based on these radiant heat transfer calculations, it is concluded that a fire in the Administration Building would not propagate into the ANO-1 Turbine Building. This calculation is indirectly credited in the FPRA by virtue of excluding the Administration Building from areas that can affect plant risk (PRA-A1-05-004, PRA-A1-05-009, CALC-08-E-0016-01).

The radiant heat transfer calculations are conducted using the Point Source Model and the Solid Flame Model as contained in FDT^S (NUREG-1805); specifically, the spreadsheet 05.1_Heat_Flux_Calculations_Wind_Free.xls is used. The most adverse prediction among the two models is selected for comparison to the performance criterion for fire propagation (12.5 kW/m^2 [1.1 Btu/s-ft^2]). The predicted heat flux (1.34 kW/m^2 [0.12 Btu/s-ft^2]) is over nine times lower than the performance threshold.

The verification basis for the FDT^S (NUREG-1805) wind free heat flux model is provided in NUREG-1824, Volume 3, which also provides a validation basis for the heat flux correlations; however, the application at ANO-1 falls outside the parameter space. This may be seen by comparing the *R/D* non-dimensional parameter as described in NUREG-1934, where *R* is the separation distance between the target and the fire centerline and *D* is the effective fire diameter. The NUREG-1824, Volume 3, range for this parameter is 2.2 – 5.7; the value used at ANO-1 is 1.5.

Additional validation for the low *R/D* value is available in the SFPE empirical heat flux model validation report (SFPE 1999). Based on a comprehensive assessment of various heat flux correlations against large scale fire test data, it is found that the Point Source Model is conservative when the predicted heat flux is less than 5 kW/m^2 (0.44 $Btu/s\text{-}ft^2$) and that the Solid Flame model is conservative when the predicted heat flux is greater than 5 kW/m^2 (0.44 $Btu/s\text{-}ft^2$). In addition, the Point Source Model is bounding when a safety factor of two is applied to the predicted value (SFPE 1999). The *R/D* range considered in SFPE (1999) is between about 0.7 – 10, which brackets the value of 1.5 used in CALC-ANO1-FP-08-00003.

With regard to the radiant heat transfer analysis described in CALC-ANO1-FP-08-00003, the most adverse prediction of the Point Source Model and the Solid Flame Model is used, thus ensuring at least one model meets the recommended application of SFPE (1999). Further, because the margin between the predicted heat flux and the threshold heat flux is about nine, a safety factor of two can be applied to the results and it can be concluded that the result is bounding. In summary, the verification for the FTDS model used in CALC-ANO1-FP-08-00003 is provided in NUREG-1824, Volume 3. The ANO-1 application falls outside the NUREG-1824, Volume 3, validation space; however, SFPE (1999) provides additional validation for the models used that encompasses the application at ANO-1. Given that the ANO application falls within the validation space of the SFPE (1999) study and is used in a manner consistent with this study, it is concluded that V&V basis for the FDTS (NUREG-1805) analysis meets the NFPA 805, Section 2.4.1.2.3, requirements.

Table J-1 V & V Basis for Fire Models / Model Correlations Used in Fire PRA			
Calculation	**Application**	**V & V Basis**	**Discussion**
Main CR Abandonment	Calculation of operator abandonment times in the Main Control Room.	NUREG-1824, Volume 1 NUREG-1824, Volume 5 NIST SP 1026 NIST SP 1041 NIST SP 1086 NUREG/CR-4527, Volume 2 NRL/MR/6180-04-8746	The abandonment time in the MCR is determined by computing the time for the visibility and temperature to reach thresholds as specified in NUREG/CR-6850. CFAST, Version 6.0.5, has been validated for certain configurations in terms of predicting the temperature increase in an enclosure in accordance with NUREG-1824, Volume 5. In addition, NUREG/CR-4527, Volume 2, provides full scale test data of electrical panel fires in control room like structures. These tests are modeled using the CFAST, Version 6.1.1, and the results are documented in report entitled "Evaluation of Unit 1 Control Room Abandonment Times at the Arkansas Nuclear One Facility." CFAST, Version 6.1.1, is found to provide a reasonable and conservative estimate of both the hot gas layer temperature and visibility as a function of time given the input fire size for a control room like enclosure. This information is documented in Appendix D of CALC-ANO1-FP-09-00011. The MCR abandonment application falls within the non-dimensional parameter space for the NUREG-1824, Volumes 1 and 5, V&V report as estimated using the methods described in NUREG-1934. The application also falls within the model limits as specified in NIST SP 1026 and 1041. Additional V&V documentation is provided in NIST SP 1086 and NRL/MR/6180-04-8746 that expand the validation parameter space from that included in NUREG-1824, Volume 1, including multiple compartment applications.

Table J-1 V & V Basis for Fire Models / Model Correlations Used in Fire PRA			
Calculation	**Application**	**V & V Basis**	**Discussion**
Generic Fire Modeling Treatments, Revision 0	Definition of zones of influence about specific classes of ignition sources. Scenario screening for the multi-compartment analysis.	NUREG-1824, Volume 1 NUREG-1824, Volume 3 NUREG-1824, Volume 5 NIST SP 1026 NIST SP 1041 NIST SP 1086 Table J-2	Table J-2 provides a summary of the validation basis for the empirical models used in the "Generic Fire Modeling Treatments" report. The "Generic Fire Modeling Treatments" report uses CFAST, Version 6.0.10, in a simple geometry that minimizes the boundary heat losses given a volume. For the volume postulated, the configuration produces the most adverse result regardless of the actual dimensions used. The application falls within the model limits as specified in NIST SP 1026 and 1041. Except for the global equivalence ratio, the non-dimensional parameters fall within the V&V space of NUREG-1824, Volumes 1 and 5. Although equivalence ratios are considered over a much larger range than addressed by the NUREG-1824, Volume 1, validation tests, the results are based on a single time point based on an equivalence ratio that is close to unity or lower and thus may fall directly within the NUREG-1824, Volume 1, validation parameter space. Additional validation results that consider the higher predictive capability under higher equivalence ratios are provided in NIST SP 1086.
Evaluation of the Development and Timing of Hot Gas Layer Conditions in Generic ANO-2 Fire Compartments and Secondary Combustibles	Calculation of the time the hot gas layer reaches critical temperature thresholds for scenarios involving secondary combustibles (cable trays). Scenario screening for the multi-compartment analysis.	NUREG-1824, Volume 1 NUREG-1824, Volume 5 NUREG/CR-7010, Volume 1 NIST SP 1026 NIST SP 1041 NIST SP 1086 NRL/MR/6180-04-8746	Detailed evaluations are provided for specific ignition source-secondary combustible configurations involving multiple cable trays. Two fire modeling tools are used in this assessment: the FLASH-CAT calculation method (NUREG/CR-7010, Volume 1) and CFAST, Version 6.1.1 (NIST SP 1041). The FLASH-CAT model is used to compute the temporal heat release rate profiles for specific cable tray arrangements where secondary combustibles are included. CFAST, Version 6.1.1, is used to compute the time the hot gas layer temperature reaches various threshold values given the ignition source and secondary combustible heat release rates. NUREG-1824, Volume 5, provides the verification basis for CFAST. Supplemental verification is provided in PRA-A2-05-018 for the specific CFAST version used. Verification for the FLASH-CAT model is provided in PRA-A2-05-017 via comparisons with NUREG/CR-7010, Volume 1, results. The FLASH-CAT model uses the recommended input parameters of NUREG/CR-7010, Volume 1, and is used to calculate the heat release rate in horizontal cable trays containing cables similar to those tested. Therefore, the application falls within the validated range for FLASH-CAT.

Table J-1 V & V Basis for Fire Models / Model Correlations Used in Fire PRA

Calculation	Application	V & V Basis	Discussion
Combined Ignition Source – Cable Tray Fire Scenario ZOIs for Arkansas Nuclear One Unit 2 Applications	Definition of zones of influence about specific classes of ignition sources involving cable tray secondary combustibles for use in the FPRA.	NUREG-1824, Volume 1 NUREG-1824, Volume 3 Table J-2 NUREG/CR-6850 NUREG/CR-7010, Volume 1	The same methods developed in Generic Fire Modeling Treatments, Revision 0, are used to generate ZOI definitions. The heat release rate estimates for the cable trays uses the FLASH-CAT calculation method (NUREG/CR-7010, Volume 1). Verification for the FLASH-CAT model is provided in PRA-A2-05-017 via comparisons with NUREG/CR-7010, Volume 1, results. The FLASH-CAT model uses the recommended input parameters of NUREG/CR-7010, Volume 1, and is used to calculate the heat release rate in horizontal cable trays containing cables similar to those tested. Therefore, the application falls within the validated range for FLASH-CAT.
Secondary Combustible Classification and Screening for ANO1 and ANO2	Provides a screening process for minor quantities of secondary combustible materials.	NUREG-1824, Volume 1 NUREG-1824, Volume 3 Table J-2	The calculation uses the same methods as the Generic Fire Modeling treatments to assess the percent change in the ZOI boundary given a small quantity of combustible materials. The results are computed for typical 98^{th} percentile ignition sources directly from the equations listed in the secondary combustible screening report. The verification of this application was performed as part of the technical review under the applicable Quality Assurance program. The validation basis is the same as the Generic Fire Modeling Treatments.
Supplemental Generic Fire Model Treatments: Transient Ignition Source Strength (Supplement 3)	Characterization of the heat release rate per unit area, fire duration, and flame height for transient ignition sources. Provides revised ZOI tables for transient fuel packages based on the analysis of the transient fire test data.	NUREG-1824, Volume 1 NUREG-1824, Volume 3 NUREG-1824, Volume 5 NIST SP 1026 NIST SP 1041 NIST SP 1086 Table J-2	The supplement provides an analysis of the transient fuel package fire tests in order to better characterize the heat release rate per unit area, the fire duration, and the flame height. These parameters, which are used in the development of the ZOI in the original "Generic Fire Modeling Treatments" report and prior to the development of Supplement 3, were conservatively bounded. Supplement 3 provides the basis for a narrower parameter value range as determined from the actual fire test reports on which the NUREG/CR-6850 conditional probability distribution was established. Revised ZOI tables are developed for transient ignition source fuel packages using the results of the fire test data analysis. The ZOIs are computed using the same processes as the original "Generic Fire Modeling Treatments" report and the V&V basis is therefore the same.

Table J-1 V & V Basis for Fire Models / Model Correlations Used in Fire PRA

Calculation	Application	V & V Basis	Discussion
Thermal Analysis of Concrete Embedded Conduit, Revision 0	Basis for excluding concrete embedded raceways from adjacent fire zones per EC-494.	NRL/MR/6180-04-8746 Technical Report K/CSD/INF-89/4 Technical Report K/CSD/TM-61 Technical Report ORNL/NUREG/CSD-2/V2/R3	The fire resistance of conduit embedded in concrete is calculated using the finite difference model HEATING, Version 7.3 (Technical Report PSR-199) for various concrete cover thicknesses, conduit diameters, and conduit types. The base finite difference model is one-dimensional, but it includes material properties that vary with temperature and boundary conditions that vary with time. Several two-dimensional geometries are evaluated and compared with the one-dimensional counterparts and it is shown that the one-dimensional model is universally conservative in this application. A sensitivity analysis is provided that demonstrates the results are not dependent on material property or boundary condition uncertainty, unless there is sustained flame impingent. NRL/MR/6180-04-8746 provides a verification and validation assessment of HEATING, Version 7.3 (Technical Report PSR-199), as applied to fire exposure configurations using the method recommended by Wickström (Wickström, 1999; Wickström et al. 1999; Pålsson et al., 2000). Other validation and verification studies on older revisions are documented in Technical Report K/CSD/INF-89/4, Technical Report K/CSD/ TM-61, and Technical Report ORNL/NUREG/CSD 2/ V2/R3. A validation case involving a two-dimensional slab exposed to a convection boundary condition as a model application benchmark is provided in the embedded conduit calculation.
Building Separation Analysis, Revision 0	Provides a basis for crediting the separation between the Administration Building and the ANO-1 Turbine Building.	NUREG-1824, Volume 3 SFPE (1999)	The Administration Building and the ANO-1 Turbine Building separation do not meet the NFPA 80A building separation requirements. The building separation analysis (CALC-ANO1-FP-08-00003) provides a radiant heat transfer computation using the Point Source Model and the Solid Flame Model as contained in NUREG-1805 FDT^{S} model (NUREG-1805). This calculation is implicitly used in the FPRA by virtue of excluding the Administration Building from the group of areas in which a fire could affect the plant risk. The radiant heat transfer application described in CALC-ANO1-FP-08-00003 is consistent with the underlying basis for the empirical models. However, the input parameter range falls outside the NUREG-1824, Volume 3, V&V space. In this case, SFPE (1999) provides the additional V&V basis for both the Point Source Model and the Solid Flame Model, and leads to the conclusion that the overall application is conservative.

Table J-2 V & V Basis for Fire Models / Model Correlations Used: Generic Treatments Correlations

Correlation	Location in Generic Fire Modeling Treatment	Original Reference	Application	Original Correlation Range	Subsequent Validation and Verification	Limits in Treatments
Flame Height	Page 18	Heskestad [1981] Heskestad [1984]	Provides a limit on the use of the Zone of Influence (ZOI)	$-5 \leq \log_{10}\left[\left[\frac{c_p T_\infty}{g\rho_\infty(\Delta H_{c/r})^3}\right]\frac{\dot{Q}^2}{D^5}\right] \leq 5$ In practice, wood and hydrocarbon fuels, momentum or buoyancy dominated, with diameters between 0.05 – 10 m (0.16 – 33 ft).	Directly NUREG 1824, Volume 3 Indirectly NUREG 1824, Volume 5 (Correlation used in CFAST)	$\frac{4\dot{m}\Delta H_C}{\pi D^2} < 3000$
Point Source Model	Page 19	Modak (Thermal Radiation from Pool Fires)	Lateral extent of ZOI – comparison to other methods	Isotropic flame radiation. Compared with data for 0.37 m (1.2 ft) diameter PMMA pool fire and a target located at a R_o/R ratio of 10.	NUREG 1824, Volume 3 SFPE (1999)	Predicted heat flux at target is less than 5 kW/m^2 (0.44 Btu/s-ft^2) per SFPE [(1999).
Method of Shokri and Beyler	Page 19	Shokri et al. (Radiation from Large Pool Fires)	Lateral extent of ZOI – comparison to other methods	Pool aspect ratio less than 2.5. Hydrocarbon fuel in pools with a diameter between 1 – 30 m (3.3 – 98 ft). Vertical target, ground level.	NUREG 1824, Volume 3 SFPE (1999)	Ground based vertical target.
Method of Mudan (and Croce)	Page 20	Mudan (Thermal Radiation Hazards from Hydrocarbon pool Fires)	Lateral extent of ZOI – comparison to other methods	Round pools; Hydrocarbon fuel in pools with a diameter between 0.5 – 80 m (1.64 – 262 ft).	SFPE (1999)	Total energy emitted by thermal radiation less than total heat released.
Method of Shokri and Beyler	Page 20	Shokri et al. (Radiation from Large Pool Fires)	Lateral extent of ZOI	Round pools; Hydrocarbon fuel in pools with a diameter between 1 – 50 m (3.3 – 164 ft).	NUREG 1824, Volume 3 SFPE (1999)	Predicted heat flux at target is greater than 5 kW/m^2 (0.44 Btu/s-ft^2) per SFPE (1999). Shown to produce most conservative heat flux over range of scenarios considered among all methods considered.

Table J-2 V & V Basis for Fire Models / Model Correlations Used: Generic Treatments Correlations

Correlation	Location in Generic Fire Modeling Treatment	Original Reference	Application	Original Correlation Range	Subsequent Validation and Verification	Limits in Treatments
Plume heat fluxes	Page 22	Wakamutsu et al.(2003)	Vertical extent of ZOI	Fires with an aspect ratio of about 1 and having a plan area less than 1 m^2 (0.09 ft^2).	Wakamatsu et al. (2003) (larger fires) SFPE Handbook of Fire Protection Engineering, Section 2-14 (2008)	Area source fires with aspect ratio ~ 1. Used with plume centerline temperature correlation; most severe of the two is used as basis for the ZOI dimension. This is not a constraint in the fire model analysis for the cases evaluated.
Plume centerline temperature	Page 23	Yokoi (Report Number 34) Beyler (Fire Plumes and Ceiling Jets)	Vertical extent of ZOI	Alcohol lamp assumed to effectively be a fire with a diameter ~0.1 m (0.33 ft).	NUREG 1824, Volume 3 SFPE Handbook of Fire Protection Engineering, Section 2–1 (2008)	Area source fires with aspect ratio ~ 1. Used with plume flux correlation; most severe of the two is used as basis for the ZOI dimension.
Hydrocarbon spill fire size	Page 51	SFPE Handbook of Fire Protection Engineering, Section 2-15 (2002)	Determine heat release rate for unconfined hydrocarbon spill fires	Hydrocarbon spill fires on concrete surfaces ranging from ~1 to ~10 m (3.3 – 33 ft) in diameter.	None. Based on limited number of observations.	None. Transition from unconfined spill fire to deep pool burning assumed to be abrupt.
Flame extension	Page 100	SFPE Handbook of Fire Protection Engineering, Section 2–14 (2002)	Determine the fire offset for open panel fires	Corner fires ranging from ~10 to ~1,000 kW (9.5 - 948 Btu/s). Fires included gas burners and hydrocarbon pans.	None. Based on limited number of observations.	None. Offset is assumed equal to the depth of the ceiling jet from the experiments.
Line source flame height	Page 101	Delichatsios (1984)	Determine the vertical extent of the ZOI	Theoretical development.	SFPE Handbook of Fire Protection Engineering, Section 2-14 (2008)	None. Transition to area source assumed for aspect plan ratios less than four. Maximum of area and line source predictions used in this region.

Table J-2 V & V Basis for Fire Models / Model Correlations Used: Generic Treatments Correlations

Correlation	Location in Generic Fire Modeling Treatment	Original Reference	Application	Original Correlation Range	Subsequent Validation and Verification	Limits in Treatments
Corner flame height	Page 108	SFPE Handbook of Fire Protection Engineering, Section 2-14 (2002)	Determine the vertical extent of the ZOI	Corner fires ranging from ~10 to ~1,000 kW (9.5 - 948 Btu/s). Fires included gas burners and hydrocarbon pans.	None. Correlation form is consistent with other methods; comparison to dataset from SFPE Handbook, Section 2-14 (2002) provides basis.	None.
Air mass flow through opening	Page 140	Kawagoe (1958)	Compare mechanical ventilation and natural ventilation	Small scale, ⅓ scale, and full scale single rooms with concrete and steel boundaries. Vent sizes and thus opening factor varied. Wood crib fuels.	Drysdale (*Fire Dynamics*) SFPE (2004)	None. SFPE (2004) spaces with a wide range of opening factors.
Line fire flame height	Page 210	Yuan et al. (An Experimental Study of Some Line Fires)	Provides a limit on the use of the ZOI Extent of ZOI for cable tray fires	$0.002 < Z/\dot{Q}' < 0.6$ In practice, from the base to several times the flame height based on 0.015 – 0.05 m (0.05 – 0.16 ft) wide gas burners.	None. Correlation form is consistent with other methods; comparison to dataset from Yuan et al. provides basis.	None.
Cable heat release rate per unit area	Page 210	NBSIR 85-3196	Provides assurance that the method used is bounding	Cables with heat release rates per unit area ranging from about 100 – 1000 kW/m^2 (8.8 – 88 Btu/s-ft^2).	None.	Correlation predicts a lower heat release rate than assumed in the treatments and is based on test data.
Line fire plume centerline temperature	Page 212	Yuan et al.	Provides a limit on the use of the ZOI Extent of ZOI for cable tray fires	$0.002 < Z/\dot{Q}' < 0.6$ In practice, from the base to several times the flame height based on 0.015 – 0.05 m (0.05 - 0.16 ft) wide gas burners.	None. Correlation form is consistent with other methods; comparison to dataset from Yuan et al. provides basis.	None.

Table J-2 V & V Basis for Fire Models / Model Correlations Used: Generic Treatments Correlations

Correlation	Location in Generic Fire Modeling Treatment	Original Reference	Application	Original Correlation Range	Subsequent Validation and Verification	Limits in Treatments
Ventilation limited fire size	Page 283	Babrauskas (Estimating Room Flashover Potential)	Assessing the significance of vent position on the hot gas layer temperature.	Ventilation factors between 0.06 – 7.51. Fire sizes between 11 - 2,800 kW (10 - 2,654 Btu/s) Wood, plastic, and natural gas fuels.	SFPE (2004)	None. Provides depth in the analysis of the selected vent positions. The global equivalence ratio provides an alternate measure of the applicability of the analysis and for reported output is within the validation range of CFAST.

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Attachment 6 to

1CAN031602

Updated Attachment S – Modifications and Implementation Items

S. Plant Modifications and Items to be Completed During Implementation

Table S-1, Plant Modifications, provided below includes a description of the modifications along with the following information:

- A problem statement,
- Risk ranking of the modification,
- An indication if the modification is currently included in the FPRA,
- Compensatory measure in place, and
- A risk-informed characterization of the modification and compensatory measure.

The following ranking legend should be used when reviewing the table:

- High = Modification which would have an impact on FPRA and affect multiple Fire Areas.
- Med = Modification which would have an impact on FPRA and affect individual Fire Areas, or include IN 92-18 modifications.
- Low = Modification which would have no or insignificant impact on risk.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-1	High (PRA)	1	New Auxiliary Feedwater (AFW) pump: Due to multiple impacts to the Emergency Feedwater (EFW) system, the need for an additional source of feedwater to the Steam Generators (SGs) was identified. LAR Source: Attachment C, listed as a global modification to reduce risk	ANO plans a modification to install a new AFW pump (common feedwater system for both units) and associated motor operated valves with diverse power sources and controls independent of the existing EFW pumps. The pump will be capable of feeding either SG The new AFW pump will be designed to meet or exceed the flow requirements of the ANO-1 EFW pump P-7B. The new AFW pump proposed design includes: - The capability to be operated from the ANO-1 Control Room and locally. - Electrical isolation from Control Room functions to prevent a fire in the Control Room from affecting local control of AFW components. - Local controls and monitoring instrumentation to ensure proper operation and water flow to the SG.	Yes	Yes	This AFW modification is credited globally from a PRA perspective to provide a reliable additional source of feedwater. The local control panel modification is also credited from a PRA perspective to provide an alternate means to perform required actions outside the ANO-1 Control Room. Manual actions are credited in fire areas that contain redundant safe shutdown equipment. The modification process will ensure these actions are feasible. Compensatory measures have been established until compliance can be achieved by transitioning to a 10 CFR 50.48(c) licensing basis.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-2	High (PRA)	1	Switchgear A-1: In multiple fire areas, a loss of normal DC control power could result in a loss of switchgear A-1. LAR Source: Attachment C, listed as a global modification to reduce risk	ANO plans a modification to install a redundant DC control power supply to switchgear A-1 to eliminate loss of switchgear due to loss of normal DC control power. In the event the normal DC control power source is lost, an automatic transfer to this alternate DC power source will occur. The modification for the backup or alternate DC power source will add a battery eliminator which is supplied from either an ANO-1 or ANO-2 non-1E source via an automatic transfer switch. Installation of automatic transfer switches, cables and electrical conduit is proposed.	Yes	Yes	This modification is credited globally from a PRA perspective. Installation of an alternate A-1 switchgear DC control power source reduces the risk of a fire induced A-1 DC control power cable failure causing a loss of offsite power. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.
S1-3	High (PRA)	1	Switchgear A-2: In multiple fire areas, a loss of normal DC control power could result in a loss of switchgear A-2 LAR Source: Attachment C, listed as a global modification to reduce risk	ANO plans a modification to install a redundant DC control power supply to switchgear A-2 to eliminate loss of switchgear due to loss of normal DC control power. In the event the normal DC control power source is lost, an automatic transfer to this alternate DC power source will occur. The modification for the backup or alternate DC power source will add a battery eliminator which is supplied from either an ANO-1 or ANO-2 non-1E source via an automatic transfer switch. Installation of automatic transfer switches, cables and electrical conduit is proposed.	Yes	Yes	This modification is credited globally from a PRA perspective. Installation of an alternate A-2 switchgear DC control power source reduces the risk of a fire induced A-2 DC control power cable failure causing a loss of offsite power. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-4	Med (PRA)	1	Switchgear A-3: In Fire Area I-2, loss of DC control power to 4160kV switchgear A-3 could result in the loss of control functions for Primary Makeup Pump (P-36A), EFW pump (P-7B), Service Water (SW) pump P-4A. LAR Source: Attachment C, Fire Area I-2 Risk Summary, VFDR I2-01-b, VFDR I2-02-a, and VFDR I2-03-c	ANO plans a modification to install a second diverse cable route to the A-3 DC control power. An auctioneering feature will be employed such that a fire induced failure in a single fire zone will not render the DC control function unavailable. Routing of the second red train A-3 switchgear room DC power cables outside the green train A-4 switchgear equipment room in Fire Area 99-M is planned. The new second cable route is expected to impact Fire Zones 100-N, 197-X, 161-B, 159-B, 67-U, and 110-L. The proposed scheme will also ensure availability of the A-3 DC control power should there be a fire in Fire Zones 67-U or 98-J.	Yes	Yes	This modification is credited for Fire Area I-2. In conjunction with the modifications described in items S1-2, S1-25, and S1-26, the second diverse cable route reduces the risk of a fire induced circuit failure of the switchgear and the possible loss of control functions to pumps P-36A, P-7B, and P-4A. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-5	High (PRA)	1	Switchgear H-1: In multiple fire areas, the loss of normal DC control power to switchgear H-1 could preclude the Reactor Coolant Pumps (RCPs) from being tripped in the Control Room. LAR Source: Attachment C, listed as a global modification to reduce risk, VFDR B-1@BOFZ-04, VFDR F-02, VFDR I1-04, and VFDR O-01	ANO plans a modification to install a redundant DC control power supply to H-1 switchgear to eliminate loss of switchgear due to loss of normal DC control power. Additionally, ANO plans a modification to remove internal DC jumpers and separately protect H-1 switchgear line and load breaker control power. This will prevent a fire originating in a cubicle from disabling the ability to trip the RCPs due to loss of shared control power.	Yes	Yes	The modification to install a redundant DC control power supply is credited globally from a PRA perspective. The modification to separate line and load breaker control power is only credited in Fire Area B-1@BOFZ. Both modifications reduce the risk of a fire induced circuit failure to the DC power cables feeding switchgear H-1, which could preclude tripping the RCPs from the Control Room. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.
S1-6	High (PRA)	1	Switchgear H-2: In multiple fire areas, the loss of normal DC control power to switchgear H-2 could preclude the RCPs from being tripped in the Control Room. LAR Source: Attachment C, listed as a global modification to reduce risk, VFDR B-1@BOFZ-04, VFDR F-02, VFDR I1-04, and VFDR O-01	ANO plans a modification to install a redundant DC control power supply to H-2 switchgear to eliminate loss of switchgear due to loss of normal DC control power. Additionally, ANO plans a modification to remove internal DC jumpers and separately protect H-2 switchgear line and load breaker control power. This will prevent a fire originating in a cubicle from disabling the ability to trip the RCPs due to loss of shared control power.	Yes	Yes	The modification to install a redundant DC control power supply is credited globally from a PRA perspective. The modification to separate line and load breaker control power is only credited in Fire Area B-1@BOFZ. Both modifications reduce the risk of a fire induced circuit failure to the DC power cables feeding switchgear H-2, which could preclude tripping the RCPs from the Control Room. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-7	Med (PRA)	1	A-309, 4160V AC Breaker: In Fire Area B-1@BOFZ, a fire induced fault in the turbine building could result in spurious closing or preclude automatic trip functions at A-309 (vital switchgear A-3 supply breaker from switchgear A-1) that could challenge the automatic start of the credited Emergency Diesel Generator (EDG). LAR Source: Attachment C, Fire Area B-1@BOFZ Risk Summary, VFDR B-1@BOFZ-01	ANO plans to modify circuits for breaker A-309 to assure the protective features remain intact, i.e., breakers remain tripped and do not impede automatic start of the associated EDG and associated closure of EDG output breaker A-308.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area B-1@BOFZ. Modification to the circuits associated with breaker A-309 is planned to assure the protective features remain intact, i.e., breaker remains tripped and does not impede automatic start of the associated EDG and closure of EDG output breaker (A-308). In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.
S1-8	Med (PRA)	1	A-409, 4160V AC Breaker: In Fire Area B-1@BOFZ, a fire induced fault in the turbine building could result in spurious closing or preclude automatic trip functions at A-409 (vital switchgear A-4 supply breaker from switchgear A-2) that could challenge the automatic start of the credited EDG. LAR Source: Attachment C, Fire Area B-1@BOFZ Risk Summary, VFDR B-1@BOFZ-01	ANO plans to modify circuits for breaker A-409 to assure the protective features remain intact, i.e., breakers remain tripped and do not impede automatic start of the associated EDG and associated closure of EDG output breaker A-408.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area B-1@BOFZ. Modification to the circuits associated with breaker A-409 is planned to assure the protective features remain intact, i.e., breaker remains tripped and does not impede automatic start of the associated EDG and closure of EDG output breaker (A-408). In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-9	Med (PRA)	1	Control Room Cabinet C20: In Fire Area G, Fire Zone 129-F, PRA determined that the installation of smoke detector(s) in Control Room Cabinet C20 will reduce risk of a fire induced circuit and equipment failure. LAR Source: Attachment C, Fire Area G Risk Summary	ANO has installed a smoke detector in ANO-1 Control Room Cabinet C20 in accordance with the NFPA 72, Fire Alarm Detection, code of record. The new smoke detector loop is connected via signal cable to the ANO-1 Control Room Fire Alarm Panel C-463 for trouble and alarm functions.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area G. The modification to install a smoke detector system in ANO-1 Control Room Cabinet C20 reduces the risk of a fire induced circuit and equipment failure that could result in the loss of Control Room Cabinet C20. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.
S1-10	Med (PRA)	1	Air Operated Valve (AOV) CV-1052: In Fire Area G, PRA determined that Quench Tank drain valve CV-1052 control circuit should be modified to preclude spurious operation. CV-1052 control circuit does not have automatic features via interlocks to preclude spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, Fire Area G Risk Summary	ANO plans a modification to add an automatic feature to prevent solenoid or electro-pneumatic valve positioner from opening CV-1052 as a result of a fire induced circuit failure in the Control Room.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area G. This modification reduces the risk of fire induced AOV circuit failures (hot shorts, open circuits, and short to ground) and can preclude spurious operation. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-11	Med (PRA)	1	Motor Operated Valve (MOV) CV-1053: In Fire Area G, PRA determined that Quench Tank drain valve CV-1053 should be modified to preclude spurious operation. CV-1053 does not have automatic features via interlocks to preclude spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, Fire Area G Risk Summary	ANO plans to modify CV-1053 by adding an “inhibit” circuit which will preclude spurious opening of the MOV due to intercable or intracable hot shorts.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area G. This modification reduces the risk of fire induced MOV hot short circuit failure and will preclude spurious operation. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.
S1-12	High (PRA)	1	MOV CV-1221: In Fire Area G, PRA determined that Letdown isolation valve CV-1221 should be modified to meet requirements per IN 92-18. CV-1221 does not have automatic features via interlocks to preclude spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, Fire Area G Risk Summary, VFDR G-02-a	ANO has modified CV-1221 to meet the requirements of IN 92-18. This modification added an “inhibit” circuit which will preclude spurious opening of the MOV due to intercable or intracable hot shorts. The circuit modification incorporated an available spare conductor in an existing cable between the Control Room cabinet and the 480 V MCC.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area G. The modification reduces the risk of fire induced MOV hot short circuit failure and will preclude spurious operation. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-13	High (PRA)	1	MOV CV-1405: In multiple fire areas, PRA determined that Train A Emergency Core Cooling (ECCS) Reactor Building sump suction valve CV-1405 should be modified to meet requirements of IN 92-18. CV-1405 does not have automatic features via interlocks to preclude spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, listed as a global modification to reduce risk, VFDR B173-02-b, VFDR B8SEPR-03-b, VFDR C-01-b, and VFDR G-02-c	ANO has modified CV-1405 to meet the requirements of IN 92-18. This modification added an “inhibit” circuit which will preclude spurious opening of the MOV due to intercable or intracable hot shorts. The circuit modification incorporated an available spare cable for the conductor needed between the Control Room cabinet and the 480 V MCC.	Yes	Yes	This modification is credited globally from a PRA perspective. This modification reduces the risk of fire induced MOV hot short circuit failure and will preclude spurious operation. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.
S1-14	High (PRA)	1	MOV CV-1406: In multiple fire areas, PRA determined that Train B ECCS Reactor Building sump suction valve CV-1406 should be modified to meet requirements of IN 92-18. CV-1406 does not have automatic features via interlocks to preclude spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, listed as a global modification to reduce risk, VFDR B-1@120-03-d, VFDR G-02-c, VFDR I1-03-c, and VFDR I3-03-e	ANO has modified CV-1406 to meet the requirements of IN 92-18. This modification added an “inhibit” circuit which will preclude spurious opening of the MOV due to intercable or intracable hot shorts. The circuit modification incorporated an available spare cable for the conductor needed between the Control Room cabinet and the 480 V MCC.	Yes	Yes	This modification is credited globally from a PRA perspective. This modification reduces the risk of fire induced MOV hot short circuit failure and will preclude spurious operation. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-15			Not Used				
S1-16	Med (PRA)	1	AOV CV-4400: In Fire Area G, PRA determined that Reactor Building sump drain valve CV-4400 control circuit should be modified to preclude spurious operation. CV-4400 control circuit does not have automatic features via interlocks to preclude spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, Fire Area G Risk Summary	ANO plans to modify the control circuit for CV-4400 by adding an "inhibit" circuit which will preclude spurious opening of the AOV due to intercable or intracable hot shorts. The circuit modification plan adds an automatic feature to prevent solenoid or electro-pneumatic valve positioner from opening CV-4400 as a result of a fire induced circuit failure in the Control Room.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area G. This modification reduces the risk of fire induced AOV hot short circuit failure and will preclude spurious operation. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.
S1-17	Med (PRA)	1	MOV CV-4446: In Fire Area G, PRA determined that Reactor Building sump drain valve CV-4446 should be modified to preclude spurious operation. CV-4446 does not have automatic features via interlocks to preclude spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, Fire Area G Risk Summary	ANO plans to modify CV-4446 by adding an "inhibit" circuit which will preclude spurious opening of the MOV due to intercable or intracable hot shorts.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area G. This modification reduces the risk of fire induced MOV circuit failures (hot shorts, open circuits, and short to ground) and will preclude spurious operation. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-18	Med (PRA)	1	MOV CV-5611: In Fire Area G, PRA determined that Reactor Building firewater valve CV-5611 should be modified to preclude spurious operation. CV-5611 does not have automatic features via interlocks to preclude spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, Fire Area G Risk Summary	ANO plans to modify CV-5611 by adding an “inhibit” circuit which will preclude spurious opening of the MOV due to intercable or intracable hot shorts.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area G. This modification reduces the risk of fire induced MOV hot short circuit failure and will preclude spurious operation. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.
S1-19	Med (PRA)	1	MOV CV-5612: In Fire Area G, PRA determined that Reactor Building firewater valve CV-5612 should be modified to preclude spurious operation. CV-5612 does not have automatic features via interlocks to preclude spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, Fire Area G Risk Summary	ANO plans to modify CV-5612 by adding an “inhibit” circuit which will preclude spurious opening of the MOV due to intercable or intracable hot shorts.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area G. This modification reduces the risk of fire induced MOV hot short circuit failure and will preclude spurious operation. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-20	Med (PRA)	1	AOV CV-7401: In Fire Area G, PRA determined that Reactor Building purge valve CV-7401 control circuit should be modified to preclude spurious operation. CV-7401 control circuit does not have automatic features via interlocks to preclude spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, Fire Area G Risk Summary	ANO plans to modify the control circuit for CV-7401 by adding an "inhibit" circuit which will preclude spurious opening of the AOV due to intercable or intracable hot shorts. The circuit modification plan adds an automatic feature to prevent solenoid or electro-pneumatic valve positioner from opening CV-7401 as a result of a fire induced circuit failure in the Control Room.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area G. This modification reduces the risk of fire induced AOV hot short circuit failure and will preclude spurious operation. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.
S1-21	Med (PRA)	1	AOV CV-7402: In Fire Area G, PRA determined that Reactor Building purge valve CV-7402 control circuit should be modified to preclude spurious operation. CV-7402 control circuit does not have automatic features via interlocks to preclude spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, Fire Area G Risk Summary	ANO plans to modify the control circuit for CV-7402 by adding an "inhibit" circuit which will preclude spurious opening of the AOV due to intercable or intracable hot shorts. The circuit modification plan adds an automatic feature to prevent solenoid or electro-pneumatic valve positioner from opening CV-7402 as a result of a fire induced circuit failure in the Control Room.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area G. This modification reduces the risk of fire induced AOV hot short circuit failure and will preclude spurious operation. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-22	Med (PRA)	1	AOV CV-7403: In Fire Area G, PRA determined that Reactor Building purge valve CV-7403 control circuit should be modified to preclude spurious operation. CV-7403 control circuit does not have automatic features via interlocks to preclude spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, Fire Area G Risk Summary	ANO plans to modify the control circuit for CV-7403 by adding an "inhibit" circuit which will preclude spurious opening of the AOV due to intercable or intracable hot shorts. The circuit modification plan adds an automatic feature to prevent solenoid or electro-pneumatic valve positioner from opening CV-7403 as a result of a fire induced circuit failure in the Control Room.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area G. This modification reduces the risk of fire induced AOV hot short circuit failure and will preclude spurious operation. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.
S1-23	Med (PRA)	1	AOV CV-7404: In Fire Area G, PRA determined that Reactor Building purge valve CV-7404 control circuit should be modified to preclude spurious operation. CV-7404 control circuit does not have automatic features via interlocks to preclude spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, Fire Area G Risk Summary	ANO plans to modify the control circuit of CV-7404 by adding an "inhibit" circuit which will preclude spurious operation of the AOV due to intercable or intracable hot shorts. The circuit modification plan adds an automatic feature to prevent solenoid or electro-pneumatic valve positioner from opening AOV valve CV-7404 as a result of a fire induced circuit failure in the Control Room.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area G. This modification reduces the risk of fire induced AOV hot short circuit failure and will preclude spurious operation. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-24	Med (PRA)	1	SW Pump P-4A: In Fire Area I-2 circuit impacts may cause a loss of SW pump P-4A. LAR Source: Attachment C, Fire Area I-2 Risk Summary, VFDR I2-02-a	ANO plans a circuit modification to reconfigure the circuit that supports remote operation of SW pump P-4A. Circuits are planned to be reconfigured to avoid Fire Area I-2. Any new raceway or cables needed for these circuits will be installed outside of any zone of influence for postulated fire sources or routed in locations where deterministic compliance can be demonstrated.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area I-2. This modification to reconfigure the P-4A circuit reduces the risk of a fire induced circuit failure. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.
S1-25	Med (PRA)	1	EFW Pump P-7B: In Fire Area I-2 circuit impacts may result in loss of EFW pump P-7B. LAR Source: Attachment C, Fire Area I-2 Risk Summary, VFDR I2-01-b	ANO plans a circuit modification to reroute cables that support remote operation of P-7B. Circuits are planned to be rerouted to avoid Fire Area I-2 using embedded conduit as available or routed in raceways that already contain other cables that would impact P-7B. Any new raceway needed for these circuits will be installed outside of any zone of influence for postulated fire sources or routed in locations where deterministic compliance can be demonstrated.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area I-2. This modification to reroute cables reduces the risk of a fire induced circuit failure. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-26	Med (PRA)	1	Primary Makeup Pump P-36A: In Fire Area I-2 circuit impacts may result in a loss of Primary Makeup pump P-36A. LAR Source: Attachment C, Fire Area I-2 Risk Summary, VFDR I2-03-c	ANO plans a circuit modification to reconfigure cables that support remote operation of P-36A. P-36A circuits are planned to be reconfigured to avoid Fire Area I-2. Any new raceway or cables needed for these circuits will be installed outside of any zone of influence for postulated fire sources or routed in locations where deterministic compliance can be demonstrated.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area I-2 This modification to reconfigure the P-36A circuits reduces the risk of a fire induced circuit failure. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.
S1-27	High (PRA)	1	Sluice Gate Valve SG-1: In multiple fire areas, PRA determined that Sluice Gate valve SG-1 should be modified to remove the potential of spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, listed as a global modification to reduce risk, VFDR B-1@120-02-c and VFDR C-03-e	ANO has modified Sluice Gate valve SG-1 to remove the potential for spurious closing as a result of a fire induced circuit failure. The modification allows SG-1 to remain open in all PRA fire scenarios. The circuit modification incorporated an available spare conductor in an existing cable between the Control Room cabinet and the 480 V MCC.	Yes	Yes	This modification is credited globally from a PRA perspective. This modification removes the potential of spurious operation to reduce overall plant risk for SG-1 as a result of a fire induced circuit failure. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-28	High (PRA)	1	Sluice Gate Valve SG-2: In multiple fire areas, PRA determined that Sluice Gate valve SG-2 should be modified to remove the potential of spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, listed as a global modification to reduce risk, VFDR G-05-a	ANO has modified Sluice Gate valve SG-2 to remove the potential for spurious closing as a result of a fire induced circuit failure. The modification allows SG-2 to remain open in all PRA fire scenarios. The circuit modification incorporated an available spare conductor in an existing cable between the Control Room cabinet and the 480 V MCC.	Yes	Yes	This modification is credited globally from a PRA perspective. This modification removes the potential of spurious operation to reduce overall plant risk for SG-2 as a result of a fire induced circuit failure. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.
S1-29	High (PRA)	1	Sluice Gate Valve SG-3: In multiple fire areas, PRA determined that Sluice Gate valve SG-3 should be modified to remove the potential of spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, listed as a global modification to reduce risk	ANO has modified Sluice Gate valve SG-3 to remove the potential for spurious closing as a result of a fire induced circuit failure. The modification allows SG-3 to remain open in all PRA fire scenarios. The circuit modification incorporated an available spare conductor in an existing cable between the Control Room cabinet and the 480 V MCC.	Yes	Yes	This modification is credited globally from a PRA perspective. This modification removes the potential of spurious operation to reduce overall plant risk for SG-3 as a result of a fire induced circuit failure. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-30	High (PRA)	1	Sluice Gate Valve SG-4: In multiple fire areas, PRA determined that Sluice Gate valve SG-4 should be modified to remove the potential of spurious operation to reduce overall plant risk as a result of a fire induced circuit failure. LAR Source: Attachment C, listed as a global modification to reduce risk, VFDR G-05-a	ANO has modified Sluice Gate valve SG-4 to remove the potential for spurious closing as a result of a fire induced circuit failure. The modification allows SG-4 to remain open in all PRA fire scenarios The circuit modification incorporated an available spare conductor in an existing cable between the Control Room cabinet and the 480 V MCC.	Yes	Yes	This modification is credited globally from a PRA perspective. This modification removes the potential of spurious operation to reduce overall plant risk for SG-4 as a result of a fire induced circuit failure. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-31	High (PRA)	C	NFPA 805 non-compliance issues were encountered when smaller fire area were defined such that multiple walls, dampers, penetration seals, and doors were credited and used in the Fire PRA model as rated fire barriers in the NRC regulatory basis for NFPA 805. Multiple walls and doors barriers will require upgrading to comply with NFPA 805. LAR Source: Attachment A, Section 3.11.2	ANO plans to provide an adequate-for-the-hazard evaluation and if necessary a modification to upgrade fire barrier walls, dampers, penetration seals, and doors to rated barriers for those barriers credited for deterministic compliance and subsequently credited in the Fire PRA analysis. These fire barriers below have been previously identified as NRC regulatory basis to ensure compliance with NFPA 805 and have compensatory measures established. Fire barriers to be addressed as identified by EC-1956 are: 15-5, 15-4, 39-5, 44-2, 45-2, 46-4, 64-3, 67-4, 70-7, 72-5, 73-5, 75-2, 75-3, 75-4, 76-2, 76-3, 77-2, 78-2, 79-6, 81-4, 81-6, 81-7, 82-2, 88-1, 88-3, 88-5, 89-1, 89-5, 90-2, 90-4, 93-4, 101-5, 103-2, 103-4, 104-2, 105-2, 120-5, 121-1, 122-5, 123-1, 125-1, 143-1, 144-2, 144-3, 144-5, 144-6, 147-4, 149-2, 162-3, 162-4, 162-5, 170-1, 183-4, and 183-5.	Yes	Yes	This modification will be completed to meet NFPA 805 code requirements. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-32	Low (Code)	C	NFPA 50A, Gaseous Hydrogen Systems, code non-compliance issues were identified in the Hydrogen Gas Bottle Storage Room related to inadequate vent piping and room ventilation. The hydrogen storage room light switch was identified as not meeting Article 501 for Class I, Division 2 locations of the National Electric Code (NEC). LAR Source: Attachment A, Section 3.3.7.1	ANO has modified the ventilation for the Hydrogen Bottle Storage area to ensure compliance with NFPA 50A. In addition, electrical equipment and wiring changes were made to meet the requirements of NFPA 70 (NEC), Article 501 for Class I, Division 2.	No	No	The subject hydrogen gas system bottle storage area is not credited by the PRA. This modification has been completed to meet NFPA 50A code requirements. Compliance with this code is not part of the current licensing basis, therefore, no compensatory measures were needed.
S1-33	Low (Code)	C	NFPA 10, Fire Extinguishers, code non-compliance issues (such as incorrect number of fire extinguishers for travel distance, and incorrect type and size for the hazard area) were identified with ANO portable fire extinguishers. LAR Source: Attachment A, Section 3.7	ANO has resolved NFPA 10 deficiencies identified in CALC-ANOC-FP-09-00009. In general, this modification involved portable fire extinguisher physical relocation, substitution of existing extinguishers, and documentation updates to reflect these plant changes. The proper number of fire extinguishers that meet travel distance requirements in coverage areas, adequately sized fire extinguishers, and the correct type of extinguisher that is rated for the fire hazard in each area have been installed.	No	No	The subject fire extinguishers are not credited in the PRA. This modification has been completed to meet NFPA 10 code requirements. Compliance with this code is not part of the current licensing basis, therefore, no compensatory measures were needed.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-34			Cabinet C539: In Fire Area I-1, impacts against the power supply for EFIC Signal Conditioning Cabinet C539 can result in a loss of instrumentation and the operator cues necessary for post fire shutdown. LAR Source: Attachment C, Fire Area I-1 Risk Summary, VFDR I1-05-a	ANO plans a modification to rework the power circuits from panel RS-1 to C539 that will eliminate the impacts in Fire Area I-1.	Yes	Yes	This modification is credited from a PRA perspective in Fire Area I-1 This modification removes the potential of a loss of instrumentation as a result of fire induced circuit failure. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.
S1-35	Med (92-18)	1	Non Power Operation (NPO) MOVs CV-1050, CV-1410, CV-1404: ANO-1 has no redundancy to the single Reactor Coolant System (RCS) drop line to the Decay Heat Removal (DHR) system with three in-series valves CV-1050, CV-1410, and CV-1404. The NPO assessment determined that any one of the three RCS drop line valves could fail in a closed and unrecoverable position resulting in a loss of DHR. LAR Source: Attachment D, VFDR NPO-RCS-DHR	ANO plans a modification for CV-1404 to meet the requirements of IN 92-18. This modification adds an “inhibit” circuit which will preclude spurious closing of the MOV due to intercable or intracable hot shorts. Procedural changes are planned to secure MOVs CV-1050 and CV-1410 in the open position by opening breakers to remove power.	No	Yes	The NPO modification reduces the risk of fire induced MOV circuit failures (hot shorts, open circuits, and short to ground). This MOV modification can prevent a non-recoverable position failure resulting in the loss of DHR. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-1 Plant Modifications

Item	Rank	Unit	Problem Statement	Proposed Modification	In FPRA	Comp Measure	Risk Informed Characterization
S1-36	High (PRA)	1	NFPA 13, Standard for the Installation of Sprinkler Systems (1971 Edition), code non-compliance issues were identified in CALC-ANO1-FP-09-00007, Rev. 1, Unit 1 Electrical Penetration. These non-compliance issues are allowable sprinkler spacing exceeded and obstructions blocking sprinkler spray patterns located in the Upper (South and North) Electrical Penetration Rooms and Lower (South and North) Electrical Penetration Rooms. LAR Source: Attachment A, Section 3.9.1 (1)	ANO plans to provide a modification to physically relocate/rework existing sprinklers, add sprinklers, add or rework hangers and fire protection branch line piping, and add sprinkler deflectors to resolve non-compliant code issues and meet NFPA 13 requirements.	Yes	Yes	These modifications will be completed to meet NFPA 13 requirements. The Fire PRA model credited the non-compliant sprinkler systems in the fire areas to reduce the risk in the hot gas layer (HGL) and multi-component analysis (MCA) scenarios. The sprinkler systems were not designed or installed for full sprinkler coverage in these fire areas. In accordance with station directives, compensatory measures per OP-1003.014 have been established as appropriate.

Table S-2 items provided below are those items (procedure changes, process updates, and training to affected plant personnel) that will be completed prior to the implementation of new NFPA 805 fire protection program.

Table S-2 Implementation Items

Item	Unit	Description	LAR Section / Source
S2-1	C	Develop a monitoring program required by NFPA 805 that will include a process to monitor and trend the fire protection program based on specific goals established to measure effectiveness.	LAR Section 4.6 and Attachment A, Section 3.2.3 (3)
S2-2	1	Revise or develop fire protection flushing activity to perform fixed water spray system flushing and drainage of underground lead-in connections in accordance with NFPA 15, 1977 Edition Code.	Attachment A, Section 3.9.1 (2)
S2-3	C	Revise appropriate fire protection administrative procedures to include the following: • In accordance with FAQ 06-0020, the term "applicable NFPA Standards" is considered to be equivalent to those NFPA Standards identified in the current licensing basis (CLB) for existing procedures and systems in the fire protection program that are transitioning to NFPA 805. New Fire Protection Systems would be subject to the most current code or standard. • Terminology for zero transient combustibles and changes needed to support Fire PRA assumptions.	Attachment A, Section 3.3.1.2 (5)
S2-4	1	Revise existing procedure(s) or develop new procedure(s) for NPO required to transition to NFPA 805 based upon insights gained from ANO-1 NPO calculation.	Attachment D, VFDR NPO-Procedure
S2-5	1	Revise operator manual action (OMA) procedures/documents to include feasibility criteria in FAQ 07-0030 for the recovery actions listed in Table G-1 of Attachment G, Recovery Action Transition.	Attachment G, Step 4
S2-6	C	Develop or revise technical documents and procedures that relate to new Fire Protection design and licensing basis (e.g., ANO Fire Protection Program, OP-1003.014, Technical Requirements Manual, Design Basis Document, Pre-Fire Plans, Maintenance and Surveillance Procedures, Configuration Control Program, Training and Qualification Guidelines, etc.) as required for implementation of NFPA 805.	LAR Sections 4.7.1, 4.7.2, and 4.7.3, Attachment E Table E-1
S2-7	1	Revise CALC-ANOC-FP-09-00007, Rev. 0, for NFPA 30 to update code report for Oil Tank T-25 dike/berm compliance and perform a civil engineering evaluation for Oil Tank T-26 in tank vault, Fire Area B-1, Fire Zone 187 DD. The air supply duct location in the vault wall near the floor provides a potential oil leakage path via the supply duct outside of the vault.	Attachment A, Section 3.3.8
S2-8	1	Perform an evaluation to determine that Oil Tank T-29 supports are acceptable in accordance with American Petroleum Institute (API) and National Fire Protection Association (NFPA) codes/standards, since T-29 supports documentation from construction is not available.	Attachment A, Section 3.3.8
S2-9	1	Validate the change in risk by revising the FPRA model for each modification or implementation item completed that is credited either directly or indirectly by PRA. If the as-built change-in-risk from each modification or implementation item, including the procedure changes in Implementation Item S2-6, exceeds RG 1.205 acceptance criteria, the results shall be entered into the corrective action program to evaluate the cause of risk increase and determine appropriate resolution. The FPRA update will be performed in accordance with Entergy fleet PSA Maintenance procedure EN-DC-151, Section 5.2.	LAR Section 4.8.2

Table S-2 Implementation Items

Item	Unit	Description	LAR Section / Source
S2-10	1	Revise drawings and pre-fire plans for Fire Area I-1, Fire Zone 98-J corridor; since this wall will be credited by PRA as a radiant energy barrier wall with Door 57. PRA requires corridor to be divided or split into two separate fire compartments at C-4 Line wall on EL. 372. This division of the Fire Zone 98-J corridor will reduce the risk in the HGL/MCA scenarios.	Attachment C, Fire Area I-1 Fire Zone 98-J

Attachment 7 to

1CAN031602

Updated Attachment W – Fire PRA Insights

W. Fire PRA Insights

W.1 Fire PRA (FPRA) Overall Risk Insights

Risk insights were documented as part of the development of the FPRA. The total plant fire CDF/LERF were derived using the NUREG/CR-6850 methodology as guidance for FPRA development and are useful in identifying the areas of the plant where fire risk is greatest. The risk insights generated were useful in identifying areas where specific contributors might be mitigated via modification. A detailed description of significant risk sequences associated with the fire initiating events that represent a 1% contribution of the calculated fire risk for the plant was prepared for the purposes of gaining these insights and an understanding of the risk significance of multiple spurious operation (MSO) combinations. These insights are provided in Table W-1 (Table W-1a for CDF and Table W-1b for LERF).

Fire Scenario Selection

Fire scenarios were selected based on the definition of 'significant accident sequence' from RG 1.200, Revision 2:

> *Significant accident sequence: A significant sequence is one of the set of sequences, defined at the functional or systemic level that, when ranked, compose 95% of the CDF or the LERF/LRF, or that individually contribute more than ~1% to the CDF or LERF/LRF.*

The top 46 fire scenarios account for over 90% of the cumulative fire CDF. Of these, 22 scenarios contribute 1% or greater on an individual basis. These 22 scenarios are presented in Table W-1a. A strong correlation exists between the CDF and LERF. Twenty-two LERF scenarios account for 1% or more of the total LERF value. Of these 22 LERF cases, 13 were included in the W-1a CDF table. All LERF scenarios (and the associated risk insights) that account for 1% or more of the total LERF are listed in Table W-1b.

Modifications

Several modifications were identified in the fire risk evaluations (FREs) that contributed to the reduction in plant cumulative ΔCDF and ΔLERF. The risk benefits of these proposed modifications are reflected in the delta risk values presented in Table W-2.

See Attachment S for a complete list of all modifications including additional details of each.

Recovery Actions

Each human action credited in the FPRA model was evaluated in the ANO-1 Fire PRA Human Reliability Analysis Notebook. This includes several new actions added to the model during application of the NUREG/CR-6850 methodology.

Safe Shutdown Analysis actions were also reviewed for potential actions adverse to risk. All equipment and components needed to support the recovery action were identified as a 'variance from deterministic requirements' (VFDRs). Additionally, recovery actions were reviewed for adverse impact on the FPRA. An analysis of the risk associated with recovery actions was completed and the total delta risk of recovery actions is 3.14E-5 (ΔCDF) and 5.58E-07 (ΔLERF).

Given a fire that results in Main Control Room (MCR) abandonment, the risk of recovery actions (any actions still available given fire damage) associated with remote shutdown is always beneficial. The actions identified in Attachment G as defense-in-depth recovery actions (which are not credited in the FPRA) will tend to reduce the overall risk associated with recovery actions.

Unapproved Analysis Methods

Development of the ANO-1 FPRA did not deviate from the methods outlined in NUREG/CR-6850 (including FAQs documented in Attachment H of the original LAR and those FAQs referenced in responses to RAIs, and other interim guidance documents). No unapproved analysis methods were used or applied in any of the supporting analyses.

Uncertainty

The results presented below represent the combined effort and calculations of several tasks. Uncertainty in the FPRA results occurs because there is both inherent randomness in essentially all of the elements that comprise the FPRA and because there is a lack of, or weaknesses in, the state of knowledge in these elements.

Two types of uncertainty are considered in probabilistic risk assessments, both of which may be modeled with probability distributions:

- Aleatory uncertainty, which characterizes the inherent randomness of a parameter.
- Epistemic uncertainty, which characterizes the state of knowledge about a parameter.

Latin hypercube analysis was used to propagate parametric uncertainties through the ANO-1 FPRA model to generate probability density distributions for CDF and LERF. The parameters used to support this analysis were ignition frequency, circuit failure, non-suppression, human reliability analysis (HRA), and existing internal event PRA failure data.

Uncertainty results are not included in the results presented in this attachment. Individual task uncertainty and collective FPRA uncertainty details are documented in the Fire PRA Uncertainty and Sensitivity Analysis.

W.2 Risk Change Due to NFPA 805 Transition

The risk change due to the NFPA 805 transition meets the acceptance guidelines of RG 1.205. RG 1.205 requires that the total risk increase should be consistent with the acceptance guidelines in RG 1.174 in accordance with the guidance in Regulatory Position 2.2.4.2 of RG 1.205, Revision 1.

Change in CDF and LERF

The total ΔCDF for the transition to NFPA 805 is calculated to be -6.74E-07 (the sum of the calculated delta risk from Table W-2). The total ΔLERF is calculated to be 1.25E-05. These results show a net risk benefit for both CDF and LERF associated with this transition. These values include credited recovery actions and plant modifications (documented in Attachments G and S, respectively). These changes in the plant CDF and LERF meet the RG 1.174 criteria as the total change in risk associated with the transition to NFPA 805 results in a small risk reduction and the total plant fire risk is below 1E-04 for CDF and 1E-05 for LERF.

The risk results show a reduction in risk associated with the transition to NFPA 805 due to the methodology used in the FREs. The compliant case measures the current plant with all VFDRs protected (corresponding PRA basic events set to TRUE, or protected from failure) in the model quantification. The non-compliant case evaluates the plant at the point of full implementation of NFPA 805. In these cases, the variant components are not protected (corresponding PRA components subject to potential fire damage or random failure). However, the non-compliant case credits plant modifications (documented in Attachments S). Thus, the delta risk evaluations ultimately compare the risk of each individual area at the point of full implementation of NFPA 805 with the risk of the same area of the current plant given an ideal, deterministically compliant arrangement. The reduction in risk is a result of the risk benefit of the scheduled modifications having greater impact than the total sum of the risk associated with deterministic non-compliance.

Site Risk from Internal Events

Although RG 1.174 does not require calculation of total CDF and LERF, if the increases are below the ∆CDF and ∆LERF of 1E-06 and 1E-07 respectively, the RG does recommend that, if there is an indication that the CDF is 'considerably higher' than 1E- 04 or if LERF is 'considerably higher' than 1E-05, then the focus should be on finding ways to decrease CDF or LERF.

The total CDF including Fire and Internal events has a value of 8.01E-05 (Internal Events CDF (2.88E-06) + Internal Floods (1.04E-06) + Fire CDF (7.62E-05)), and the total LERF has a value of 8.97E-06 (Internal Events LERF (5.82E-08) + Internal Floods (1.73E-07) + Fire LERF (8.74E-06)). Both values are below the RG 1.174 criteria of 1E-04 (CDF) and 1E-05 (LERF).

The aforementioned total CDF and LERF values do not include contribution from external events. Therefore, the contribution to risk from external events is captured below.

Site Risk from External Events

Seismic – An NRC report ("Generic Issue 199 (GI-199) – Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants," August 2010) provides Seismic CDF estimates for many of the nuclear facilities in the United States. The study uses information from the site Individual Plant Examination of External Events (IPEEE) along with 2008 United States Geological Survey (USGS) Seismic Hazard Curves to estimate the CDF due to seismic events. This document estimates the ANO-1 Seismic CDF to be 4.1E-6.

Flooding and other External Events – High winds, floods, or off-site industry facility accidents do not contribute significantly to ANO site risk. For the external events the CDF is also estimated to be less than 1E-6. This is consistent with the discussions of the events in Sections 2.3 through 2.11 of NUREG-1407.

A bounding estimate of the overall CDF risk due to external events (including seismic, external flooding, and off-site industry facility accidents) is estimated to be less than 1E-5. A total bounding estimate for LERF external events is assumed to be 0.1 of the total CDF, which is less than 1E-6.

Table W-1a – Fire PRA CDF Significant Fire Initiating Events (Individually Representing > 1% of the Calculated CDF)

Scenario	Description	Contribution		Risk insights	CCDP[1]	IF[2]	CDF[3]
		% of Total	Cumulative				
129-F/A	Base Scenario	25.27%	25.27%	Fire scenario 129-F represents the Main Control Room (MCR) abandonment scenario. Following MCR abandonment, the operators are required to prevent a Reactor Coolant Pump (RCP) seal Loss of Coolant Accident (LOCA) by manually tripping the RCPs at the H1/H2 switchgear in the turbine building. Additional actions are taken to isolate letdown valve CV-1221, de-energize a failed open electromatic relief valve (ERV) CV-1000, and trip any spuriously running High Pressure Injection (HPI) pumps to prevent an over pressurization of the Reactor Coolant System (RCS). Actions to manually operate HPI pumps are not recovered in the scenario to mitigate these failure events. Primary to secondary heat removal is available through the common feedwater (CFW) pump's local control station outside the MCR that is being added per the CFW pump modification. The CFW pump will have a dedicated offsite power source and Steam Generator (SG) indication will be available via the Safety Parameter Display System (SPDS) instrumentation as part of the CFW pump modification.	2.69E-01	7.17E-05	1.93E-05
129-F-AS/A	C20	5.97%	31.24%	Fire scenario 129-F-AS models a fire inside panel C20 located inside the MCR. C20 houses the plant protective relays associated with the automatic transfer functions for the power supply to the A-3 and A-4 safety related 4KV switchgear. Smoke detection has been installed as a plant modification to reduce the risk associated with this scenario (see Table S-1, Item S1-9). The dominant cutset requires the MCR to trip the RCPs on loss of seal injection. Via an automatic transfer switch, the CFW pump will retain its power supply from a dedicated offsite source. The turbine-driven Emergency Feedwater (EFW) pump is also available as a source of feedwater for primary to secondary heat removal. HPI is unavailable for injection due to loss of power.	6.58E-02	6.91E-05	4.55E-06

Table W-1a – Fire PRA CDF Significant Fire Initiating Events (Individually Representing > 1% of the Calculated CDF)							
Scenario	Description	Contribution		Risk insights	CCDP[1]	IF[2]	CDF[3]
		% of Total	Cumulative				
129-F-C/A	C11	4.52%	35.76%	C11, C12, C13, C14, and C16 have openings within the panels that can communicate smoke and heat within the cabinet. As a result, the damage target set and risk insights are the same for all five scenarios. The dominant risk sequences are driven by the circuits for remote RCP control that are housed in panel C13. Loss of any four of the RCP pump control circuits may require a manual trip of the circuit breakers at the H1/H2 6.9KV bus in the turbine building on loss of seal cooling. Within cabinet C16 a NFPA-805 modification added a shorting switch to CV-1406 to prevent spurious valve operation that could lead to the Borated Water Storage Tank (BWST) drain down to the containment sump (Generic PWR MSO-15). A NUREG-7150 hot short value is applied to the circuit within the cabinet in the event the shorting switch is damaged by the fire before the switch sends the circuit to ground preventing the spurious operation. Spurious drain down to the sump could render the HPI injection pumps unavailable for RCP seal cooling or seal LOCA makeup to the primary loop. Both EFW pumps and the new CFW pump will be available for primary to secondary heat removal.	4.03E-02	8.55E-05	3.45E-06
129-F-D/A	C12	4.52%	40.29%	See Risk Insights for C11 (129-F-C/A)	4.03E-02	8.55E-05	3.45E-06
129-F-E/A	C13	4.52%	44.81%	See Risk Insights for C11 (129-F-C/A)	4.03E-02	8.55E-05	3.45E-06
129-F-G/A	C16	4.52%	49.34%	See Risk Insights for C11 (129-F-C/A)	4.03E-02	8.55E-05	3.45E-06
33-K/B	Panel Fire Outside Shield Wall - IGF = (Bin 15&26 contribution)	2.94%	52.27%	Fire scenario 33-K is a severe fire that conservatively damages the entire contents in the south side of the containment building (Fire Area J - South). The dominant risk insights are the result of spurious Emergency Feedwater Initiation and Control (EFIC) and Engineered Safeguards Actuation System (ESAS) signals that would require operator overrides to start the EFW pumps, or trip/throttle back a spurious HPI injection pump. The dominant cutsets require an Operator action to close the open letdown valve CV-1221 or throttle back HPI to prevent over pressurization of the primary system in order to prevent an RCS boundary breach. HPI is available for feed-and-bleed and RCS inventory make-up. CFW is available for primary to secondary heat removal.	1.54E-03	1.45E-03	2.24E-06

Table W-1a – Fire PRA CDF Significant Fire Initiating Events (Individually Representing > 1% of the Calculated CDF)

Scenario	Description	Contribution % of Total	Contribution Cumulative	Risk insights	CCDP[1]	IF[2]	CDF[3]
32-K/A	Base Scenario	2.52%	54.80%	Fire scenario 32-K impacts all targets within Fire Zone 32-K. The dominant risk contributors are associated with random failure of the operator action to start the new CFW pump, or overriding a false EFIC signal for failure of primary to secondary heat removal. HPI is available in this scenario and feed-and-bleed is credited for cutsets that randomly fail primary to secondary heat removal. The 32-K scenario requires a manual action to isolate letdown by closing CV-1221 to prevent a small LOCA. The MCR is required to throttle the HPI pumps to prevent over pressurization of the RCS.	6.64E-04	2.89E-03	1.92E-06
149-E/HGL	Base Scenario – Severe Fire	2.48%	57.28%	149-E/HGL is a severe fire in the upper north electrical penetration room. The risk is driven by fire-induced failure of the diesel generator room coolers in conjunction with the startup transformer X-03. The CFW pump provides primary to secondary heat removal via a separate dedicated offsite power source. Injection is unavailable as a result of a loss of power.	1.43E-02	1.33E-04	1.89E-06
129-F-F/A	C14	2.26%	59.54%	See Risk Insights for C11 (129-F-C/A).	4.03E-02	4.28E-05	1.72E-06
100-N/HGL	Base Scenario – Severe Fire	2.13%	61.67%	Fire scenario 100-N/HGL is a severe fire that is located in the south switchgear room which damages all targets within the zone. The top risk cutset requires the control room to trip the RCPs on loss of seal injection. HPI is available for this scenario when Service Water (SW) pump P-4C is running. The CFW pump is the only source of primary to secondary heat removal available for this scenario. Green train power to safety bus A-4 remains available.	3.14E-03	5.18E-04	1.63E-06
110-L/A	Base Scenario	1.86%	63.54%	Fire scenario 110-L is a base scenario (Appendix R type fire) in the DC battery room. The dominant risk cutsets are influenced by the loss of DC power to the red train power supply including a loss of offsite power. The green train Emergency Diesel Generator (EDG) and the Alternate AC Diesel Generator (AACDG or Station Blackout diesel generator) are available. The control room is required to trip the RCPs on loss of seal injection using the new DC power supply modification. The CFW pump modification and the turbine driven EFW pump are credited for primary to secondary heat removal. An Operator action is also required to throttle back the HPI pumps following spurious actuation of the pumps to prevent over pressurization of the RCS.	1.52E-03	9.33E-04	1.42E-06

Table W-1a – Fire PRA CDF Significant Fire Initiating Events (Individually Representing > 1% of the Calculated CDF)

Scenario	Description	Contribution % of Total	Contribution Cumulative	Risk insights	CCDP[1]	IF[2]	CDF[3]
97-R/A	Cable Spreading Room Only Fire	1.60%	65.14%	Scenario 97-R, the cable spreading room, is a severe transient fire that impacts all targets located within 97-R. This scenario is similar to the MCR abandonment scenario except the CFW controls are routed outside the cable spreading room and can be operated from within the control room.	1.52E-01	8.00E-06	1.22E-06
104-S/HGL	Base Scenario – Severe Fire	1.51%	66.65%	Fire Scenario 104-S is a severe fire in the electrical equipment room. The dominant risk cutset involves a fire induced spurious start of the P-36B HPI pump requiring an Operator action to prevent over pressurization of the RCS. The CFW pump is the only available source of primary to secondary heat removal. HPI remains available for make-up and feed-and-bleed.	3.80E-03	3.03E-04	1.15E-06
99-M/HGL	Base Scenario – Severe Fire	1.45%	68.10%	Fire scenario 99-M is a severe fire that impacts all targets in the green train switchgear room. A NFPA-805 modification has been proposed to reconfigure the circuits for the red train components P-36A, P-4A, and P-7B to maintain red train SW, safety injection, and EFW (LAR Table S-1, Items S1-24, S1-25, and S1-26). As a result, the top dominant risk cutsets requires the control room to trip the RCPs on random loss of HPI to provide RCP seal injection. HPI is available, but requires the control room to manually override a false EFIC signal. The CFW pump or motor driven EFW pump P-7B are available to provide primary to secondary heat removal.	2.05E-03	5.40E-04	1.11E-06
129-F-H/A	C18	1.42%	69.53%	Panel C18 (scenario 129-F-H/A) is the engineered safeguards panel located on the back vertical board in the MCR. The dominant risk cutset involves a fire induced spurious start of the P-36A/B HPI pumps requiring an Operator action to prevent over pressurization of the RCS. The CFW or the turbine driven EFW pumps are available for sources of primary to secondary heat removal. C18 is the location of the shorting switch for CV-1407 and is not credited for a fire inside the panel. As a result, HPI is unavailable for make-up in this scenario.	1.27E-02	8.55E-05	1.09E-06
32-K-M1/M	MCA (32-K-33-K)	1.36%	70.89%	See Scenario 33-K-M1/M.	9.16E-01	1.13E-06	1.04E-06
33-K-M1/M	MCA (33-K-32-K)	1.36%	72.25%	33-K/M1/M is a conservative multi-compartment analysis scenario where both the north and south sides of containment are conservatively assumed to be damaged by fire. Core damage is induced via loss of instrumentation.	9.16E-01	1.13E-06	1.04E-06

Table W-1a – Fire PRA CDF Significant Fire Initiating Events (Individually Representing > 1% of the Calculated CDF)

Scenario	Description	Contribution % of Total	Contribution Cumulative	Risk insights	CCDP[1]	IF[2]	CDF[3]
34-Y/A	Base Scenario	1.34%	73.60%	Fire scenario 34-Y, Piping Area, represents a severe fire damaging all components and cables (Appendix R type fire). All trains of SW and HPI are unavailable due to fire damage, along with the motor driven EFW pump. The top dominant risk cutset requires the control room to trip the RCPs since RCP seal injection is unavailable and no LOCA mitigation is available. Additionally, fire-induced spurious start of the HPI pumps requires an Operator action to prevent over pressurization of the RCS. The CFW pump or the turbine driven EFW pump P-7A is available for primary to secondary heat removal.	2.53E-03	4.05E-04	1.02E-06
129-F-B-R/A	C10 (Red Train)	1.09%	74.69%	Panel C10 (Scenario 129-F-B-R/A) is the red train electrical auxiliary systems panel located on the back vertical board in the MCR. Offsite power and the red train EDG are both unavailable due to fire damage. Power from the green train EDG and the AACDG are available as the primary power supplies. CFW has a redundant offsite power feed and is available along with the turbine driven EFW pump for primary to secondary heat removal. Green train HPI is available.	9.82E-03	8.49E-05	8.34E-07
129-F-AH/A	C26	1.09%	75.78%	Panel C26 (Scenario 129-F-AH/A) is an auxiliary systems panel located in the electrical equipment area within the MCR. This cabinet contains the circuits for the SW bay sluice gate valves. Modifications to prevent spurious operation of the sluice gates has been proposed (LAR Table S-1, Items S1-27, S1-28, S1-29 and S1-30), but are not credited for a fire located within the C26 panel (to allow for potential damage to the shorting switch mechanism). As a result, SW is unavailable for this fire scenario. The top risk cutsets require the operators to trip the RCPs to prevent a RCP seal LOCA after loss of seal injection. The CFW pump or EFW pumps are available to provide primary to secondary heat removal. HPI injection is unavailable due to loss of SW.	4.84E-03	1.71E-04	8.27E-07
100-N-E-NS/A	A-3	1.04%	76.82%	Scenario 100-N-E-NS is a non-severe scenario for a fire inside vital 4KV switchgear A-3. This fire is initiated within the A-3 switchgear, but is suppressed before damage to the overhead cable trays occurs. A fault on vital switchgear A-3 and fire induced circuits within the switchgear are assumed as part of the scenario. The green train power supply from A-4 remains available. The CFW pump or the turbine driven EFW pump is available for primary to secondary heat removal.	2.65E-03	2.99E-04	7.93E-07

Notes:
[1] CCDP – Conditional Core Damage Probability
[2] IF – Ignition Frequency (includes severity factor and probability of non-suppression, where applicable.)
[3] CDF – Core Damage Frequency

Table W-1b – Fire PRA LERF Significant Fire Initiating Events (Individually Representing > 1% of the Calculated LERF)

Scenario	Description	Contribution % of Total	Contribution Cumulative	Risk insights	CLERP[1]	IF[2]	LERF[3]
129-F-AS/A	C20	13.27%	13.27%	See Table W-1a for risk insights. The dominant Large Early Release Frequency (LERF) sequence is driven by a pressure induced steam generator tube rupture (PI-SGTR) for loss of primary to secondary heat removal core damage sequences.	1.68E-02	6.91E-05	1.16E-06
129-F/A	Base Scenario	11.89%	25.16%	See Table W-1a for risk insights. The containment isolation valves will be modified to prevent spurious operation and are not contributing to the LERF. The dominant LERF sequence is driven by a thermally induced steam generator tube rupture (TI-SGTR).	1.45E-02	7.17E-05	1.04E-06
100-N/HGL	Base Scenario – Severe Fire	6.41%	31.57%	Fire scenario 100-N is located in the south switchgear room. This scenario represents a severe fire which damages all targets within the zone. The top risk cutset requires the control room operators to trip the RCPs since RCP seal injection is unavailable. HPI is available for this scenario when SW pump P-4C is running. The CFW pump is the only source of primary to secondary heat removal credited for this scenario. Green train power to vital 4.16KV switchgear A-4 is available. LERF sequences are dominated by TI-SGTR resulting from loss of red train power needed to cycle open the ERV and depressurize the RCS.	1.08E-03	5.18E-04	5.60E-07
100-N-E-NS/A	A-3	3.55%	35.12%	Scenario 100-N-E-NS is a non-severe scenario for a fire at vital switchgear A-3. This fire initiates within the A-3 switchgear, but is suppressed before damage to the overhead cable trays occurs. A fault on vital switchgear A-3 and fire induced circuits within the switchgear are assumed as part of the scenario. The green train power supply from A-4 remains available. The CFW pump or the turbine driven EFW pump is available for primary to secondary heat removal. The LERF sequences are dominated by TI-SGTR resulting from fire induced loss of red train power needed to cycle open the ERV and depressurize the RCS.	1.04E-03	2.99E-04	3.11E-07
33-K-M1/M	MCA (33-K-32-K)	3.41%	38.54%	33-K/M1/M is a conservative multi-compartment analysis scenario where both the north and south sides of containment are conservatively damaged. This scenario amounts to approximately 3% of the overall LERF frequency, and core damage is induced via loss of instrumentation. The LERF sequences are dominated by probabilities of TI-SGTR.	2.63E-01	1.13E-06	2.98E-07
32-K-M1/M	MCA (32-K-33-K)	3.41%	41.95%	See Scenario 33-K-M1/M.	2.63E-01	1.13E-06	2.98E-07
32-K/A	Base Scenario	2.72%	44.67%	See Table W-1a for risk insights. The LERF sequences are dominated by probabilities of TI-SGTR.	8.23E-05	2.89E-03	2.38E-07

Table W-1b – Fire PRA LERF Significant Fire Initiating Events (Individually Representing > 1% of the Calculated LERF)

Scenario	Description	Contribution		Risk insights	CLERP[1]	IF[2]	LERF[3]
		% of Total	Cumulative				
129-F-B-R/A	C10 (Red Train)	2.66%	47.33%	Scenario 129-F-B-R/A is a cabinet along the back vertical board sections in the Control Room that house the red train circuits for the electrical and auxiliary systems. Offsite power and the red train EDG are unavailable to due to fire damage. CFW or the turbine driven EFW pump is available for primary to secondary heat removal and green train HPI is available. LERF sequences are dominated by TI-SGTR resulting from loss of red train power needed to cycle open the ERV and depressurize the RCS.	2.74E-03	8.49E-05	2.32E-07
129-F-BA/A	MCR Abandonment Dual Unit Shutdown	2.58%	49.91%	129-F-BA/A is a low probability, high consequence scenario that results in damage to the ANO-1 sensitive electronics located within the ANO-1 MCR resulting from a hot gas layer forming from a fire in the ANO-2 MCR. This scenario would require a challenging dual unit shutdown and was conservatively assigned a conditional core damage probability (CCDP) of 1.0. The LERF sequences are dominated by TI-SGTR resulting from loss of red train power needed to cycle open the ERV and depressurize the RCS.	3.29E-01	6.85E-07	2.25E-07
100-N-M3/M	MCA (100-N-128-E)	2.56%	52.47%	Multi-compartment scenario 100-N-M3/M is a low probability, high consequence scenario where a fire in Fire Zone 100-N breaches a credited fire area boundary spreading a hot gas layer into Fire Zone 128-E. This scenario resulted in loss of red and green train equipment and instrumentation. The LERF sequences are dominated by TI-SGTR resulting from loss of red train power needed to cycle open the ERV and depressurize the RCS.	3.56E-01	6.30E-07	2.24E-07
99-M-M4/M	MCA (99-M-159-B)	2.40%	54.87%	Multi-compartment scenario 99-M-M4/M is a low probability, high consequence scenario where a fire in Fire Zone 100-N breaches a credited fire area boundary spreading a hot gas layer into Fire Zone 159-B.	3.59E-01	5.85E-07	2.10E-07
99-M-M3/M	MCA (99-M-110-L)	2.21%	57.08%	Multi-compartment scenario 99-M-M3/M is a low probability, high consequence scenario where a fire in Fire Zone 100-N breaches a credited fire area boundary spreading a hot gas layer into Fire Zone 110-L.	3.29E-01	5.86E-07	1.93E-07
149-E/HGL	Base Scenario – Severe Fire	2.05%	59.13%	See Table W-1a for risk insights. The LERF sequences are dominated by TI-SGTR resulting from fire induced loss of CV-1000 control circuits to cycle open the ERV and depressurize the RCS.	1.35E-03	1.33E-04	1.79E-07

Table W-1b – Fire PRA LERF Significant Fire Initiating Events (Individually Representing > 1% of the Calculated LERF)

Scenario	Description	Contribution		Risk insights	CLERP[1]	IF[2]	LERF[3]
		% of Total	Cumulative				
129-F-B-G/A	C10 (Green Train)	2.03%	61.16%	Panel C10 (Scenario 129-F-B-G/A) is the green train electrical auxiliary systems panel located on the back vertical board in the control room. Offsite power and the green train EDG are both unavailable due to fire damage. Red train power from the red train EDG and the AACDG are available as the primary power supplies. CFW has a redundant offsite power feed and is available along with the turbine driven EFW pump for primary to secondary heat removal. Red train HPI is available. The LERF sequences are dominated by TI-SGTR resulting from random loss of red train power needed to cycle open the ERV and depressurize the RCS.	2.09E-03	8.49E-05	1.78E-07
129-F-J/A	C01, C02, C03, C04, C09, C100	1.82%	62.98%	Scenario 129-F-J/A is the fire at the main control board in the control room. The CFW pump is the only source of feedwater for primary to secondary heat removal. The LERF sequences are dominated by TI-SGTR resulting from fire induced loss of red train power needed to cycle open the ERV and depressurize the RCS.	2.37E-02	6.72E-06	1.59E-07
110-L/A	Base scenario	1.43%	64.41%	See Table W-1a for risk insights. The LERF sequences are dominated by TI-SGTR resulting from fire induced loss of red train power needed to cycle open the ERV and depressurize the RCS.	1.34E-04	9.33E-04	1.25E-07
197-X- TN7/A	197-X- TN7 Transient Base Scenario	1.43%	65.84%	Scenario 197-X- TN7 is a large transient fire in the turbine building. A loss of offsite power is mitigated by the availability of both EDGs for backup power. The CFW pump or either EFW pump is available for primary to secondary heat removal. The LERF sequences are dominated by PI-SGTR resulting from fire induced failure to reduce pressure on the intact Steam Generator.	3.51E-05	3.56E-03	1.25E-07
99-M/HGL	Base Scenario – Severe Fire	1.38%	67.23%	See Table W-1a for risk insights.	2.24E-04	5.40E-04	1.21E-07
129-F-AU/A	C30	1.36%	68.59%	Panel C30 (Scenario 129-F-AU/A) is the balance of plant relay panel located in the electrical equipment area within the MCR. Offsite power is unavailable but both EDGs and the AACDG are available. The CFW pump or turbine driven pump is available for primary to secondary heat removal. HPI is also available. The LERF sequences are dominated by TI-SGTR resulting from fire induced loss of CV-1000 control circuits to cycle open the ERV and depressurize the RCS.	5.58E-04	2.14E-04	1.19E-07
97-R/A	Cable Spreading Room Only Fire	1.29%	69.88%	See Table W-1a for risk insights.	1.40E-02	8.00E-06	1.12E-07

Table W-1b – Fire PRA LERF Significant Fire Initiating Events (Individually Representing > 1% of the Calculated LERF)

Scenario	Description	Contribution		Risk insights	CLERP[1]	IF[2]	LERF[3]
		% of Total	Cumulative				
129-F-I/A	C19	1.19%	71.07%	Panel C19 (Scenario 129-F-I/A) is the plant auxiliary systems panel located on the back vertical board in the MCR. Offsite power and the AACDG are available, but the EDGs are failed due to fire damage. CFW is available along with the motor driven EFW pump for primary to secondary heat removal. SW and HPI are available. The LERF sequences are dominated by TI-SGTR resulting from random loss of red train power needed to cycle open the ERV and depressurize the RCS.	6.10E-04	1.71E-04	1.04E-07
104-S/HGL	Base Scenario – Severe Fire	1.09%	72.16%	See Table W-1a for risk insights.	3.16E-04	3.03E-04	9.57E-08

Notes:
[1] CLERP – Conditional Large Early Release Probability
[2] IF – Ignition Frequency (includes severity factor and probability of non-suppression, where applicable.)
[3] LERF – Large Early Release Frequency

Table W-2 – ANO-1 Fire Area Risk Summary

Fire Area	Area Description	NFPA 805 Basis	Fire Area CDF	Fire Area LERF	VFDR[1] (Yes/No)	RAs	Fire Risk Eval ΔCDF	Fire Risk Eval ΔLERF	Additional Risk of RAs (CDF/LERF)
A	10-EE, East Decay Heat Removal Pump Room	4.2.3.2	2.01E-09	4.50E-10	N	N/A	N/A	N/A	N/A
AAC	SBOD, Alternate Diesel Building	4.2.3.2	4.50E-09	3.15E-09	N	N/A	N/A	N/A	N/A
B-1@120-E	120-E, Boric Acid Addition Tank and Pump Room, 125-E, Respirator Storage Room, 128-E, Controlled Access Area, 149-E, Upper North Electrical Penetration Room, Hot Tool Room and Decontamination Room, 79-U, Upper North Piping Penetration Room	4.2.4.2	3.79E-06	4.00E-07	Y	N	5.45E-07	-7.18E-07	N/A
B-1@170-Z	170-Z, Steam Piping Area	4.2.4.2	5.00E-09	4.48E-09	Y	N	-3.01E-10	2.85E-09	N/A
B-1@40-Y	40-Y, Pipe Area	4.2.4.2	3.94E-09	9.66E-11	Y	N	3.68E-09	2.68E-11	N/A
B-1@73-W	73-W, Condensate Demineralizer Area	4.2.4.2	8.55E-07	4.46E-08	Y	N	-4.22E-06	-6.88E-07	N/A
B-1@BOFZ	157-B, Chemical Addition Area, 159-B, Spent Fuel Area, 160-B, Computer Room, 161-B, Ventilation Equipment Area, 163-B, Reactor Building Purge Room, 167-B, Computer Transformer Room, 168-B, Transformer Room, 175-CC, Lube Oil Storage Tank Room, 187-DD, Dirty & Clean Lube Oil Storage Tank Room, 197-X, Unit 1 Turbine Building, 2026-Y, Unit 1 Drumming Station, 75-AA, Boiler Room, 78-BB, Gas Bottle Storage Area	4.2.4.2	2.12E-06	3.79E-07	Y	Y	-1.29E-05	-5.28E-06	7.21E-07 / 3.96E-09
B-1@WHD	197-X, Unit 1 Turbine Building	4.2.4.2	4.73E-07	1.24E-07	Y	N	-2.45E-08	-8.68E-08	N/A

Table W-2 – ANO-1 Fire Area Risk Summary

Fire Area	Area Description	NFPA 805 Basis	Fire Area CDF	Fire Area LERF	VFDR[1] (Yes/No)	RAs	Fire Risk Eval ΔCDF	Fire Risk Eval ΔLERF	Additional Risk of RAs (CDF/LERF)
B-7	12-EE, Tendon Gallery Access Area, 14-EE, West Decay Heat Removal Pump Room, 4-EE, General Access Area	4.2.3.2	1.16E-08	5.50E-09	N	N	N/A	N/A	N/A
B-8@SEPR	104-S, Electrical Equipment Room, 105-T, Lower South Electrical Penetration Room, 144-D, Upper South Electrical Penetration Room, , 76-W, Compressor Room	4.2.4.2	1.36E-06	1.39E-07	Y	N	-4.90E-06	-8.54E-07	N/A
B-8@SPPR	46-Y, Lower South Piping Penetration Area, 77-V, Upper South Piping Penetration Room	4.2.4.2	3.77E-09	1.40E-09	Y	N	-3.41E-09	-1.37E-10	N/A
B-9	67-U, Lab And Demineralizer Access Area, 68-P, Reactor Coolant Makeup Tank Room, 88-Q, Communications Room, 89-P, Controlled Access Area	4.2.4.2	2.10E-07	8.89E-09	Y[1]	N	N/A	N/A	N/A
B-10	162-A, Stairwell Number 1	4.2.4.2	1.31E-10	8.41E-11	Y	N	-1.04E-10	-3.15E-11	N/A
C	20-Y, Radwaste Processing Area, 31-Y, Purification Demineralizer Area, 34-Y, Pipe Area, 38-Y, Emergency Feedwater Pump Area, 47-Y, Penetration Ventilation Area, 53-Y, Lower North Piping Penetration Area	4.2.4.2	1.66E-06	6.94E-08	Y	N	1.38E-06	2.90E-08	N/A
D	1-E, North Emergency Diesel Generator Exhaust Fans, 86-G, North Diesel Generator Room	4.2.3.2	1.18E-08	3.16E-09	N	N/A	N/A	N/A	N/A
E	100-N, South Switchgear Room	4.2.4.2	3.25E-06	1.19E-06	Y	N	-4.82E-06	-1.28E-06	N/A

Table W-2 – ANO-1 Fire Area Risk Summary

Fire Area	Area Description	NFPA 805 Basis	Fire Area CDF	Fire Area LERF	VFDR[1] (Yes/No)	RAs	Fire Risk Eval ΔCDF	Fire Risk Eval ΔLERF	Additional Risk of RAs (CDF/LERF)
F	110-L, South Battery Room	4.2.4.2	1.56E-06	1.75E-07	Y[1]	N	N/A	N/A	N/A
G	129-F, Unit 1 Control Room, 2098-C, Core Protection Calculator (CPC) Room, 2098-L, Cable Spreading Room, 2119-H, Records Storage, 2136-I, Health Physics, Corridor, 2137-I, Upper South Electrical Penetration Room and Hot Instrument Shop, 2150-C, Core Protection Calculator (CPC) Room, 2199-G, Control Room, 97-R, Cable Spreading Room and Relay Room	4.2.4.2	4.65E-05	3.68E-06	Y	Y	2.77E-05	-9.07E-07	3.07E-05 / 5.54E-07
H	2-E, South Emergency Diesel Generator Exhaust Fans, 87-H, South Diesel Generator Room	4.2.3.2	1.11E-07	1.12E-08	N	N/A	N/A	N/A	N/A
I-1	98-J, Access Corridor	4.2.4.2	2.60E-06	4.66E-07	Y	N	9.97E-07	-1.03E-07	N/A
I-2	99-M, North Switchgear Room	4.2.4.2	2.52E-06	6.40E-07	Y	N	-5.78E-06	-2.77E-06	N/A
I-3	112-I, Lower North Electrical Penetration Room	4.2.4.2	2.47E-07	4.68E-08	Y	N	1.92E-07	3.04E-08	N/A
J-NORTH	32-K, North Side Containment Building	4.2.4.2	2.96E-06	5.36E-07	Y[1]	N	N/A	N/A	N/A
J-SOUTH	33-K, South Side Containment Building	4.2.4.2	3.28E-06	3.78E-07	Y[1]	N	N/A	N/A	N/A
K	16-Y, Clean Waste Receiver Tank Area, 2020-JJ, BMS Holdup Tank Vault	4.2.3.2	1.41E-10	1.07E-10	N	N/A	N/A	N/A	N/A
L	TKVLT, Emergency Diesel Fuel Storage Vault	4.2.3.2	9.12E-08	7.67E-09	N	N/A	N/A	N/A	N/A

Table W-2 – ANO-1 Fire Area Risk Summary

Fire Area	Area Description	NFPA 805 Basis	Fire Area CDF	Fire Area LERF	VFDR[1] (Yes/No)	RAs	Fire Risk Eval ΔCDF	Fire Risk Eval ΔLERF	Additional Risk of RAs (CDF/LERF)
MH01	1MH01, Manholes	4.2.3.2	1.90E-09	4.69E-10	N	N/A	N/A	N/A	N/A
MH02	1MH02, Manholes	4.2.3.2	5.15E-08	5.19E-09	N	N/A	N/A	N/A	N/A
MH03	1MH03, Manholes	4.2.4.2	5.78E-07	7.84E-08	Y	N	5.57E-07	7.41E-08	N/A
MH04	1MH04, Manholes	4.2.3.2	4.55E-07	5.40E-08	N	N/A	N/A	N/A	N/A
MH05	1MH05, Manholes	4.2.4.2	5.78E-07	7.85E-08	Y	N	5.57E-07	7.41E-08	N/A
MH06	1MH06, Manholes	4.2.3.2	4.58E-07	5.44E-08	N	N/A	N/A	N/A	N/A
MH09	1MH09, Manholes	4.2.3.2	2.63E-08	2.21E-09	N	N/A	N/A	N/A	N/A
MH10	1MH10, Manholes	4.2.3.2	2.63E-08	2.21E-09	N	N/A	N/A	N/A	N/A
N	INTAKEU1, Intake Pump House Unit 1	4.2.4.2	7.52E-08	7.14E-09	Y	N	5.19E-08	-9.52E-10	N/A
O	95-O, North Battery Room	4.2.4.2	4.10E-08	4.71E-09	Y	N	-1.22E-08	-1.21E-08	N/A
YARD	YARD, Protected Area Outside Plant Inside Fence	4.2.3.2	4.99E-09	3.80E-09	N	N/A	N/A	N/A	N/A
Various	ANO-2 – Specific Fire Areas[2]	4.2.3.2	2.53E-07	1.36E-07	N	N/A	N/A	N/A	N/A
	Total		**7.62E-05**	**8.74E-06**			**-6.74E-07**	**-1.25E-05**	**3.14E-05 / 5.58E-07**

[1] In several areas, VFDRs exist, but are not linked to PRA components or basic events. In these cases no delta risk calculation was performed (as there is no delta to evaluate). An example of this may be heating, ventilation, and air conditioning (HVAC) components. In the deterministic realm the loss of HVAC to both trains of safe shutdown (SSD) equipment would be considered a VFDR. However, in a realistic PRA it may be shown that loss of HVAC does not prevent the equipment from performing its function during the mission time of the analysis, and therefore the HVAC components would not be modeled in the PRA. Another example of this is equipment required for the transition to cold shutdown. Such items may have VFDRs associated with them, but are outside the scope of PRA as cold shutdown is beyond the 24-hour mission time.

[2] ANO-2 specific fire areas were conservatively assessed to contribute to the ANO-1 CDF/LERF from fires originating in areas that are not associated with ANO-1 or are not considered common areas. Fires in these areas typically do not impact circuits for ANO-1 components and are not expected to cause, or require, an ANO-1 plant trip. However, since the two units are adjacent, there is the potential that cables for shared components or ANO-1 cables with unknown routing are routed through ANO-2 specific fire areas. Therefore, the fire risk in each of the ANO-2 specific fire areas was quantified to assess the impact of loss of cabling in these areas on ANO-1 and the results were summed to provide the values. The risk values were calculated with the conservative assumption that a fire in each of these areas would result in a trip of ANO-1. Fires in the ANO-2 specific fire zones within Fire Area G (2098-C, 2098-L, 2119-H, 2136-I, 2137-I, 2150-C, and 2199-G) are not included in this value since these are included in the Fire Area G results.

Attachment 8 to

1CAN031602

Updated Enclosure 2
Proposed Operating License and Technical Specification Changes (mark-up)

(8) <u>Fire Protection</u>

Entergy Operations, Inc.~~EOI~~ shall implement and maintain in effect all provisions of the approved f~~F~~ire p~~P~~rotection p~~P~~rogram ~~as described in Appendix 9A to the SAR and as approved in the Safety Evaluation dated March 31, 1992, subject to the following provision:~~that comply with 10 CFR 50.48(a) and 10 CFR 50.48(c), as specified in the licensee amendment request dated January 29, 2014, and supplements dated May 19, 2015, June 16, 2015, July 21, 2015, August 12, 2015, September 22, 2015, November 4, 2015, November 17, 2015, January 15, 2016, March 25, 2016, and April 7, 2016, and as approved in the SE dated ___________. Except where NRC approval for changes or deviations is required by 10 CFR 50.48(c), and provided no other regulation, technical specification, license condition or requirement would require prior NRC approval,

~~1. AP&L[1] may proceed with and is required to complete the modifications identified in Paragraphs 3.1 through 3.19 of the NRC's Fire Protection Safety Evaluation on the facility dated August 22, 1978, and supplements thereto. These modifications shall be completed as specified in Table 3.1 of the Safety Evaluation Report or supplements thereto. In addition, the licensee may proceed with and is required to complete the modifications identified in Supplement 1 to the Fire Protection Safety Evaluation Report, and any future supplements. These modifications shall be completed by the dates identified in the supplement.~~

~~2. T~~the licensee may make changes to the ~~approved~~ f~~F~~ire p~~P~~rotection p~~P~~rogram without prior approval of the Commission ~~only~~ if those changes satisfy the provisions set forth in 10 CFR 50.48(a) and 10 CFR 50.48(c), the change does not require a change to a technical specification or a license condition, and the criteria listed below are satisfied~~would not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire~~.

<u>Risk-Informed Changes that may be Made Without Prior NRC Approval</u>

A risk assessment of the change must demonstrate that the acceptance criteria below are met. The risk assessment approach, methods, and data shall be acceptable to the NRC and shall be appropriate for the nature and scope of the change being evaluated; be based on the as-built, as-operated, and maintained plant; and reflect the operating experience at ANO-1. Acceptable methods to assess the risk of the change may include methods that have been used in the peer-reviewed fire PRA model, methods that have been approved by NRC through a plant-specific license amendment or NRC approval of generic methods specifically for use in NFPA 805 risk assessments, or methods that have been demonstrated to bound the risk impact.

~~[1] The Original licensee authorized to possess, use, and operate the facility was AP&L. Consequently, certain historical references to AP&L remain in the license conditions.~~

1. Prior NRC review and approval is not required for changes that clearly result in a decrease in risk. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

2. Prior NRC review and approval is not required for individual changes that result in a risk increase less than 1×10^{-7}/year (yr) for CDF and less than 1×10^{-8}/yr for LERF. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

Moved to Page 7

(9) Mitigation Strategies

The licensee shall develop and maintain strategies for addressing large fires and explosions that include the following key areas:

1. Fire fighting response strategy with the following elements:

   (a) Pre-defined coordinated fire response strategy and guidance
   (b) Assessment of mutual aid fire fighting assets
   (c) Designated staging areas for equipment and materials
   (d) Command and control
   (e) Training of response personnel

2. Operations to mitigate fuel damage considering the following:

   (a) Protection and use of personnel assets
   (b) Communications
   (c) Minimizing fire spread
   (d) Procedures for implementing integrated fire response strategy
   (e) Identification of readily-available pre-staged equipment
   (f) Training on integrated fire response strategy
   (g) Spent fuel pool mitigation measures

3. Actions to minimize release to include consideration of:

   (a) Water spray scrubbing
   (b) Dose to onsite responders

~~[1] The Original licensee authorized to possess, use, and operate the facility was AP&L. Consequently, certain historical references to AP&L remain in the license conditions.~~

Other Changes that may be Made Without Prior NRC Approval

1. Changes to NFPA 805, Chapter 3, Fundamental Fire Protection Program

   Prior NRC review and approval are not required for changes to the NFPA 805, Chapter 3, fundamental fire protection program elements and design requirements for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is functionally equivalent or adequate for the hazard. The licensee may use an engineering evaluation to demonstrate that a change to NFPA 805, Chapter 3 element is functionally equivalent to the corresponding technical requirement. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard.

   The licensee may use an engineering evaluation to demonstrate that changes to certain NFPA 805, Chapter 3 elements are acceptable because the alternative is “adequate for the hazard.” Prior NRC review and approval would not be required for alternatives to four specific sections of NFPA 805, Chapter 3, for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is adequate for the hazard. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard. The four specific sections of NFPA 805, Chapter 3, are as follows:

   - Fire Alarm and Detection Systems (Section 3.8);
   - Automatic and Manual Water-Based Fire Suppression Systems (Section 3.9);
   - Gaseous Fire Suppression Systems (Section 3.10); and,
   - Passive Fire Protection Features (Section 3.11).

2. Fire Protection Program Changes that have No More than Minimal Risk Impact

   Prior NRC review and approval are not required for changes to the licensee’s fire protection program that have been demonstrated to have no more than a minimal risk impact. The licensee may use its screening process as approved in the NRC SE dated ___________ to determine that certain fire protection program changes meet the minimal criterion. The licensee shall ensure that fire protection defense-in-depth and safety margins are maintained when changes are made to the fire protection program.

Moved to Page 8

(10) Upon implementation of Amendment 239 adopting TSTF-448, Revision 3, the determination of control room envelope (CRE) unfiltered air inleakage as required by SR 3.7.9.4, in accordance with Specifications 5.5.5.c.(i), 5.5.5.c.(ii), and 5.5.5.d, shall be considered met. Following implementation:

1. The first performance of SR 3.7.9.4, in accordance with Specification 5.5.5.c.(i), shall be within 15 months of the approval of TSTF-448. SR 3.0.2 will not be applicable to this first performance.

2. The first performance of the periodic assessment of CRE habitability, Specification 5.5.5.c.(ii), shall be within 15 months of the approval of TSTF-448. SR 3.0.2 will not be applicable to this first performance.

3. The first performance of the periodic measurement of CRE pressure, Specification 5.5.5.d, shall be within 15 months of the approval of TSTF-448. SR 3.0.2 will not be applicable to this first performance.

3. This renewed license is effective as of the date of issuance and shall expire at midnight, May 20, 2034.

FOR THE NUCLEAR REGULATORY COMMISSION

Original Signed by:
Jon R. Johnson

Jon R. Johnson, Acting Director
Office of Nuclear Reactor Regulation

Attachment:
Appendix A - Technical Specifications and
Technical Specifications Bases (ML011710071 and ML011710100)

Date of Issuance: June 20, 2001

Transition License Conditions

1. Before achieving full compliance with 10 CFR 50.48(c), as specified by 2. below, risk-informed changes to the Entergy Operations, Inc. fire protection program may not be made without prior NRC review and approval unless the change has been demonstrated to have no more than a minimal risk impact, as described in 2. above.

2. The licensee shall implement the modifications to its facility, as described in Table S-1, “Plant Modifications,” Attachment S, of Entergy Operations, Inc. letter 1CAN031602, dated March 25, 2016, prior to startup from the second refueling outage following issuance of the Safety Evaluation. The licensee shall maintain appropriate compensatory measures in place until completion of the modifications.

3. The licensee shall complete the implementation items as listed in Table S-2, “Implementation Items,” Attachment S, of Entergy Operations, Inc. letter 1CAN031602, dated March 25, 2016, within six months after issuance of the Safety Evaluation.

(9) Mitigation Strategies

From Page 5

The licensee shall develop and maintain strategies for addressing large fires and explosions that include the following key areas:

1. Fire fighting response strategy with the following elements:

   (a) Pre-defined coordinated fire response strategy and guidance
   (b) Assessment of mutual aid fire fighting assets
   (c) Designated staging areas for equipment and materials
   (d) Command and control
   (e) Training of response personnel

2. Operations to mitigate fuel damage considering the following:

   (a) Protection and use of personnel assets
   (b) Communications
   (c) Minimizing fire spread
   (d) Procedures for implementing integrated fire response strategy
   (e) Identification of readily-available pre-staged equipment
   (f) Training on integrated fire response strategy
   (g) Spent fuel pool mitigation measures

3. Actions to minimize release to include consideration of:

   (a) Water spray scrubbing
   (b) Dose to onsite responders

From Page 6

(10) Upon implementation of Amendment 239 adopting TSTF-448, Revision 3, the determination of control room envelope (CRE) unfiltered air inleakage as required by SR 3.7.9.4, in accordance with Specifications 5.5.5.c.(i), 5.5.5.c.(ii), and 5.5.5.d, shall be considered met. Following implementation:

1. The first performance of SR 3.7.9.4, in accordance with Specification 5.5.5.c.(i), shall be within 15 months of the approval of TSTF-448. SR 3.0.2 will not be applicable to this first performance.

2. The first performance of the periodic assessment of CRE habitability, Specification 5.5.5.c.(ii), shall be within 15 months of the approval of TSTF-448. SR 3.0.2 will not be applicable to this first performance.

3. The first performance of the periodic measurement of CRE pressure, Specification 5.5.5.d, shall be within 15 months of the approval of TSTF-448. SR 3.0.2 will not be applicable to this first performance.

3. This renewed license is effective as of the date of issuance and shall expire at midnight, May 20, 2034.

FOR THE NUCLEAR REGULATORY COMMISSION

Original Signed by:
Jon R. Johnson

Jon R. Johnson, Acting Director
Office of Nuclear Reactor Regulation

Attachment:
Appendix A - Technical Specifications and Technical Specifications Bases (ML011710071 and ML011710100)

Date of Issuance: June 20, 2001

Attachment 9 to

1CAN031602

Updated Enclosure 3
Revised Operating License and Technical Specification Pages

(8) Fire Protection

Entergy Operations, Inc. shall implement and maintain in effect all provisions of the approved fire protection program that comply with 10 CFR 50.48(a) and 10 CFR 50.48(c), as specified in the licensee amendment request dated January 29, 2014, and supplements dated May 19, 2015, June 16, 2015, July 21, 2015, August 12, 2015, September 22, 2015, November 4, 2015, November 17, 2015, January 15, 2016, March 25, 2016, and April 7, 2016, and as approved in the SE dated ___________. Except where NRC approval for changes or deviations is required by 10 CFR 50.48(c), and provided no other regulation, technical specification, license condition or requirement would require prior NRC approval,

Risk-Informed Changes that may be Made Without Prior NRC Approval

A risk assessment of the change must demonstrate that the acceptance criteria below are met. The risk assessment approach, methods, and data shall be acceptable to the NRC and shall be appropriate for the nature and scope of the change being evaluated; be based on the as-built, as-operated, and maintained plant; and reflect the operating experience at ANO-1. Acceptable methods to assess the risk of the change may include methods that have been used in the peer-reviewed fire PRA model, methods that have been approved by NRC through a plant-specific license amendment or NRC approval of generic methods specifically for use in NFPA 805 risk assessments, or methods that have been demonstrated to bound the risk impact.

1. Prior NRC review and approval is not required for changes that clearly result in a decrease in risk. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

2. Prior NRC review and approval is not required for individual changes that result in a risk increase less than 1×10^{-7}/year (yr) for CDF and less than 1×10^{-8}/yr for LERF. The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins. The change may be implemented following completion of the plant change evaluation.

Other Changes that may be Made Without Prior NRC Approval

1. Changes to NFPA 805, Chapter 3, Fundamental Fire Protection Program

   Prior NRC review and approval are not required for changes to the NFPA 805, Chapter 3, fundamental fire protection program elements and design requirements for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is functionally equivalent or adequate for the hazard. The licensee may use an engineering evaluation to demonstrate that a change to NFPA 805, Chapter 3 element is functionally equivalent to the corresponding technical requirement. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard.

   The licensee may use an engineering evaluation to demonstrate that changes to certain NFPA 805, Chapter 3 elements are acceptable because the alternative is "adequate for the hazard." Prior NRC review and approval would not be required for alternatives to four specific sections of NFPA 805, Chapter 3, for which an engineering evaluation demonstrates that the alternative to the Chapter 3 element is adequate for the hazard. A qualified fire protection engineer shall perform the engineering evaluation and conclude that the change has not affected the functionality of the component, system, procedure, or physical arrangement, using a relevant technical requirement or standard. The four specific sections of NFPA 805, Chapter 3, are as follows:

   - Fire Alarm and Detection Systems (Section 3.8);
   - Automatic and Manual Water-Based Fire Suppression Systems (Section 3.9);
   - Gaseous Fire Suppression Systems (Section 3.10); and,
   - Passive Fire Protection Features (Section 3.11).

2. Fire Protection Program Changes that have No More than Minimal Risk Impact

   Prior NRC review and approval are not required for changes to the licensee's fire protection program that have been demonstrated to have no more than a minimal risk impact. The licensee may use its screening process as approved in the NRC SE dated ___________ to determine that certain fire protection program changes meet the minimal criterion. The licensee shall ensure that fire protection defense-in-depth and safety margins are maintained when changes are made to the fire protection program.

Transition License Conditions

1. Before achieving full compliance with 10 CFR 50.48(c), as specified by 2. below, risk-informed changes to the Entergy Operations, Inc. fire protection program may not be made without prior NRC review and approval unless the change has been demonstrated to have no more than a minimal risk impact, as described in 2. above.

2. The licensee shall implement the modifications to its facility, as described in Table S-1, “Plant Modifications,” Attachment S, of Entergy Operations, Inc. letter 1CAN031602, dated March 25, 2016, prior to startup from the second refueling outage following issuance of the Safety Evaluation. The licensee shall maintain appropriate compensatory measures in place until completion of the modifications.

3. The licensee shall complete the implementation items as listed in Table S-2, “Implementation Items,” Attachment S, of Entergy Operations, Inc. letter 1CAN031602, dated March 25, 2016, within six months after issuance of the Safety Evaluation.

(9) Mitigation Strategies

The licensee shall develop and maintain strategies for addressing large fires and explosions that include the following key areas:

1. Fire fighting response strategy with the following elements:

   (a) Pre-defined coordinated fire response strategy and guidance
   (b) Assessment of mutual aid fire fighting assets
   (c) Designated staging areas for equipment and materials
   (d) Command and control
   (e) Training of response personnel

2. Operations to mitigate fuel damage considering the following:

   (a) Protection and use of personnel assets
   (b) Communications
   (c) Minimizing fire spread
   (d) Procedures for implementing integrated fire response strategy
   (e) Identification of readily-available pre-staged equipment
   (f) Training on integrated fire response strategy
   (g) Spent fuel pool mitigation measures

3. Actions to minimize release to include consideration of:

   (a) Water spray scrubbing
   (b) Dose to onsite responders

(10) Upon implementation of Amendment 239 adopting TSTF-448, Revision 3, the determination of control room envelope (CRE) unfiltered air inleakage as required by SR 3.7.9.4, in accordance with Specifications 5.5.5.c.(i), 5.5.5.c.(ii), and 5.5.5.d, shall be considered met. Following implementation:

1. The first performance of SR 3.7.9.4, in accordance with Specification 5.5.5.c.(i), shall be within 15 months of the approval of TSTF-448. SR 3.0.2 will not be applicable to this first performance.

2. The first performance of the periodic assessment of CRE habitability, Specification 5.5.5.c.(ii), shall be within 15 months of the approval of TSTF-448. SR 3.0.2 will not be applicable to this first performance.

3. The first performance of the periodic measurement of CRE pressure, Specification 5.5.5.d, shall be within 15 months of the approval of TSTF-448. SR 3.0.2 will not be applicable to this first performance.

3. This renewed license is effective as of the date of issuance and shall expire at midnight, May 20, 2034.

FOR THE NUCLEAR REGULATORY COMMISSION

Original Signed by:
Jon R. Johnson

Jon R. Johnson, Acting Director
Office of Nuclear Reactor Regulation

Attachment:
Appendix A - Technical Specifications and
Technical Specifications Bases (ML011710071 and ML011710100)

Date of Issuance: June 20, 2001