Entergy Operations, Inc.
1448 S.R. 333
Russellville, AR 72802
Tel 479-858-3110

Jeremy G. Browning
Vice President - Operations
Arkansas Nuclear One

1CAN061501

June 16, 2015

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

SUBJECT: 60-Day Response to Request for Additional Information
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 letter dated May 5, 2015 (Reference 2), the NRC requested additional information 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, probabilistic risk assessment (PRA), change evaluations, proposed modifications for non-compliances, and supporting attachments.

Based on the complexity of the questions included in the Reference 2 letter, the NRC established response due-dates of 30, 60, 90, or 120 days, from the date of the ANO-1 NFPA 805 Audit Exit Meeting, April 23, 2015. Responses to the 30-day RAIs were included in Reference 3 along with one 60-day RAI (SSA RAI 02). Enclosed are responses to the remaining 60-day RAIs. In addition, two 90-day responses, Fire Modeling (FM) RAI 03 and PRA RAI 02.c, are included in this letter.

Changes or additional information, as detailed in this letter, with respect to the original Entergy request (Reference 1) have been reviewed and Entergy has determined that the changes do 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.

No new commitments have been identified in this letter.

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 June 16, 2015.

Sincerely,

ORIGINAL SIGNED BY JEREMY G. BROWNING

JGB/dbb

Attachment: 60-day Responses to Request for Additional Information – ANO-1 Transition to NFPA-805

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)

cc: Mr. Marc L. Dapas
Regional Administrator
U. S. Nuclear Regulatory Commission
Region IV
1600 East Lamar Boulevard
Arlington, TX 76011-4511

NRC Senior Resident Inspector
Arkansas Nuclear One
P. O. Box 310
London, AR 72847

U. S. Nuclear Regulatory Commission
Attn: Ms. Andrea E. George
MS O-8B1
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Mr. Bernard R. Bevill
Arkansas Department of Health
Radiation Control Section
4815 West Markham Street
Slot #30
Little Rock, AR 72205

Attachment 1 to

1CAN061501

60-day Responses to Request for Additional Information
ANO-1 Transition to NFPA-805

60-DAY RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
ANO-1 Transition to NFPA-805

By letter dated May 5, 2015 (Reference 2), the NRC requested additional information associated with the Entergy Operations, Inc. (Entergy) request (Reference 1) to transition the Arkansas Nuclear One, Unit 1 (ANO-1), fire protection licensing basis to National Fire Protection Association (NFPA) Standard NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants (2001 Edition)*. Included below are Entergy responses to all questions requiring a 60-day response with respect to the *request for additional information* (RAI) (Reference 2). In addition, two 90-day responses, Fire Modeling (FM) RAI 03 and PRA RAI 02.c, are included in this letter.

Fire Protection Engineering (FPE)

Note: Responses to FPE RAIs 02, 03, 05, and 08 were provided in Entergy's 30-day letter (Reference 3). FPE RAI 07 is expected to be addressed in the 90-day RAI response.

FPE RAI 01

The LAR Attachment A, cites previous NRC approval as the compliance strategy for several elements of Chapter 3 of NFPA 805. The compliance basis statements for these previously approved elements do not clearly state that the basis for the previous approval remains valid per the guidance in Section 2.3.1 of Regulatory Guide (RG) 1.205, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants," December 2009 (ADAMS Accession No. ML092730314) and Nuclear Energy Institute (NEI) 04-02, "Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program Under 10 CFR 50.48(c)," Revision 2, April 2008 (ADAMS Accession No. ML081130188).

Please confirm the continued validity of the bases for the previous approvals and include a discussion of any changes or modifications that have been made to the plant that may impact the bases for the previous approvals.

Response

The elements of NFPA 805, Chapter 3, that cite "Complies by previous NRC approval" as the compliance strategy have been reviewed to determine if any changes or modifications have been made that would impact the bases for the previous approvals. The configuration of the affected NFPA 805 Chapter 3 elements with the exception of NFPA 805, Chapter 3, Section 3.3.12, have not been modified since the associated NRC documentation evaluated the NFPA 805, Chapter 3 elements. The cited NRC documentation remains valid for the LAR, Attachment A, elements with the exception of NFPA 805, Chapter 3, Section 3.3.12, with no identified changes or modifications that invalidate the original approval bases.

As reflected in Attachment K, Appendix R, Exemption 19, RCP Oil Collection System, Not Meeting III.O Criteria, and clarified in Attachment T of the original license amendment request, modifications associated with the Reactor Coolant Pump (RCP) lube oil collection system have been implemented since the original exemption was granted. Entergy believes the original basis for the above exemption is maintained (i.e., the single difference being that the tanks will not hold the total oil volume from one RCP without minor spillage into the curbed area).

The plant modification process employed at ANO is highly robust and considers impacts on the current licensing basis, such as the basis for past NRC exemption approvals. Each change is reviewed in accordance with the requirements of 10 CFR 50.59 to ensure the current plant licensing basis remains valid. As a result, the basis for the exemption approvals remains valid.

<u>FPE RAI 04</u>

LAR Section 4.1.1, "Overview of Evaluation Process" states, in part:

> Each section and subsection of NFPA 805 Chapter 3 was reviewed against the current fire protection program. Upon completion of the activities associated with the review, the following compliance statement(s) was used:
>
> - Complies - For those sections/subsections determined to meet the specific requirements of NFPA 805.
> - Complies with use of Existing Engineering Equivalency Evaluations (EEEEs) - For those sections/subsections determined to be equivalent to the NFPA 805 Chapter 3 requirements as documented by engineering analysis.

In LAR Attachment A, the compliance statement for certain NFPA 805, Chapter 3 sections (for example, 3.4.3(c)), is "Complies" and the Compliance Basis states, for example, "This requirement was evaluated by NFPA 600 Code Compliance Evaluation." For other NFPA 805 Chapter 3 sections (for example, 3.5.10), the compliance statement is "Complies with EEEE," and the Compliance Basis states, for example, "This requirement was evaluated by NFPA 24 Code Compliance Evaluation."

Please confirm that those elements associated with the "Complies" statements, and that describe the compliance basis as a Code Evaluation, have been determined to meet all applicable codes or compliance standards as determined by the referenced code evaluation.

Response

The code compliance evaluations associated with the NFPA 805 Chapter 3 sections listed in the LAR Attachment A that utilize a Compliance Statement of 'Complies' and describe the compliance basis as a code evaluation were reviewed to determine if the code compliance evaluations were fully compliant. The review determined the following LAR Attachment A sections are associated with code compliance evaluations that are not fully compliant (i.e., Justified Compliance is utilized):

3.4.1(a)	3.4.3(c)(1)	3.5.5	3.9.5
3.4.1(a)(1)	3.4.3(c)(2)	3.5.6	3.10.1
3.4.3	3.4.3(c)(3)	3.5.7	3.10.1(2)
3.4.3(a)(1)	3.4.3(c)(4)	3.5.8	3.10.2
3.4.3(a)(2)	3.4.3(c)(5)	3.5.9	3.10.3
3.4.3(a)(3)	3.4.4	3.6.2	3.10.5
3.4.3(a)(4)	3.5.4	3.6.3	3.10.9
			3.10.10

The Compliance Statement for the listed sections should be changed from ‘Complies’ to ‘Complies with use of EEEEs’.

Code Compliance Evaluations were performed for the following NFPA 805 Chapter 3 sections and not included in the Compliance Basis section:

3.4.1(b)	Add CALC-ANOC-FP-08-00005
3.4.1(c)	Add CALC-ANOC-FP-08-00005
3.4.1(d)	Add CALC-ANOC-FP-08-00005
3.4.1(e)	Add CALC-ANOC-FP-08-00005
3.9.2	Add CALC-ANOC-FP-09-00013, CALC-ANO1-FP-09-00006, and CALC-ANO1-FP-09-00007
3.9.3	Add CALC-ANOC-FP-09-00013, CALC-ANO1-FP-09-00006, and CALC-ANO1-FP-09-00007

The Compliance Statement for the listed sections should be changed from “Complies” to “Complies with use of EEEEs.”

With regard to the above reviews and changes, the Compliance Statement for several of the NFPA 805 Chapter 3 sections stated “Complies” and referenced an ANO Code Compliance Report. When performing the initial Code Compliance Reports, in some instances (but not all) “Justified Compliance” was used for the code section compliance bases. In support of this RAI response, the use of ‘Justified Compliance’ has been conservatively interpreted as use of EEEEs. Therefore, Entergy requests the NRC utilize the revised classifications reflected above in lieu of those contained in the original LAR to complete the review of the ANO-1 NFPA 805 application.

<u>FPE RAI 06</u>

LAR Section 4.1.1, "Overview of Evaluation Process," states, in part:

> Each section and subsection of NFPA 805 Chapter 3 was reviewed against the current fire protection program. Upon completion of the activities associated with the review, the following compliance statement(s) was used:
>
> - Complies by previous NRC approval - For those sections/subsections where the specific NFPA 805 Chapter 3 requirements are not met but previous NRC approval of the configuration exists.
>
> - Complies with use of Existing Engineering Equivalency Evaluations (EEEEs) - For those sections/subsections determined to be equivalent to the NFPA 805 Chapter 3 requirements as documented by engineering analysis.

In LAR Attachment A, the compliance statements for NFPA 805 Sections 3.9.5, 3.11.2, and 3.11.4 is "Complies with EEEE," but the Compliance Basis includes a citation or discussion of previous NRC approval and references the original Safety Evaluation Report dated August 22, 1978 (ADAMS Accession No. ML021210569).

Please clarify the compliance strategy for these elements of NFPA 805 Chapter 3, including what portion, if any, is based on previous NRC approval.

Response

The Compliance Statement or Basis provided below should be used in LAR Attachment A for the following sections of NFPA 805 Chapter 3. Entergy requests the NRC utilize the revised information reflected below in lieu of that contained in the original LAR in completing the review of the ANO-1 NFPA 805 application. The NFPA 805 sections for which the Compliance Statement is being revised from “Complies” to “Complies with use of EEEEs” were previously addressed in FPE RAI 04.

Section 3.5.4

NFPA 20 provides rated capacities for pumping rate and pressure for standard pumps. The ANO fire pumps are standard pumps rated at 2500 gpm and 125 psia. These capacities meet or exceed NFPA 20 requirements. The pump configuration and capacities have also been previously evaluated by the NRC (NRC letter to Entergy dated August 22, 1978, “ANO-1 Fire Protection Safety Evaluation Report (SER) Amendment 35 (1CNA087810)). The Code Compliance Evaluation for NFPA 20 contains “Justified Compliances.”

The Compliance Statement should be revised to state: “Complies with use of EEEEs.”

The Compliance Basis should be revised to state:

> “This requirement was evaluated by NFPA 20 Code Compliance Evaluation. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance.”

Section 3.5.5

NFPA 20 provides requirements for room location and room construction. The ANO configuration meets or exceeds NFPA 20 requirements. The location of the pumps and separation criteria has been previously approved by the NRC via SER Amendment 35. The Code Compliance Evaluation for NFPA 20 contains “Justified Compliances.”

The Compliance Statement should be revised to state: “Complies with use of EEEEs.”

The Compliance Basis should be revised to state:

> ”This requirement was evaluated by NFPA 20 Code Compliance Evaluation. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance.”

Section 3.5.6

NFPA 20 provides requirements for water pressure control using a pressure switch responsive to water pressure in the fire system and that interfaces with the pump control circuit. The ANO configuration meets or exceeds NFPA 20 requirements. The ability for the fire pumps to automatically start on system low pressure and operate until manually secured has been previously evaluated by the NRC via SER Amendment 35. The Code Compliance Evaluation for NFPA 20 contains “Justified Compliances.”

The Compliance Statement should be revised to state: “Complies with use of EEEEs.”

The Compliance Basis should be revised to state:

> ”This requirement was evaluated by NFPA 20 Code Compliance Evaluation. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance.”

Section 3.5.7

NFPA 20 discusses discharge header and isolation valves. NFPA 24 discusses “Sectional Valves.” The configuration meets or exceeds NFPA requirements. The fire water piping system has been previously evaluated by the NRC via SER Amendment 35. The NRC evaluation is detailed as to the piping system description.

The Compliance Statement should be revised to state: “Complies by previous NRC approval.”

The Reference Documents should be revised to add:

> “CALC-ANOC-FP-09-00015, ANO Code Compliance Report for NFPA 24 1995 Edition.”

Section 3.5.8

NFPA 20 discusses the use of an automatic pressure maintenance pump to maintain relatively high pressure on the fire protection system. The pump should be sized to maintain the desired pressure against the leakage in the system as approved by the AHJ.

The ANO configuration meets or exceeds NFPA 20 requirements. The ability to maintain pressure on the fire protection system with a jockey pump has been previously evaluated by the NRC via SER Amendment 35. The Code Compliance Evaluation for NFPA 20 contains “Justified Compliances.”

The Compliance Statement should be revised to state: “Complies with use of EEEEs.”

The Compliance Basis should be revised to state:

> “This requirement was evaluated by NFPA 20 Code Compliance Evaluation. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance.”

Section 3.5.10

NFPA 24 discusses underground pipe and fittings. The details of the system design and subsequent acceptability has been previously evaluated by the NRC via SER Amendment 35. The Code Compliance Evaluation for NFPA 20 contains “Justified Compliances.”

The Compliance Basis should be revised to state:

"This requirement was evaluated by NFPA 24 Code Compliance Evaluation. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance."

Section 3.6.1

NFPA 14 provides requirements for the three classes of standpipe and hose systems. The ANO configuration meets or exceeds requirements for NFPA 14 Class II systems. The NRC approved the use of hose stations with 1½ fire hose which is consistent with Class II systems.

The Compliance Statement should be revised to state: "Complies with Clarification."

The Compliance Basis should be revised to state:

"This requirement was evaluated by NFPA14 Code Compliance Evaluation. The ANO-1 standpipe and hose systems are considered Class II and have been evaluated for acceptability. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance."

Section 3.6.2

NFPA 14 provides requirements for minimum water supply at the hydraulically most remote hose connection outlet. The ANO configuration for the hose stations meets or exceeds the NFPA 14 requirements. The Code Compliance Evaluation for NFPA 14 contains "Justified Compliances."

The Compliance Statement should be revised to state: "Complies with use of EEEEs."

The Compliance Basis should be revised to state:

"This requirement was evaluated by NFPA 14 Code Compliance Evaluation. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance."

The Reference Documents should be revised to remove reference to ANO-1 License Amendment 43.

Section 3.6.3

NFPA 14 provides requirements for hose nozzles. The ANO configuration meets or exceeds the NFPA 14 requirements. A general discussion of fire hose nozzles was evaluated by the NRC via SER Amendment 35.

The Compliance Statement should be revised to state: "Complies with use of EEEEs."

The Compliance Basis should be revised to state:

"This requirement was evaluated by NFPA 14 Code Compliance Evaluation. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance."

Section 3.7

The ANO configuration meets or exceeds NFPA 10 requirements. A general discussion of fire extinguishers was evaluated by the NRC via SER Amendment 35. The Code Compliance Evaluation for NFPA 10 contains “Justified Compliances.”

The Compliance Basis should be revised to state:

> “This requirement was evaluated by NFPA 10 Code Compliance Evaluation. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance.
>
> See implementation item in Attachment S”

Section 3.8.1

NFPA 72/72A/72D/72E provides requirements for alarm initiating devices. The ANO configuration meets or exceeds NFPA 72/72A/72D/72E requirements. The NRC SER for Amendment 35 provides a general statement about the alarm and signaling systems. The Code Compliance Evaluation for NFPA 20 contains “Justified Compliances.”

The Compliance Basis should be revised to state:

> “This requirement was evaluated by NFPA 72 Code Compliance Evaluation. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance.”

Section 3.9.5

NFPA 24 provides requirements for the installation of fire service mains and their appurtenances. The ANO configuration meets or exceeds NFPA 24 requirements. The NRC SER for Amendment 35 provides a summary about the fire water piping and valving configuration. The Code Compliance Evaluation for NFPA 24 contains “Justified Compliances.”

The Compliance Statement should be revised to state: “Complies with use of EEEEs.”

The Compliance Basis should be revised to state:

> “This requirement was evaluated by NFPA 24 Code Compliance Evaluation. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance.”

Section 3.10.1

NFPA 12A provides requirements for the Halon gaseous fire suppression system utilized in the ANO-1 Control Room. The ANO configuration meets or exceeds the requirements of NFPA 12A. The NRC SER for Amendment 35 provides a summary about the Gas Fire Suppression System configuration. The Code Compliance Evaluation for NFPA 12A contains “Justified Compliances.”

The Compliance Statement should be revised to state: "Complies with use of EEEEs."

The Compliance Basis should be revised to state:

> "This requirement was evaluated by NFPA 12A Code Compliance Evaluation. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance."

Section 3.11.2

Engineering Changes EC-1527 and EC-1956 provide requirements for the fire barriers utilized in ANO-1. The NRC SER Amendment 35 provides a summary about the ANO-1 fire barriers and should be considered For Information Only.

The Compliance Basis should be revised to state:

> "This requirement was evaluated by EC1527 and EC1956. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance."

The Reference Documents should be revised to add:

> "EC-1527, Provide As-Built FB Drawings for NRC Rated Barriers."

Section 3.11.3

The ANO configuration meets or exceeds the requirements of NFPA 80 and NFPA 90A. Fire barrier penetrations have been previously evaluated by the NRC via SER Amendment 35.

The Compliance Basis should be revised to state:

> "ANO complies with clarification in regards to NFPA 101 in that the features referenced in NFPA 101 are documented in the NFPA 80 and 90A Code Compliance Evaluations. NFPA 101, Section 8.2.3.2.1(a), with regards to rated fire door assemblies, refers to NFPA 80. NFPA 101, Section 9.2.1, with regards to rated fire dampers, refers to NFPA 90A. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance."

Section 3.11.4

The ANO configurations have been previously evaluated by EEEEs. The NRC SER for Amendment 35 provides a summary about the ANO-1 fire penetration fire stops and does not support compliance.

The Compliance Basis should be revised to state:

> "Through Penetration Stops have either been confirmed against a fire tested configuration or have been evaluated by EEEEs which are documented in Table B-3 by fire area. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance."

Section 3.11.4(a)

The ANO configurations have been previously evaluated by EEEEs. The NRC SER for Amendment 35 provides a summary about the ANO-1 fire penetration annular fire stops and does not support compliance.

The Compliance Basis should be revised to state:

> "Through Penetration Stops have either been confirmed against a fire tested configuration or have been evaluated by EEEEs which are documented in Table B-3 by fire area. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance."

Section 3.11.4(b)

The ANO configurations have been previously evaluated by EEEEs. The NRC SER for Amendment 35 provides a summary about the ANO-1 fire penetration conduit fire seals and does not support compliance.

The Compliance Basis should be revised to state:

> "Through Penetration Stops have either been confirmed against a fire tested configuration or have been evaluated by EEEEs which are documented in Table B-3 by fire area. The ANO-1 License Amendment 35 SER is considered For Information Only and does not support compliance."

Safe Shutdown Analysis (SSA)

Note: Responses to 30-day SSA RAIs 01, 03, 04, 05 and 60-day SSA RAI 02 were submitted in Entergy letter dated May 19, 2015 (Reference 2). SSA RAIs 07, 09, and 10 are expected to be addressed in the 90-day RAI response, and SSA RAI 11 in the 120-day RAI response.

<u>SSA RAI 06</u>

NFPA 805 Section 2.4.2.4, requires that

> An engineering analysis shall be performed in accordance with the requirements of Section [2.4] for each fire area to determine the effects of fire or fire suppression activities on the ability to achieve the NSPC of Section 1.5 ....

RG 1.205, Revision 1, dated December 2009 (ADAMS Accession No. ML092730342), endorsed NEI 04-02, Revision 2, as one acceptable approach to performing and documenting the engineering analyses required to transition to a risk-informed, performance-based FPP in accordance with 10 CFR 50.48(c) and NFPA 805. On a fire area basis, NEI 04-02 requires that the licensee document how the NSPC are met. The guidance in NEI 04-02 recommends that this information be presented in LAR Attachment C, Table B-3, "Fire Area Transition." In LAR Section 4.2.4, "Overview of the Evaluation Process," Step 5 - Final Disposition, the licensee stated that the final disposition of variances from deterministic requirements (VFDRs) is documented in LAR Attachment C (NEI 04-02 Table B-3).

In LAR Attachment C, VFDRs B173-03, B8SEPR-04, and I3-04 state that fire damage to cables associated with the power supply to battery charger D-03B, D-03A, and D-04A, respectively, would require a local manual transfer for the redundant battery charger, if it is not aligned. The disposition of the VFDRs and their associated fire risk evaluation state that no further action is required for the fire-affected battery charger, but does not discuss if the local manual transfer to the non-affected redundant battery charger is credited in the fire risk evaluation.

Please clarify whether the local manual transfer for the non-affected redundant battery charger is credited in the fire risk evaluations, and if so, discuss how the local manual transfer is modeled with respect to risk-related recovery actions.

Response

ANO-1 has two independent safety related 125 volt battery-backed buses that provide DC power to plant equipment. Each 125 VDC bus is equipped with two battery chargers that allow for maintenance and improved system reliability. Only one battery charger is aligned to each bus at a given time to maintain bus voltage and the battery in a charged condition. A plant operator is needed to manually perform the local transfer from one charger to the other.

A review the FREs (Fire Risk Evaluations) associated with VFDRs B173-03, B8SEPR-04, and I3-04 confirms there are no recovery actions for risk reduction benefit or defense-in-depth credited to perform a local manual transfer to the non-affected alternate battery charger in the event the aligned charger fails due to fire. Other considerations that support not requiring a recovery to align the battery charger include the opposite train of DC remaining unaffected in each subject fire area.

In each of these fire areas, the *affected* safety related battery remains available for five hours (reference CALC-92-E-0021-01, Attachment 17) should the charger fail. Any 125 VDC control circuit fed from the affected DC bus, inclusive of switchgear protective relays needed for breaker coordination, will remain functional, as control power will be maintained for at least five hours. Concerns related to loss of protective features and coordination after five hours for impacted switchgear (4.16KV and above) in these fire areas are as follows

- CALC-10-E-0023-03: ANO-1 Fire Area B-8@SEPR Risk Evaluation

  VFDR B8SEPR-04 (Loss of Red Train Battery Charger D-03A)

  The power cables from both A-3 and A-4 that feed the swing High Pressure Injection (HPI) pump P-36B, along with the associated transfer switch, are in Fire Area B-8@SEPR. Protection for both trains is from the switchgear. Green train switchgear A-4 remains protected, as its DC control power is unaffected by the fire. In the event the red train 4.16 KV cables installed in conduit failed after five hours, the upstream breaker at switchgear A-1 would clear the fault, protecting the startup transformer feeding both switchgear A-1 and A-2. Switchgear A-2 feeds bus A-4, which is redundant to A-3. Switchgear A-1 and A-2 have planned modifications to install redundant DC control power (reference LAR Table S-1, Items S1-2 and S1-3) that assures protective features will be maintained. Additionally, Fire Area B-8@SEPR has 6.9 KV Reactor Coolant Pump (RCP) power cables, but the RCPs will be secured early in the event and, switchgear H-1 and H-2 which power the RCPs, have planned modifications for redundant DC control power (reference LAR Table S-1, Items S1-5 and S1-6).

- CALC-10-E-0023-22: ANO-1 Fire Area I-3 Risk Evaluation

  VFDR I3-04 (Loss of Green Battery Charger D-04A)

  Fire Area I-3 has 6.9 KV RCP power cables, but the RCPs will be secured early in the event and, switchgear H-1 and H-2 which power the RCPs, have planned modifications for redundant DC control power (reference LAR Table S-1, Items S1-5 and S1-6). There are no 4.16 KV power cables in this area.

- CALC-10-E-0023-07: ANO-1 Fire Area B-1@73-W Risk Evaluation

  VFDR B173-03(Loss of Red Train Battery Charger D-03B)

  The impacted power cables in fire area B-1@73-W are from red train switchgear A-3 as the affected charger D-03B supports the red train battery. If the red train power cables fail after five hours, then the fault will be cleared by the breaker at A-1 as described above for Fire Area B-8@SEPR.

SSA RAI 08

NFPA 805 Section 1.3.1, "Nuclear Safety Goal," states:

> The nuclear safety goal is to provide reasonable assurance that a fire during any operational mode and plant configuration will not prevent the plant from achieving and maintaining the fuel in a safe and stable condition.

NFPA 805 Section 1.4.1, Nuclear Safety Objectives, states:

> In the event of a fire during any operational mode and plant configuration, the plant shall be as follows:
>
> 1) Reactivity Control. Capable of rapidly achieving and maintaining subcritical conditions.
>
> 2) Fuel Cooling. Capable of achieving and maintaining decay heat removal and inventory control functions.
>
> 3) Fission Product Boundary. Capable of preventing fuel clad damage so that the primary containment boundary is not challenged.

In LAR Section 4.3.2, the licensee provided the results of the evaluation process for Non-Power Operations (NPO) analysis. Please provide the following information pertaining to NPO discussions provided in the results discussion in LAR Section 4.3 and LAR Attachment D:

a) LAR Section 4.3.2 and LAR Attachment D stated that additional equipment identified as being needed for NPO, but not previously evaluated, was evaluated and added as necessary to Plant Data Monitoring Systems (PDMS) and, where added, flagged accordingly as being only required for NPO. Please provide a list of the additional components and a list of those at-power components that have a different functional requirement for NPO. Describe the difference between the at-power safe shutdown function and the NPO function. Include with this list a general description by system indicating why components would be selected for NPO and not be included in the at-power analysis.

b) LAR Attachment D states the licensee followed the guidance of FAQ 07-0040, "Non-Power Operations Clarifications," dated August 11, 2008 (ADAMS Accession No. ML082200528). Please provide a list of key safety functions (KSF) pinch points by fire area that were identified in the NPO fire area reviews using FAQ 07-0040 guidance including a summary level identification of unavailable paths in each fire area. Describe how these locations will be identified to the plant staff for implementation.

c) During NPO modes, spurious actuation of valves can have a significant impact on the ability to maintain decay heat removal and inventory control. Please provide a description of any actions being credited to minimize the impact of fire-induced spurious actuations on power operated valves (e.g., air-operated valves and motor-operated valves) during NPO (e.g., pre-fire rack-out, actuation of pinning valves, and isolation of air supplies).

d) During normal outage evolutions, certain NPO credited equipment will have to be removed from service. Please describe the types of compensatory actions that will be used during such equipment down-time.

e) The description of the NPO review in the LAR does not identify locations where KSFs are achieved via recovery actions or for which instrumentation not already included in the at-power analysis is needed to support recovery actions required to maintain safe and stable conditions. Please identify those recovery actions and instrumentation relied upon in the NPO, and describe how recovery action feasibility is evaluated. Include in the description whether these variables have been or will be factored into operator procedures supporting these actions.

Response

a) Section 4.6 of CALC-09-E-0008-01, “ANO-1 NFPA 805 Non-Power Operations Assessment,” provides a listing of additional equipment that is not currently part of the safe shutdown program, but required to support NPO. A listing of this equipment is provided below with discussion of why each is included in NPO and not at-power. Attachment 8.34 included in CALC-09-E-0008-03, “ANO-1 NFPA 805 Fault Tree and PID Attachments,” is the compiled NPO Equipment List for ANO-1 and has approximately 142 pieces of equipment listed with functional requirements at power, Hot Shut Down (HSD), Cold Shut Down (CSD), and for NPO. Support equipment (electrical, service water) that is in the NPO list has the same requirement for safe and stable. Reactor Coolant System (RCS) interface valves to low pressure Decay Heat Removal (DHR) system are closed at power and opened for NPO.

List of Additional Components for which Cable Selection was Performed

Equipment ID	**Equipment Description**	**Discussion**
C553	ICC Monitor & Display - Train A	Signal conditioning for RCS level instruments used only for NPO and not required at power.
C554	ICC Monitor & Display - Train B	Signal conditioning for RCS level instruments used only for NPO and not required at power.
LT-1195	RCS Refueling Level – Loop B Hot Leg Narrow Range Level	RCS level instruments used only for NPO and not required at power.
LT-1198	RCS Refueling Level – Loop B Hot Leg Wide Range Level	RCS level instruments used only for NPO and not required at power.
TE-1404/ TIT-1404	P-34A Suction Temperature	Local temperature indication only credited for NPO. DHR is a low-pressure system not credited at power.
TE-1405/ TIT-1405	P-34B Suction Temperature	Local temperature indication only credited for NPO. DHR is a low-pressure system not credited at power.
X02	ANO-1 Unit Aux Transformer	Provisions allowing X02 to be used for offsite power during refueling outage if the startup transformer is out of service for maintenance.

b) Section 6.1 of CALC-09-E-0008-01 contains all fire area evaluations for ANO-1 and identifies Key Safety Function (KSF) pinch points. A summary level listing of KSF paths for each fire area due to NPO pinch points is included below. ANO-1 NFPA 805 LAR transition implementation Item S2-4 addresses incorporation of these insights from the ANO-1 NPO calculation into operating procedures. The operating procedure changes will provide necessary input to the plant staff for KSF pinch point issues.

Key Safety Function (KSF) Paths by Fire Area due to NPO Pinch Points

Area	ANO-1 KSF Pinch Point / Path Impact(s)
A	None – Deterministically compliant
B@197-X	Electrical – System alignment Service Water – Swing pump alignment
B1@NAB	Service water – Sluice gate and discharge path alignment Inventory – Borated water makeup source Decay Heat Removal – Suction from RCS
B-1@SAB	Electrical – Align load center Service Water – Discharge path alignment Decay Heat Removal – Suction from RCS and system alignment Inventory - Borated water makeup source
B-7	None – Deterministically compliant
B-8	Service water – Discharge path alignment Inventory – Borated water source flow diversion Decay Heat Removal – Suction from RCS
B-9	None – Deterministically compliant
B-10	None – Deterministically compliant
C	Service water – Flow diversion Inventory – Borated water makeup source Decay Heat Removal – Suction from RCS
D	None – Deterministically compliant
E	Service water – Discharge path alignment
F	None – Deterministically compliant
H	None – Deterministically compliant
I-1	Service Water – Pump and discharge path alignment Inventory – Borated water makeup source Decay Heat Removal – Suction from RCS
I-2	Service Water – Pump and discharge path alignment Decay Heat Removal – Suction from RCS and system alignment
I-3	Service Water – Swing pump discharge path alignment
J	None – Deterministically compliant
K	None – Deterministically compliant

Area	ANO-1 KSF Pinch Point / Path Impact(s)
L	None – Deterministically compliant
N	Service Water – Swing pump alignment
O	None – Deterministically compliant
YD	None – Deterministically compliant
MH01	None – Deterministically compliant
MH02	None – Deterministically compliant
MH03	Service Water – Swing pump alignment
MH04	None – Deterministically compliant
MH05	Service Water – Swing pump alignment
MH06	None – Deterministically compliant
MH09	None – Deterministically compliant
MH10	None – Deterministically compliant
G	Control Room • Decay Heat removal • Inventory • Service Water • Electrical • Reactivity

c) The NPO assessment performed by CALC-09-E-0008-01 identified procedural changes to pre-position and open breakers for two motor-operated valves (MOVs) with a modification to the third in-series MOV associated with the single line from the RCS to the DHR system (LAR Attachment S, Table S-1, Item S1-35). No other actions for pre-positioning of equipment are relied upon as a strategy to reduce fire risk during High Risk Evolutions (HREs) by the NPO assessment. The decision to use additional pre-positioning actions will be controlled by OP-1015.048, “Shutdown Operations Protection Plan,” that includes provisions for a fire protection specialist to be included in the Outage Risk Assessment Team (ORAT) for fire risk management. Risk management actions can include procedure changes for pre-positioning of valves and the racking down or opening of breakers preventing spurious operation.

d) OP-1015.048, “Shutdown Operations Protection Plan,” contains guidance concerning management of risk during evolutions where equipment may be removed from service.

- Maintain Defense-in-Depth by alternate means when pre-outage planning reveals that specified systems, structures, or components will be unavailable.
- Planning and scheduling outage activities in a manner that optimizes safety system availability.
- Protect key plant equipment/systems/train while redundant or related equipment is out of service. Limiting access to these sensitive areas prevents introduction of transients and performance of risk significant tasks.

e) Each fire area evaluation contained in Section 6.1 of CALC-09-E-0008-01 is either classified as deterministically compliant with all KSFs maintained or as being a pinch point due to one or more KSFs being impacted. In those areas that are not in deterministic compliance, an assessment was performed to identify a set of equipment that could require recovery based upon a total fire area burn up with worst case failures postulated and all redundant paths and equipment failed. These potential defense-in-depth recoveries for NPO are considered feasible as they are a smaller set of the same actions used and previously evaluated by the manual action feasibility study CALC-85-E-0086-02 for Appendix R. The NPO calculation concluded in Section 2.0 that fire areas not in deterministic compliance are demonstrated to be acceptable based upon defense-in-depth and risk informed processes.

   Available instrumentation needed to support NPO is identified in the summary portion of each fire area evaluation in Section 6.1 of CALC-09-E-0008-01. This instrumentation is RCS level indication (inventory), neutron monitoring (reactivity), and RCS temperature.

   Some of the modifications in LAR Attachment S, Table S-1, are expected to improve availability of systems, which may eliminate some pinch points. These modifications will be incorporated into the NPO assessment by design processes following implementation.

Fire Modeling (FM)

Note: Fire Modeling RAIs 01, 02, 04, and 06 are expected to be addressed in the 90-day RAI response. One 90-day response, FM RAI 03, is included in this letter below.

FM RAI 03

NFPA 805, Section 2.7.3.2, "Verification and Validation," states, in part, that:

> Each calculational model or numerical method used shall be verified and validated through comparison to test results or comparison to other acceptable models.

LAR Section 4.5.1.2, "Fire PRA," states, in part, that:

> Fire modeling was performed as part of the Fire PRA development (NFPA 805 Section 4.2.4.2).

Reference is made to LAR Attachment J, "Fire Modeling V&V," for a discussion of the V&V of the fire models that were used.

Furthermore, LAR Section 4.7.3, "Compliance with Quality Requirements in Section 2.7.3 of NFPA 805," states, in part, that:

> Calculational models and numerical methods used in support of compliance with 10 CFR 50.48(c) were verified and validated as required by Section 2.7.3.2 of NFPA 805.

Regarding the V&V of fire models, for any fire modeling tool or method that was in the development of the LAR or that is identified in the response to FM RAI 01 (a) above, provide the V&V basis if not already explicitly provided in the LAR (e.g., in LAR Attachment J).

Response

The V&V basis for all know fire modeling tools or methods that support the Fire PRA (FPRA), directly or indirectly, have been described in LAR Attachment J. An interpolation of the cable damage times described in Appendix H of NUREG/CR-6850, "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities Volume 2: Detailed Methodology" is used in the ANO-1 FPRA; however, this interpolation is not considered to be a fire modeling tool or method and is thus not included in the LAR Attachment J discussion.

Note that new zone of influence (ZOI) and hot gas layer tables were developed for ANO-2 that are applicable to ANO-1 in Reports PRA-A2-05-017, Rev. 0, "Combined Ignition Source – Cable Tray Fire Scenario ZOIs for Arkansas Nuclear One Unit 2 Applications" and PRA-A2-05-018, Rev. 0, "Evaluation of the Development and Timing of Hot Gas Layer Conditions in Generic ANO-2 Fire Compartments with Secondary Combustibles." These evaluations use the same approach described in Report PRA-A1-05-011, Rev. 0, "Evaluation of Development and Timing of Hot Gas Layer Conditions in Selected ANO Fire Zones" and Report 1SPH02902.030, "Generic Fire Modeling Treatments," both of which are described in LAR Attachment J. The V&V basis for the particular calculations and configurations is documented in Attachments 1 and 3 of Report PRA-A2-05-017, Rev. 0, and Attachment 1 of Report PRA-A2-05-018, Rev. 0.

<u>FM RAI 05</u>

NFPA 805 Section 2. 7.3.4, "Qualification of Users," states, in part, that:

> Cognizant personnel who use and apply engineering analyses and numerical models (e.g., fire modeling techniques) shall be competent in that field and experienced in the application of these methods as they relate to nuclear power plants, nuclear power plant fire protection, and power plant operations.

LAR Section 4.5.1.2, "Fire PRA," states that fire modeling was performed as part of the Fire PRA development (NFPA 805 Section 4.2.4.2). This requires that qualified fire modeling and PRA personnel work together. Furthermore, LAR Section 4.7.3, "Compliance with Quality Requirements in Section 2.7.3 of NFPA 805," states:

Cognizant personnel who use and apply engineering analysis and numerical methods in support of compliance with 10 CFR 50.48(c) are competent and experienced as required by Section 2.7.3.4 of NFPA 805.

During the transition to 10 CFR 50.48(c), work was performed in accordance with the quality requirements of Section 2.7.3 of NFPA 805. Personnel who used and applied engineering analysis and numerical methods (e.g. fire modeling) in support of compliance with 10 CFR 50.48(c) are competent and experienced as required by NFPA 805 Section 2.7.3.4.

Post-transition, for personnel performing fire modeling or FPRA development and evaluation, Entergy will develop and maintain qualification requirements for individuals assigned various tasks. Position Specific Guides will be developed to identify and document required training and mentoring to ensure individuals are appropriately qualified per the requirements of NFPA 805, Section 2.7.3.4, to perform assigned work (see Attachment S).

Regarding qualifications of users of engineering analyses and numerical models, please provide the following information:

- Describe what constitutes the appropriate qualifications for the staff and consulting engineers to use and apply the methods and fire modeling tools included in the engineering analyses and numerical models.

- Describe the process for ensuring the adequacy of the appropriate qualifications of the engineers and personnel performing the fire .analyses and modeling activities.

- Explain the communication process between the fire modeling analysts, PRA personnel, consulting engineers, and operations personnel to exchange the necessary information, and any measures taken to assure fire modeling was performed adequately and will continue to be performed adequately during post-transition.

Response

<u>1st Bullet</u>

Qualifications for fire modeling are based on the education and background for those individuals performing the fire modeling tasks. Entergy reviewed the resumes and work history of the individuals performing the fire modeling tasks and ensured that each task was performed by individuals with appropriate training in the fire modeling area being performed. The qualifications that are required for the staff and consulting engineers that use and apply these technologies depend in part on the specific assigned role on the project. In general, the qualification requirements for those who are technical leads in the preparation of technical tasks are consistent with and often exceed those articulated in NEI 07-12, “Fire Probabilistic Risk Assessment (FPRA) Peer Review Process Guidelines,” for qualification of Peer Reviewers. Given the magnitude of the technical activity being performed, the technical leads are sometimes assisted by support staff. There are no specific qualifications for those in a support role as the assigned technical lead would retain overall technical responsibility for the entire body of work. The overall acceptability of the resulting body of work is established through the review and approval process of the associated analysis documentation.

<u>2nd Bullet</u>

As part of the contract proposal process and prior to assigning the task, Entergy personnel reviewed the qualifications of the engineers and personnel performing the fire analyses and modeling activities as presented in their resumes. Individuals selected to perform tasks were required to have the appropriate background for these activities as described above. For example, proposal evaluation and supplier selection activities are performed in accordance with the process established in EN-MP-105, "Bid/Proposal Evaluation and Supplier Selection," which includes:

- Technical considerations
- Research and development effort
- Qualification of supplier's personnel
- Supplier's production capability
- Supplier's past performance

<u>3rd Bullet</u>

During the preparation of the LAR, meetings were held between PRA and fire modeling staff to review the necessary fire models and to ensure the results accurately reflected the needs of the PRA model. In addition to the meetings, FPRA team members reviewed associated documentation prior to incorporation into the FPRA model. The fire modeling results are contained in calculations, which are reviewed in accordance with the appropriate quality assurance program. These calculations were reviewed under the contractor's Quality Assurance program with individuals familiar with the technical aspects of the calculation. In addition, the fire modeling calculations were reviewed by individuals at Entergy who were qualified to the respective engineering processes. At Entergy, the process contained in EN-DC-126, "Engineering Calculation Process," EN-DC-147, "Engineering Reports," and/or EN-DC-149, "Acceptance of Vendor Documents," was used to perform the review of the fire modeling. Comments were provided by the appropriate Entergy individuals.

A similar process as described above will be utilized post-transition, as required by Entergy procedures. Fire modeling will be performed as needed and reviewed by Entergy using the Entergy engineering processes reflected in EN-DC-126, "Engineering Calculation Process," EN-DC-147, "Engineering Reports," or EN-DC-149, "Acceptance of Vendor Documents."

Probabilistic Risk Assessment (PRA)

Note: PRA RAIs 01.e, 01.f, 02.a, 02.c, 02.d, 02.e, 05, 07, 08, 09, and 16 are expected to be addressed in the 90-day RAI response. One 90-day response, PRA RAI 02.c, is included in this letter below. PRA RAIs 03 (without quantitative results), 10, 11, 13, 15, 17 (without quantitative results), and 18 are expected to be addressed in the 120-day RAI response.

<u>PRA RAI 01</u> – Fire PRA Facts and Observations (F&Os)

Section 2.4.3.3 of NFPA 805 states that the probabilistic safety assessment (PSA) (PSA is also referred to as PRA) approach, methods, and data shall be acceptable to the AHJ, which is the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a FPRA and endorses, with exceptions and clarifications, NEI 04-02 Revision 2, "Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program Under 10 CFR 50.48(c)," April 2008. (ADAMS Accession No. ML081130188), as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. RG 1.200, Revision 2, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-informed Activities," March 2009 (ADAMS Accession No. ML090410014), describes a peer review process utilizing an associated ASME/ANS standard (ASME/ANS-RA-Sa-2009) as one acceptable approach for determining the technical adequacy of the PRA once acceptable consensus approaches or models have been established for evaluations that could influence the regulatory decision. The primary result of a peer review are the Facts and Observations (F&Os) recorded by the peer review team and the subsequent resolution of these F&Os.

Please clarify the following dispositions to the ANO-1 FPRA F&Os and Supporting Requirements (SRs) assessment identified in LAR Attachment V that have the potential to impact the Fire PRA results and do not appear to be fully resolved:

a) <u>PP-B3-01</u> (Credit for Spatial Separation)

   The disposition to this F&O states, in part, that: "No fires were judged to credibly breach the spatial separation and no hot gas layer potential exists." While it appears clear from this statement that there is no potential for formation of a HGL in areas where spatial separation was credited, it is not apparent what the statement "no fires were judged to credibly breach the spatial separation" means. Guidance in Section 1.5.2 of NUREG/CR-6850 allows use of partial separation of 20 feet given this space is absent of combustibles and fire ignition sources and there is no potential for formation of a HGL.

   i. Designate the distance used to define spatial separation and describe the basis for justifying that this space is absent of combustibles and fire ignition sources.

   ii. If the approach to modeling spatial separation is not consistent with guidance in NUREG/CR-6850 then replace the current approach with an acceptable approach in the integrated analysis provided in response to PRA RAI 03.

Response

The current Fire Protection Program credits spatial separation to define the Physical Analysis Unit (PAU) boundaries between the ANO-1 and ANO-2 turbine buildings and spent fuel pool rooms. It is assumed within the ANO-1 model that the definitions for spatial separation are not sufficient to substantially contain the damaging effects of any fire. Therefore, while the ANO-1 FPRA utilizes the PAU definitions from the fire protection program, no credit is taken for the "20 ft. spatial separation," nor is the associated PAU definition determined to be sufficient for substantially containing the damaging effects of any fire along the PAU boundary. All postulated fires were assumed to impact targets within their respective zone of influence, irrespective of whether that zone of influence extended beyond a non-fire barrier boundary in the plant partitioning element.

Since no spatial separation has been credited as noted above, the issues noted in Items i and ii above are addressed appropriately and are in accordance with NUREG/CR-6850.

b) <u>PP-B5-01, FSS-G4-01, and FSS-G5-01</u> (Credit for Fire Barriers)

The dispositions for F&Os PP-B5-01, FSS-G4-01, and FSS-G5-01 explain that failure of fire barriers, including active fire barriers, is evaluated in the Multiple-Compartment Analysis (MCA) by assigning a generic failure probability of 0.0074 from NUREG/CR-6850 based on the probability of fire door failure. It is not clear how this limited consideration of barrier failure reflects all the types of barriers present between Physical Analysis Units (PAUs), including active barriers such as water curtains and fusible link actuated dampers.

i. Please justify why the failure probability for a passive component can be used as the failure probability for active fire barriers given that failure probabilities of passive components are typically lower than active components.

ii. Please explain how the impact of fire on cables associated with active fire barriers was considered. If the current treatment of active barriers cannot be justified, then please provide an acceptable method in the integrated analysis provided in response to PRA RAI 03.

iii. Please update risk results as part of the integrated analysis provided in response to PRA RAI 03, postulating at least one propagation scenario summing the generic barrier probabilities for each type of barrier present between PAUs, consistent with NUREG/CR-6850 guidance.

Response

i. The ANO-1 fire protection program does not utilize water curtains or any other active fire barrier when defining the PAU. NUREG/CR-6850, Volume 2, Section 11.5.4.4, specifies barrier feature types and the corresponding failure probability (including fire and ventilation dampers, which typically utilize fusible links to actuate damper closure). Failure probabilities from NUREG/CR-6850 are utilized for evaluating the failure of the applicable partitioning element (fire doors and dampers) when evaluating scenarios from one PAU into another. The MCA (PRA-A1-05-009) evaluated the spread between two adjacent PAUs and applies the probability for the bounding barrier type (either door or damper) present for partitioning the PAU. For PAUs that are open to each other, no barrier failure probability will be applied. In summary, the FPRA does not credit passive barrier failure probabilities for active systems.

ii. There are no active fire protection systems supporting the MCA fire barriers that require an actuation system that involves signals from cables or a detection system as part of any PAU boundary at ANO-1. Fire dampers, whether considered active or passive, are actuated by fusible links that do not require electrical signals transmitted via cables to initiate the closure of the damper and no water curtains are credited. Therefore, no cable relationships are required to support PAU boundaries.

iii. The MCA is being revised to sum the generic barrier probabilities (consistent with NUREG/CR-6850 guidance, Volume 2, Section 11.5.4.4.) for each type of barrier present between the PAUs. The final results will be provided with a revised Attachment W in accordance with PRA RAI 03.

c) <u>FSS-C1-01</u> (Panel Factors)

The disposition for this F&O states that a "Conditional Probability of Propagating Fire factors" method was used for vented panels based on split fraction specifying the "fraction of the fires impacting only the ignition source panel versus those fires which impact targets within the zone of influence of the panels." The fire scenario analysis appears to indicate that an alternate method that considers rate of target damage is used instead to make the distinction between "non-severe" and "severe" fires.

i. Please explain which modeling approach was used to model fire spread to another target to meet the requirements of SR FSS-C1 to have a two-point fire intensity model.

ii. If the cited method is the "panel factors" approach not accepted by NRC, as stated in the letter from Joseph Giitter of the NRC to Biff Bradley of the NEI, dated June 21, 2012 (ADAMS Accession No. ML12171A583), then please explain why this method was not removed from the integrated analysis provided in response to PRA RAI 3.

iii. Please describe how target damage sets are developed for both "non-severe" and "severe" scenarios in the FPRA, considering circumstances where there is a HGL and where there is not.

iv. If the cited method is the not the "panel factors" approach, then please provide a brief description of the method used at ANO-1, and justify that it is consistent with accepted methods.

Response

i. The approach used to replace the panel factors method is comprised of a non-severe fire impacting the panel ignition source with a severity factor that is large enough to create a cable damage zone of influence up to a distance that excludes the nearest target. A second scenario was defined based on the 98th percentile heat release rate and the Generic Fire Modeling Treatments (GFMTs). The third scenario is a fire which impacts all targets in the fire zone. A more detailed explanation of this approach is provided in Item iii below.

ii. As noted in the response to Item i above, the panel factor method is no longer used. The FPRA that supported the LAR submittal eliminated the panel factor method. This approach will continue to be refined in support of the responses to other RAIs and the refined approach will be used post NFPA 805 transition.

iii. The current approach, which is being modified to address RAIs from the ANO-2 NFPA 805 LAR, develops a non-suppression probability (NSP) by utilizing the heat release rate probability distribution from Appendix E of NUREG/CR-6850, the time to cable damage threshold from NUREG/CR-6850 Appendix H, and the GFMT.

This methodology evaluates the cable's percent damage over time utilizing the rates from Table H-7 of NUREG/CR-6850. This method is consistent with the general principals from the Nuclear Power Plant Equipment Qualification (EQ) analysis process which utilizes the Arrhenius methodology. This process is extensively used for modeling the environmental qualification of components, such as cables, to determine the time to damage in a containment accident environment. An NRC internal evaluation supporting the use of the Arrhenius methodology for equipment qualification is provided in a February 24, 2000, NRR Memo from Samuel J. Collins to Ashok Thadani (ML003701987).

The time to cable damage as a function of heat flux exposure (reference NUREG/CR-6850, Appendix H), does not constitute a new fire modeling tool or a "method" requiring V&V. The Appendix H data is used to establish the time to damage and the PRA uses the inverse of these values, which are damage accrual rates for the particular heat flux over the duration to which the cable is exposed to the heat flux (or for which the heat flux is considered to be bounding).

The GFMTs have a validation and verification (V&V) basis and provide the inputs (heat flux at a given distance) into the analysis. The heat flux values from the GFMTs, the t^2 fire growth profile, and the values from Appendix H in NUREG/CR-6850 are combined to generate a NSP for a cable target at a given distance from the ignition source.

The NUREG/CR-6850, Appendix H, Table H-7, data provides times to target damage for thermoset cables for a set of constant incident heat flux values. This provides a time delay for target damage beyond the critical damage heat flux of 11.4 kW/m^2. For instance, Table H-7 provides a 19-minute time to damage delay for a thermoset cable with a constant incident heat flux of 11 kW/m^2. An exponential regression is applied to these data points to generate a damage rate – heat flux profile. This regression analysis provides the Arrhenius curve for these cables based on the NUREG/CR 6850, Appendix H, data. Since the damage rate is not explicitly listed in NUREG/CR-6850 for exposure heat flux values of < 11 kW/m^2, a damage rate of 1/19 min^{-1} is conservatively assumed for these heat flux values. In order to apply the NUREG/CR 6850, Appendix H, data to a fire with a t^2 growth rate, the EQ methodology of damage accrual is applied integrating the rate of damage over the heat release rate t^2 profile curve.

The fraction of fires for each heat release rate bin and the associated time to damage, using the above method, define a non-suppression time up to which the nearest target would not be damaged. A non-suppression factor is obtained for the calculated time to damage using the table of manual non-suppression probabilities specified in Supplement 1 of NUREG/CR-6850, Chapter 14. The convolution of these non-suppression probabilities across the heat release rate bins results in a non-suppression probability for fires which could damage targets beyond the nearest target. One minus this non-suppression probability defines the fraction of fires which only impact the panel ignition source and the cables terminating at the panel without damaging the nearest target and any other targets located beyond the nearest target (this is the first of the three points in the three point fire modeling treatment, the non-severe fire, impacting only the ignition source panel).

A time to an 80 °C hot gas layer in the fire zone, considering the secondary combustible tray configurations in the vicinity of the ignition source, provides the non-suppression probability associated with fire damage beyond the 98th percentile heat release rate zone of influence defined in the GFMTs. The 80 °C hot gas layer temperature is considered the limiting temperature for a hot gas layer to appreciably alter the GFMT zone of influence. The fraction of fires that result in a hot gas layer temperature, which is less than this temperature, are considered severe fires and are considered to impact all targets within the 98^{th} percentile zone of influence (this is the second point in the three point fire modeling treatment, the severe fire, impacting all targets within the 98^{th} percentile zone of influence from the GFMTs).

The fraction of fires resulting in a hot gas layer temperature exceeding the 80 °C criteria specified above are conservatively assumed to impact all targets in the fire zone (this is the third point of the three point fire modeling treatment, the hot gas layer scenario, impacting all targets in the fire zone).

The use of these three points for the fire modeling treatment, applied to each applicable heat release rate bin, is considered to be consistent with the requirements of ASME/ANS RA-Sa-2009, Supporting Requirement FSS-C1, Capability Category III.

iv. The approach used for evaluating panel ignition sources is described in detail in item iii above. As noted in that discussion the approach uses the NUREG/CR-6850 Heat Release Rate probability distributions, cable damage time versus heat release rate (from NUREG/CR-6850 Appendix H) and the GFMTs. The basis is the same methodology and V&V basis that supports the Fire Modeling Treatments and specific heat release rate and cable damage data specified in NUREG/CR-6850. Therefore, the approach uses accepted methods and is not a new method.

d) FSS-G2-01 (Distributed HGL growth rates)

The disposition to this F&O explains that distributed manual suppression probabilities based on 20-, 30-, and 60-minute HGL growth rates were used. The NRC staff reviewed the Multi-Compartment and HGL analyses report and notes that a convolution process was used involving nine HRR/Severity Factor bins, time to a HGL, and non-suppression probabilities for different volumes. However, the NRC staff did not fully understand how 20-, 30-, and 60-minute HGL growth rates were used as explained in the disposition. Describe how the use of 20-, 30-, and 60-minute HGL growth rates were incorporated into the analyses.

Response

This F&O was generated by the October 2009 Peer Review. The disposition provided was the original disposition generated for this F&O subsequent to the peer review. Subsequent to this peer review, and in response to ANO-2 NFPA 805 LAR RAIs, the ANO-1 Multi-Compartment and hot gas layer (HGL) methodology was revised. The resolution of findings associated with the peer review in conjunction with the resolution of ANO-2 RAIs resulted in the elimination of the 20-minute limit on control of fire to prevent a HGL. The updated analysis assumes a worst case ventilation configuration and incorporates a convolution of the heat release rate probability distribution and its associated time to HGL with the non-suppression probability for manual suppression specified in NUREG/CR-6850, Supplement 1. In addition, the screening methodology used in the original analysis is no longer used in the Multi-Compartment analysis. All Multi-Compartment scenarios impacting ANO-1 are now quantified. Therefore, the resolution of FSS-G2-01 from the October 2009 Peer Review is superseded by the updated Multi-Compartment analysis, which no longer uses the criteria that were the basis for this F&O.

g) <u>HRA-B3-01 and HRA-E1-01</u> (New HFEs Credited in the Fire PRA)

F&O HRA-B3-01 states that new HFEs for operator actions which are used in current procedures but not modeled in the internal events PRA have not been evaluated for viability and have not been peer reviewed against the Human Reliability Analysis (HRA) PRA Standard. The disposition explains that the HRA was performed for these events in the same manner (i.e., detailed modeling) as for HFEs modeled in the Internal Events PRA. Fire related HFEs should be evaluated using guidance in NUREG 1921, "EPRI/NRC-RES Fire Human Reliability Analysis Guidelines," July 2012 (ADAMS Accession No. ML12216A104)). Please confirm that this guidance was used for the new HFE evaluations and that the evaluations were peer reviewed.

Response

The ANO-1 HRA methodology was revised consistent with the approach used to address ANO-2 NFPA 805 LAR RAIs. The revised methodology uses the NUREG-1921 methodology with detailed Human Error Probabilities (HEPs) developed for each Human Failure Event (HFE) credited in the FPRA. A focused scope peer review was performed in June 2014 evaluating the revised HRA process. The response to RAI PRA 03 will incorporate the update of this HRA methodology along with the resolution of other RAIs.

h) <u>F&Os FQ-A4-01 and UNC-A1-01</u> (SOKC)

The dispositions to F&Os FQ-A4-01 and UNC-A1-01 indicate that quantitative analysis of uncertainty intervals was performed. Section W.1 of the LAR further explains that parametric uncertainty analysis was performed for ignition frequencies, circuit failure probabilities, non-suppression probabilities, HRA, and internal event PRA failure data. PRA Standard SR QU-A3 (referenced by Fire PRA SR FQ-A4) requires that the mean CDF be estimated accounting for the SOKC between event probabilities. It is not apparent from the uncertainty analysis whether SOKC was considered.

Please explain whether SOKC was taken into account for the uncertainty parameters cited in Section W.1 of the LAR. If CDF and LERF were estimated without accounting for the SOKC for these parameters, then please account for SOKC in the integrated analysis performed in response to PRA RAI 3.

Response

A State of Knowledge Correlation (SOKC) was applied to ignition frequencies, circuit failure probabilities, non-suppression probabilities, and HRA basic events to address the correlation between the parameters and the various fire scenarios analyzed during the parametric uncertainty evaluation. Correlation of internal events PRA failure data was incorporated in the internal events model that was used as the basis for the FPRA. The SOKC will be addressed in the FPRA documentation supporting the response to RAI PRA 03.

i) FSS-G3-06 (Insufficient technical justification)

F&O FSS-G3-06 states that there are a number of statements in the licensee's HGL and MCA analysis documentation which appear to lack technical justification and identifies six examples. The disposition to this F&O does not explicitly address the six examples provided in the F&O, nor does it explain how elimination of "Table 3-1" of the cited documentation resolves the F&O. Please explain how all issues discussed in Table 3-1 have been resolved.

Response

The items identified in Table 3-1 of the Multi-Compartment/Hot Gas Layer Analysis were superseded in subsequent revisions of the analysis based on the elimination of the screening step in the analysis. All scenarios impacting ANO-1 are now quantified with no screening applied to eliminate scenarios. The items specifically identified in the F&O and their disposition is provided below:

1 - "The 0.001 applied is a very conservative factor applied to zones over 353 cu ft. A more appropriate NSPms [non-suppression probability – manual suppression] for this scenario is 1E-04 which results in screening the scenario for the Multi-Compartment Analysis (MCA) impacts" – Question: Where does 0.001 come from? Why it is considered conservative? Where does 1E-4 come from?

Resolution: 1E-03 is the lowest non-suppression probability (NSP) allowed by FAQ 08-0050 (and NUREG/CR-6850, Supplement 1). All NSPs less than 1E-03 have been eliminated unless it can be demonstrated that a HGL cannot occur for the total duration of the fire.

2 - Why is a factor from FAQ 044 for main feed water pumps (MFWPs) to oil tank rooms used? Are there any other ignition sources other than the pumps in these areas?

Resolution: This factor has been eliminated from non-MFWP scenarios.

3 - Given the large volume of the turbine building, no hot gas layer would be able to form which would preclude the MCA impacts – Question: Is this true for MFWP and large turbine generator (TG) fires? Can we preclude Hot Gas Layer (HGL) scenarios for these ignition sources?

Resolution: The vent configuration provided for the turbine building precludes a HGL for these fires.

4 - The only adjacent zone connected through a door is 2200-MM which will not be impacted due its large volume. Other adjacent zones can use the next worse barrier failure probability for dampers, 0.0027, which lowers the Probability of Multi-Compartment Scenario (Pmca) to 9.94E-08 – Comment: The resulting screening value is barely below the screening criteria. If we are selecting probabilities from a table without considering what is in the boundary in terms of seals and dampers, proper justification for the probabilities are needed.

Resolution: Screening of scenarios based on the calculated Core Damage Frequency (CDF) has been eliminated. All MCA scenarios associated with ANO-1 fire zones are retained in the analysis.

5 - Crediting a 0.02 NSP for emergency diesel generator (EDG) oil fires from Appendix E screens the scenario without crediting manual suppression – Question: Where is this 0.02 coming from? Where is the reference for the fixed system credited?

Resolution: Screening of scenarios based on the calculated CDF has been eliminated. All MCA scenarios associated with ANO-1 fire zones are retained in the analysis.

6 - There are tray combustibles within the zone; however they are located 10 ft or more above the floor elevation and would not be impacted by a fire in this zone. Screen the scenario for MCA impacts – Question: Why does the statement "would not be impacted by a fire in this zone" apply to these specifically?

Resolution: An evaluation of cable tray combustibles has been incorporated into the HGL evaluation.

<u>PRA RAI 02</u> – Internal Events PRA F&Os

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a Fire PRA and endorses, with exceptions and clarifications, NEI 04-02, Revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. RG 1.200 describes a peer review process utilizing an associated ASME/ANS standard (currently ASME/ANS-RA-Sa-2009) as one acceptable approach for determining the technical adequacy of the PRA once acceptable consensus approaches or models have been established. The primary results of a peer review are the F&Os recorded by the peer review and the subsequent resolution of these F&Os.

Please clarify the following dispositions to Internal Events F&Os and SRs assessment identified in the LAR Attachment U that have the potential to impact the Fire PRA results and do not appear to be fully resolved:

b) <u>LE-G5</u> (LERF analysis limitations)

The F&O disposition states that LERF quantifications were performed with qualified computer codes. However, the F&O and SR LE-G5 (i.e., identify limitations in the LERF analysis that would impact applications) are applicable to more than software limitations. Please explain how LERF modeling limitations were assessed and explain the impact of these limitations on the FPRA.

Response

The Peer Review F&O referred to is 1-25, which states:

> Reviewed PRA-A1-01-001S12, Revision 1. Section 2.1 identifies several limitations of the applicability. However, the noted limitations do not address technical limitations that might impact the use in applications. (This F&O originated from SR LE-G5)

The Basis of Significance states:

> The noted limitations do not address technical limitations (if any) that might impact the use in applications. The technical aspects of the analysis are adequate and no specific limitations have been noted in this review. The analysis should support anticipated applications.

Section 2.1 of the ANO-1 LERF calculation, PRA-A1-01-001S12, Rev. 1, states that the methodology and logical inputs to the ANO-1 LERF model are fully applicable to the ANO-1 plant. Section 2.1 additionally identifies key input assumptions: (1) use of current Emergency Operating Procedures, Severe Accident Management Guidelines, and emergency response plans and expected implementation, (2) Steam Generator tube flaw distribution representative of the industry average (i.e., less than approximately 15% tube plugging), and (3) Integrated Leak Rate Test interval no longer than 15 years and acceptable as-found results. As stated in the F&O, these are not technical limitations that might impact the use of the LERF model in applications.

In order to assess LERF modeling limitations, the LERF methodology document (WCAP-16341-P) and the ANO-1 LERF calculation were reviewed to identify any limitations in the general methodology and its specific implementation in the ANO-1 LERF analysis that might impact applications.

The ANO-1 LERF model used the LERF methodology described in WCAP-16341-P. Section 7.0 of WCAP-16341 describes important assumptions made in the LERF modeling. The discussion in this section is in the context of describing epistemic uncertainty associated with model development, including completeness uncertainty. This epistemic uncertainty might represent limitations in the general LERF methodology that could potentially affect applications. The modeling assumption discussion in WCAP-16341 was reviewed to determine whether any of the uncertainty issues represented modeling limitations that could affect applications. The review determined that the assumptions either represented sources of uncertainty or descriptions of modeling approaches that were confirmed to be appropriate in the plant-specific LERF implementation in the ANO-1 LERF model. Therefore, there were no modeling limitations associated with the WCAP-16341 assumptions that could affect applications.

In addition, the ANO-1 LERF calculation was reviewed to identify any limitations in the implementation of the WCAP methodology in the ANO-1 LERF analysis that might impact applications. Section 3.0 of the LERF calculation, describing the ANO-1 modeling assumptions and their justification, was reviewed. In most cases, the assumptions described the specifics of the ANO-1 implementation of the methodology described in WCAP-16431. Other assumptions essentially stated specifics of the LERF modeling, and were justified as appropriately plant-specific. None of these assumptions involve modeling limitations that could affect applications.

Review of the LERF model Containment Event Trees (CETs) and associated fault tree logic, however, determined that there are two analysis limitations concerning the ANO-1 LERF model not having fault tree logic for the Atmospheric Dump Valves (ADVs) and the RCS Electromatic Relief Valve (ERV). These are modeling limitations that do not affect the base, internal events LERF calculation, but could affect applications, particularly the FPRA. The FPRA includes the ERV (PSV-1000) and the ADVs and their block valves (CV-2668/CV-2676 and CV-2618/ CV-2619), but the component mapping is only to the Level 1 logic, and does not link to the LERF logic. This means that spurious operation of the ADVs and ERV, which could impact Pressure-Induced Steam Generator Tube Rupture (SGTR) and Thermal-Induced SGTR, is not included in the LERF model. Therefore, the FPRA is not able to calculate the LERF impact of fire-induced failure of these components. The assessment of this limitation in the FPRA will be included in the Integrated Analysis performed in response to PRA RAI 03.

c) LE-A4, LE-E1, LE-C7 (HFE modeling for LERF)

The F&O disposition states that no dependency analysis was performed for LERF HFEs because of the "relatively long" time internal between Level 1 and Level 2 events and because the cues for Level 1 and Level 2 operator actions are different.

Please describe and justify the treatment of these and other possible dependency elements discussed in NUREG-1921 such as common crew, common instrumentation (cognitive), and stress using the guidance for dependency analysis in NUREG-1921.

Response

The ANO-1 Large Early Release Frequency (LERF) calculation PRA-A1-01-001S12, Rev. 0, “ANO-1 Large Early Release Frequency (LERF) Model,” was reviewed to identify credited operator actions for which Human Failure Event (HFE) dependency analysis would be required. The generic LERF methodology WCAP-16431-P, Rev. 0, “Simplified Level 2 Modeling Guidelines” (Westinghouse Owners Group, November 2005), includes a number of operator actions. The ANO-1 LERF model implemented this generic methodology, but in many cases the generic operator actions were not credited, by setting the operator failure probability to 1.0. For these actions that were assumed to be failed, no Human Reliability Analysis (HRA) was performed. The LERF operator actions and their treatment in the ANO-1 LERF model are:

Control Steam Generator (SG) pressure using Atmospheric Dump Valves (ADVs)

This action is assumed to be failed in the ANO-1 LERF model (HEP = 1.0, Assumption 36; for station blackout), ADV block valves are failed closed, so use of ADVs is not possible); therefore, no dependency analysis is needed.

Isolate the SGs

This action is assumed to be failed in the ANO-1 LERF model (HEP = 1.0, Assumption 15), so no dependency analysis is needed.

Close an open ADV (to prevent depressurizing SG)

Since it is assumed that the ADVs are not operated to control SG pressure, this action is not applicable and is not modeled; therefore, no dependency analysis is needed.

Depressurize the RCS (using the Electromatic Relief Valve (ERV))

This action is credited in the ANO-1 LERF model, and is modeled in the Level 1 PRA. Therefore, dependency between the Level 1 and LERF Reactor Coolant System (RCS) depressurization actions needs to be considered.

Bump the Reactor Coolant Pumps (RCPs)

Operators clearing the RCS loop seal by bumping the RCPs (“bumping the pumps”) is included in the ANO-1 LERF model. “Bumping the pumps” is assumed to be necessary in order for a thermally-induced SG tube rupture (TI-SGTR) to occur, so the failure is the operators performing the “bumping.” Failing to “bump the pumps” is considered success, since TI-SGTR will not occur if the pumps are not “bumped.” Although “bumping the pumps” is not included in the Level 1 model, because this operator action includes a HEP, the potential for dependency between this LERF action and Level 1 actions should be considered.

In-Vessel Recovery

The generic LERF methodology includes the possibility of in-vessel recovery (i.e., preventing vessel failure by restoring some core cooling after core damage, but before vessel breach). In the ANO-1 LERF model, there is no operator action modeled for in-vessel recovery, and thus no HRA, since the model credits only recovery of offsite power, which is based on loss of offsite power recovery data. Therefore, no dependency analysis is needed.

Only RCS depressurization and bumping of the RCPs need to be considered in regard to HRA dependency between Level 1 and Level 2. These are addressed in the following.

RCS Depressurization

RCS depressurization is included in the Level 1 PRA as HFE RHF1HPIERP, which is “Failure to Initiate HPI (High Pressure Injection) Cooling.” The HEP for this action is 1.2E-3. This action is directed by Emergency Operating Procedure (EOP) OP-1202.012, “Repetitive Tasks,” and is credited in the Level 1 PRA for once-through-cooling (primary feed and bleed cooling) in transients, SGTRs, and small loss of cooling accidents (LOCAs) (procedures for these events refer to OP-1202.012 for use in aligning HPI.).

RCS depressurization is also credited in the LERF model. The LERF model includes the action to depressurize the RCS under the direction of SAMG-U1, Rev. 7, “Severe Accident Management Guideline (SAMG).” The SAMGs are used by the Technical Support Center (TSC), which would be staffed as part of the Emergency Plan. The HEP for this action in the LERF model is assumed to be 0.5 (PRA-A1-01-001S12, Rev. 1, Assumption 34). The action is implemented in the LERF fault tree via events NOT_RCS_DEP_NOSBO and NOT_RCS_DEP_SBO. These events include unintentional depressurization, e.g., via stuck open primary safety valve or vent valve, so the probability of no depressurization is slightly less than 0.5 at 0.473.

The Level 1 action, RHF1HPIERP, is modeled based on EOPs. For example, OP-1202.004, “Overheating,” would invoke OP-1202.012, Repetitive Task 4, “Initiate HPI Cooling,” in a loss of feedwater scenario; this is PRA accident sequence TBF (transient with failure of SG heat removal and failure of once-through-cooling). This Level 1 action would be performed pre-core damage, in an effort to prevent core damage. The LERF action would be taken under the direction of the SAMGs after core damage has occurred, since the action is a SAMG Candidate High Level Action (CHLA) in response to a diagnosis of OX/BD (core highly oxidized/core badly damaged). The crew making the diagnosis of the need for this CHLA, deciding to perform the CHLA, and directing its implementation is the TSC staff, which is different from the Control Room staff that would be involved in the Level 1 RCS depressurization action.

NUREG-1921, Figure 6-1, is used to evaluate the dependency between the Level 1 action and the LERF action. The definition of Crew in Figure 6-1 is:

> Crew. If the time between the cues for the required actions exceeds the length of a shift (typically 12 hours), the actions are to be performed by a different crew. In this case, the "No" branch on the "Crew" decision node is selected. <u>The different crew can be considered independent because the shift change will involve a complete reevaluation of the plant status</u> [emphasis added], so *ZD* can be assigned for low stress situations (Branch 18). For elevated stress such as a fire, *LD* is assigned.

In the evaluation of dependency between the Level 1 and LERF actions, the different crew is not the result of shift change per se, but having a completely different crew staffing the TSC. Since activating the TSC will involve independent staff using a completely different procedure, and will involve a "complete reevaluation of the plant status" (one of the primary functions of the TSC), the TSC staff meets the intent of the definition of a "different crew." This makes the lower path of the "Crew" branch in Figure 6-1 applicable. The next question is with respect to the stress level. Section 6.2 of NUREG-1921 gives examples of things that can cause stress, but given that the LERF action would be associated with a core damage scenario, the stress can be assumed to be elevated. The definition of the "Crew" branch, above, says that "for elevated stress such as a fire, LD [low dependency] is assigned." This is taken to be the appropriate dependency level for the LERF action relative to the Level 1 action.

Table 6-1 of NUREG-1921 gives the equation for the adjustment to the HEP for dependency. For LD, the adjusted HEP is HEPadj = (1+19 X HEP)/20; with HEP = 0.5, HEPadj = (1 + 19x0.5)/20 = 0.525. This is a very small increase (5%). The LERF calculation (PRA-A1-01-001S12, Rev. 1) identifies the 0.5 failure probability for the action to depressurize the RCS post-core damage as a conservative value because it is a value assumed by the generic LERF methodology (WCAP-16341-P, Rev. 0, Table 6.7-1) for no specific procedures provided. The SAMG guidance identifies, following the diagnosis of the OX/DB plant damage state, that CHLA 2 (Depressurize RCS) may need to be started first (SAMG-U1, Rev. 7, Section 2.2). In addition, the actual operation of depressurizing the RCS via the ERV is proceduralized. Therefore, it is reasonable to expect that the probability of success for the RCS depressurization under the guidance of the TSC staff using the SAMGs would be higher than the 0.5 probability assumed in the generic methodology for no specific procedures. This provides a basis for concluding that the 5% increase in the LERF RCS depressurization HEP due to dependency with the Level 1 RCS depressurization action is offset by conservatism in the 0.5 probability, with the result that the 0.5 HEP used in the LERF model for failure to depressurize the RCS is appropriate and no changes are needed.

<u>"Bumping the Pumps"</u>

The generic LERF methodology (WCAP-16341-P, Rev. 0) describes "bumping the pumps" as follows.

> During a severe accident, the operators may restart an RCP for a short period of time immediately before or after core uncovery (a.k.a. bump the pump) to transfer the slug of water in the cold leg loop seal into the reactor cavity. This action is intended to delay core uncovery for a finite period of time, but significantly increases the likelihood of a thermally induced SGTR in the later stages of a severe accident by introducing full loop natural circulation between the reactor vessel and SG.

If the secondary side of the SG is dry (i.e., feedwater is unavailable), this action will be detrimental because of its contribution to TI-SGTR. In the generic methodology, the probability of the operators performing this action is 0.05, which is based on Westinghouse and CE SAMGs. According to the generic methodology document (WCAP-16341-P, Rev. 0), these SAMGs include a caution: "This action is normally accompanied in the SAMG with a caution to perform only if the associated SG is being fed." This is the reason for the relatively low probabilities of the action; since the operators are cautioned not to perform the action on a dry SG. Performing the action in that situation (and thus potentially causing a TI-SGTR) is an error of commission. The 0.05 operator action probability represents the HEP for this error of commission.

The B&W plant SAMGs used for ANO-1, however, were assumed for the ANO-1 LERF model not to have this caution. Therefore, the 0.05 HEP for Westinghouse and CE SAMGs was judged not to be applicable. Instead, a B&W-specific HEP of 0.941 from an EPRI SG risk assessment (EPRI TR-1006593, "Steam Generator Tube Integrity Risk Assessment," Volume 1: General Methodology, Figure 3-7) was used, which represents an assumption of near certainty for the error of commission. This very high HEP is undoubtedly conservative because the ANO-1 SAMGs do provide some cautions against bumping the pump. Section 3.10, "Implementation," of the SAMG includes the following text in bold at the beginning of the section:

> Bumping RCPs can lead to a bypassed RB if OTSG tubes fail as a result of RCP bumps. If the OTSG can not be adequately protected from a possible tube failure, when the RCP is operated, then this CHLA should not be performed.

Section 3.10 additionally provides the following recommendation:

> [If possible] Establish OTSG level at the inadequate subcooling margin setpoint using EFW. If EFW is not available then use AFW or MFW.

With this guidance in the SAMG implementation section for "bumping the pumps," there is some reasonable likelihood that the TSC staff would not recommend "bumping the pumps" with the SGs dry (the error of commission) and, thus, that the probability of not "bumping the pumps" is greater than 0.039 (1 – HEP). In other words, it is likely that the probability is higher than 0.039 that the staff will recognize the problem with "bumping the pumps" under these conditions and will not perform the action. That would make the HEP less than 0.941, meaning the 0.941 HEP is conservative.

There is no dependency between this LERF action and Level 1 actions because:

- there are no Level 1 (i.e., EOP) actions similar to "bumping the pumps."
- this LERF action would be undertaken by completely different staff (the TSC) from the Control Room staff performing Level 1 actions.
- the procedures are completely different, SAMGs for LERF and the EOPs for Level 1 actions.

Conclusion

The ANO-1 LERF calculation was reviewed to identify credited operator actions for which HFE dependency analysis would be required. The only operator actions included in the LERF model are depressurizing the RCS and “bumping” the RCPs. Depressurizing the RCS is an action that is in both the Level 1 and LERF models, so the guidance of NUREG-1921 was used to evaluate potential dependency. It was found that any possible dependency was very small and was offset by conservatism in the operator failure probability assumed in the LERF model. The “bumping” the RCPs action in the LERF model has no dependency on Level 1 actions because there are no similar Level 1 actions, and “bumping” the RCPs would be directed by completely different staff using completely different procedures.

PRA RAI 04 – Reduced Transient Heat Release Rates

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a fire PRA and endorses, with exceptions and clarifications, NEI 04-02, Revision 2, as providing methods acceptable to the NRC staff for adopting a fire protection program consistent with NFPA-805. By letter to NEI dated July 12, 2006 (ADAMS Accession No. ML061660105), the NRC established the ongoing FAQ process where official agency positions regarding acceptable methods can be documented until they can be included in revisions to RG 1.205 or NEI 04-02. Methods that have not been determined to be acceptable by the NRC staff require additional justification to allow the NRC staff to complete its review of the proposed method.

The fire scenario analysis appears to indicate that reductions below the 98th-percentile NUREG/CR-6850 HRR of 317 Kilowatts (kW) for transient fires may have been credited in detailed fire modeling in support of the FPRA. The licensee's analysis indicates that though a bounding 98 percent HRR of 317 kW from NUREG/CR-6850 was typically used, reduced transient fire HRRs were applied for some fire compartments. Please discuss the key factors used to justify the reduced rate below 317 kW per the guidance endorsed by the June 21, 2012, memorandum from Joseph Giitter, NRC, to Biff Bradley, NEI, "Recent Fire PRA Methods Review Panel Decisions and EPRI 1022993, 'Evaluation of Peak Heat Release Rates in Electrical Cabinets Fires'" (ADAMS Accession No. ML12171A583). Include in this discussion:

a) Identification of the fire areas where reduced HRR transient fires are credited.

b) For each location where a reduced HRR is credited, a description of the administrative controls that justify the reduced HRR including how location-specific attributes and considerations are addressed.

c) A discussion of required maintenance for ignition sources in each location, and types/quantities of combustibles needed to perform that maintenance.

d) A discussion of the personnel traffic that would be expected through each location.

e) The results of a review of records related to violations of the transient combustible and hot work controls.

Response

a) The reduced heat release rate of 69 kW for transient fires is used in fire zones where strict transient controls are to be imposed. These fire zones are:

Fire Zone 73-W	Condensate Demineralizer Area
Fire Zone 97-R	Cable Spreading Room and ICS Relay Room
Fire Zone 98-J	Emergency Diesel Generator Access Corridor
Fire Zone 105-T	Lower South Electrical Penetration Room
Fire Zone 112-I	Lower North Electrical Penetration Room
Fire Zone 144-D	Upper South Electrical Penetration Room
Fire Zone 162-A	Stairwell No. 1

These fire zones are treated as Level 1 areas per Entergy procedure EN-DC-161, “Control of Combustibles.” Transient combustibles are prohibited in these areas without performing an evaluation and/or establishing appropriate compensatory measures.

b) The enhanced transient controls in conjunction with the locations and configurations of the fire zones specified above support the use of a reduced heat release rate.

Fire Zone 73-W is a ground floor corridor area adjacent to the condensate demineralizers. The high traffic and relatively narrow configuration of the corridor precludes significant transient combustible storage while the area of the condensate demineralizers is congested and would be difficult to access and is an unlikely location for storage of transients.

Fire Zone 97-R is a limited access area (access controlled by security doors requiring appropriate access clearance for access). Fire Zone 98-J, the access corridor to Fire Zone 97-R, is also a limited access area configured as a narrow corridor with little room for storage of transients without obstruction of the transit path through the corridor.
Fire Zones 105-T, 112-I and 144-D are also limited access areas with limited traffic.

Fire Zone 162-A is a stairwell and is unlikely to be a storage location due to the impact on the ability to traverse stairwell if material was stored in the zone.

c) Ignition sources and maintenance activities are likely to occur in several of these zones. The transient controls established in EN-DC-161 apply to maintenance activities and require a continuous fire watch for any transient combustible materials left unattended.

d) Fire Zone 73-W is the only high traffic area of the fire zones listed above. All other zones are limited access specific destination areas and are likely to see only limited traffic as opposed to pass through areas (with the exception of the stairwell).

e) A review of non-conformances related to transient combustibles for the period of February 15, 2007 through June 1, 2014 identified three instances where transient combustible control requirements were violated in areas with the highest level of transient controls under the current Entergy transient combustible control program. These violations included:

1 – plastic cart

2 – wire staged for outage

3 – duct tape on piping

The violations were based on the existing transient control program which has since been enhanced to preclude transients in the areas specified above. The enhanced controls and the small number of low significance violations identified supports the use of a 69 kW transient heat release rate in these areas.

PRA RAI 06 – Transient Fire Placement at Pinch Points

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a fire PRA and endorses, with exceptions and clarifications, NEI 04-02, Revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. By letter to NEI dated July 12, 2006, the NRC established the ongoing FAQ process where official agency positions regarding acceptable methods can be documented until they can be included in revisions to RG 1.205 or NEI 04-02. Methods that have not been determined to be acceptable by the NRC staff or acceptable methods that appear to have been applied differently than described require additional justification to allow the NRC staff to complete its review of the proposed method.

The fire scenario analysis description provided in the LAR states that transient walkdowns were conducted to identify specific general transient locations where a transient combustible fire could impact trays, conduits, or risers. It is not clear from the analysis how "pinch points" were modeled for transient fires. Per the guidance provided in NUREG/CR-6850, Section 11.5.1.6, transient fires should at a minimum be placed in locations within the plant physical analysis units (PAUs) where conditional core damage probabilities (CCDPs) are highest for that PAU (i.e., at "pinch points"). The NRC staff notes that pinch points include locations of redundant trains or the vicinity of other potentially risk-relevant equipment. The NRC staff notes that transient fires due to hot work should be assumed to occur in locations where hot work is a possibility, even if improbable. Please provide the following information:

a) If different methods were used in different areas, provide an explanation for b), c), and d) for each method.

b) Explain how "pinch points" were identified and modeled for transient fires.

c) Include description of how transient fires and transient fires due to hot work are distributed within the PAUs and the criteria used to determine where such ignition sources are placed within the PAUs.

d) Include explanation of how ignition frequency for transient fires is allocated to specific fire scenarios.

Response

a) The approach used for ANO-1 was consistent for all areas except for the Turbine Building. The response to Item c below addresses the generic approach as well as the Turbine Building specific approach.

b) The approach used for evaluation of transient fires at ANO-1 did not limit the analysis to "pinch points." All transient fires impacting targets were analyzed as discussed in Item c below.

c) Transient fires for all fire zones with the exception of the Turbine Building are postulated throughout the individual fire zones in a contiguous manner. The modeling of the transient scenarios ensures that impact on any plant component or raceway within a PAU that is within the zone of influence of a transient fire is captured, not just those locations that impact redundant trains or risk-significant equipment. The Turbine Building transient fire evaluation was performed in a more conservative bounding analysis and is described below.

   All targets within a PAU are impacted by at least one transient fire. To account for overhead cable tray congestion, those targets not identified in the walk-downs of the transient zones of influence were assumed to fail in all transient fires within the PAU. Thus, transient fires are placed at all appropriate locations, including pinch points that are located within the zone of influence of a transient fire. The transient fire scenarios overlap each other, where necessary, to account for additional combinations of targets along the edge of the transient fire zone of influence.

   A hot work fire is postulated for each cable tray in a plant location where a cable fire caused by welding and cutting is specified in the NUREG/CR-6850 ignition source bins (no cable fire caused by welding and cutting is postulated in containment). The fire is assumed to impact all cables within the tray.

   Turbine Building Transient Fire Scenario approach

   The cables and equipment for risk significant components (offsite power feed, diesel generator, 4 kV switchgear and Reactor Coolant Pumps, etc.) in Fire Zone 197-X (Turbine Building fire area) were identified. Based on the zone of influence (ZOI) for transient fires (317 kW 98th percentile fires), a walk-down was performed of the routing points for the high risk components and cables in the Turbine Building. Scenarios were developed wherever one or more of these cables were found to be located within a transient ZOI within the Turbine Building. All trays/conduits/equipment within Fire Zone 197-X (except the west Heater Deck), for components other than the risk significant components identified above, were included in the transient scenarios in the walk-down for the risk significant components. A "Transient Base" scenario was developed to account for the remaining Fire Zone 197-X transient floor area factor by failing all remaining non-risk significant components routed through Fire Zone 197-X in a single scenario. The risk significant components were excluded from this scenario since any respective impact was addressed separately in the scenarios for risk significant components.

An area factor of the transient scenario ZOI divided by the Fire Zone 197-X floor area was applied to the risk significant transient. The area factor for the balance of the Turbine Building floor area is applied to the non-risk significant turbine building transient scenario. Fire Area 197-X at the west Heater Deck (WHD) is within Fire Zone 197-X, and was walked down separately. Six transient scenarios were developed within the WHD. The floor area contribution of the WHD was removed from the floor area contribution of the Fire Zone 197-X Transient Base scenario.

This set of scenarios encompasses the transient fire impacts for Fire Zone 197-X. This approach is detailed in Scenario Report Attachment H.

In summary, no areas of the Turbine Building were excluded. The total ignition frequency for transients in the Turbine Building is accounted for between the risk significant transient scenarios, the transient fire non-risk significant base scenario, and the Turbine Building WHD transient scenarios.

d) Transient fire frequency is allocated either by partitioning the total transient frequency by the number of transient scenarios in the zone or by dividing the floor area of the transient scenario by the total floor area of the fire zone in order to provide a weighting factor for each transient fire scenario with respect to all locations where transient fires could occur in the fire zone. The floor area approach applied to the Turbine Building transient fire analysis is described in Item c above.

<u>PRA RAI 12</u> – Single vs Multiple Bundle Cables in MCR Analysis

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a fire PRA and endorses, with exceptions and clarifications, NEI 04-02, Revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. By letter to NEI dated July 12, 2006, the NRC established the ongoing FAQ process where official agency positions regarding acceptable methods can be documented until they can be included in revisions to RG 1.205 or NEI 04-02. Methods that have not been determined to be acceptable by the NRC staff or acceptable methods that appear to have been applied differently than described require additional justification "to allow the NRC staff to complete its review of the proposed method.

The fire scenario analysis for determining MCR abandonment times indicates that it was assumed that "half of the panels will involve a single cable bundle and the other half will be multiple bundle cables," and that because of "rapid detection of fires in the control room significantly more than 50% of the fires are likely to be detected and suppressed before progressing to multiple cable bundle fires." These assumptions appear to be made without supporting fire modeling or event data and so it is not clear what the opportunity for suppression is before cables in multiple bundles are involved in a fire, and whether this assumption is conservative compared to, for example, specifically identifying and modeling single and multiple cable bundles based on a walkdown. The NRC staff also notes that this assumption is a deviation from NUREG/CR-6850 guidance, which treats individual electrical panels as containing either a single cable bundle or multiple cable bundles.

Please provide further justification that the assumption is conservative based on characterization of the actual cable bundle configurations in the MCR cabinets, or update risk results as part of the integrated analysis requested in PRA RAI 03.

Response

The control room abandonment frequency analysis is being revised to assume that all panels are multi-cable bundle fires to eliminate the concern identified in this RAI. The results of this revised analysis will be incorporated into the response for PRA RAI 03.

<u>PRA RAI 14</u> – Additional Risk of Recovery Actions

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. Section 2.4.4.1 of NFPA-805 further states that the change in public health risk arising from transition from the current FPP to an NFPA-805 based program, and all future plant changes to the program, shall be acceptable to the NRC. RG 1.174 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 the following information that is required to fully characterize the risk estimates.

Attachment W of the LAR, Section W.1, cites the licensee's analysis on calculation of additional risk of recovery actions risk associated with VFDRs, but does not provide a description of this calculation in the LAR. The NRC staff notes that per Attachment G of the LAR, recovery actions are only credited in two fire areas, Fire G and B-1@BOFZ. Please describe how the additional risk of recovery actions is calculated for these two areas. Please include an explanation of whether the approach is consistent with guidance in FAQ 07-0030, "Establishing Recovery Actions."

Response

From FAQ 07-0030, additional risk can be evaluated using the following process:

> “Model the recovery action explicitly in the Fire PRA, with an appropriate human error probability and calculate the CDF (LERF). Subtract the CDF (LERF) obtained by eliminating the VFDR in the PRA model to create a compliant case. This gives the ΔCDF and ΔLERF associated with performing the action compared to providing a deterministic resolution.”

Using this method, the delta risk of recovery actions is calculated by setting the HEP for recovery actions to zero or to an equivalent Control Room action HEP in the variant plant quantification. The difference between the nominal variant case risk for the associated fire scenarios and the risk with the recovery HEP adjusted as noted above provides the delta risk of recovery actions.

The use of a zero value or equivalent Control Room action HEP provides a compliant action which effectively eliminates the VFDR, necessitating credit for the HEP, as specified in FAQ 07-0030.

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)