Xcel Energy®

Prairie Island Nuclear Generating Plant
1717 Wakonade Drive East
Welch, MN 55089

June 19, 2015

L-PI-15-052
10 CFR 50.90
10 CFR 50.48(c)

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

Prairie Island Nuclear Generating Plant Units 1 and 2
Dockets 50-282 and 50-306
Renewed License Nos. DPR-42 and DPR-60

License Amendment Request to Adopt NFPA 805 Performance-Based Standard for Fire Protection for Light Water Reactors – Response to Request for Additional Information – 90-Day Responses (TAC Nos. ME9734 and ME9735)

References:

1. NSPM letter, J.P. Sorensen to NRC Document Control Desk, *License Amendment Request to Adopt NFPA 805 Performance-Based Standard for Fire Protection for Light Water Reactors,* L-PI-12-089, dated September 28, 2012 (ADAMS Accession No. ML12278A405).

2. NSPM letter, S. Sharp to NRC Document Control Desk, *Supplement to License Amendment Request to Adopt NFPA 805 Performance Based Standard for Fire Protection for Light Water Reactors,* L-PI-14-045, dated April 30, 2014 (ADAMS Accession Nos. ML14125A106 and ML14125A149).

3. NRC email, T. Beltz to S. Chesnutt, *Prairie Island Nuclear Generating Plant, Units 1 and 2 - NFPA 805 Requests for Additional Information and Response Timeline (TAC Nos. ME9734 and ME9735),* dated March 30, 2015 (ADAMS Accession No. ML15089A157).

4. NSPM letter, K. Davison to NRC Document Control Desk, *License Amendment Request to Adopt NFPA 805 Performance-Based Standard for Fire Protection for Light Water Reactors – Response to Request for Additional Information,* L-PI-15-041, dated May 28, 2015 (ADAMS Accession No. ML15153A018).

In Reference 1, the Northern States Power Company, a Minnesota Corporation (NSPM) doing business as Xcel Energy requested approval from the Nuclear Regulatory Commission (NRC) to transition the fire protection licensing basis for the Prairie Island Nuclear Generating Plant (PINGP) to 10 CFR 50.48(c), National Fire Protection

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Association Standard 805 (NFPA 805). Supplemental information was provided in letters dated November 8, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12314A144) and December 18, 2012 (ADAMS Accession No. ML12354A464).

In Reference 2, NSPM submitted a revised Fire Probabilistic Risk Assessment (PRA) in a supplement to the subject License Amendment Request (LAR). In Reference 3, the NRC staff provided requests for additional information (RAIs) regarding this request and also provided a timeline and due dates for submitting responses within 60, 90, or 120 days after an on-site Audit that was conducted March 23-25, 2015. NSPM letter dated May 28, 2015 (Reference 4) provided responses to the 60-day RAIs and one of the 90-day RAIs (Fire Protection Engineering RAI 03).

Enclosure 1 to this letter provides NSPM's responses to the remaining 90-day RAIs which are due by June 26, 2015.

Enclosure 2 provides Licensee Identified Changes to the LAR (Reference 2) that are not directly associated with RAI responses.

NSPM requests a change to the implementation period for Implementation Items listed in Attachment S, Table S-3 from 6 months to 12 months in order to ensure proper completion of the changes listed in Table S-3 and other related activities (e.g., document updates, staff training) needed for complete and thorough implementation of the NFPA 805 license amendment. NSPM requests a 12-month implementation period because of the extensive nature of the changes and other staffing demands at the two-unit PINGP site. Twelve months is also consistent with the implementation periods provided in several recently approved NFPA 805 license amendments for other licensees, e.g., Fort Calhoun Station, Cooper Nuclear Station, D.C. Cook Nuclear Plant, and Turkey Point Nuclear Generating Unit.

This letter is submitted in accordance with 10 CFR 50.90. The additional information provided in this letter does not impact the conclusions of the No Significant Hazards Evaluation or Environmental Considerations Evaluation presented in Reference 2.

In accordance with 10 CFR 50.91, NSPM is notifying the State of Minnesota of this additional information by transmitting a copy of this letter to the designated State Official.

If there are any questions or if additional information is needed, please contact Gene Eckholt at 651-267-1742.

Summary of Commitments

This letter contains no new commitments and makes no revisions to any existing commitments.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on JUN 19 2015

Kevin Davison

Kevin Davison
Site Vice President, Prairie Island Nuclear Generating Plant
Northern States Power Company - Minnesota

Enclosures (2)

cc: Administrator, Region III, USNRC
NRR Project Manager, PINGP, USNRC
Resident Inspector, PINGP, USNRC
State of Minnesota

Response to Requests for Additional Information (RAIs) Regarding the License Amendment Request to Adopt National Fire Protection Association (NFPA) Standard 805 at Prairie Island Nuclear Generating Plant Units 1 and 2

Responses to 90-Day RAIs

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Introduction

This Enclosure provides additional information from the Northern States Power Company, a Minnesota corporation (hereafter "NSPM") doing business as Xcel Energy, in support of a License Amendment Request (LAR) to transition the Fire Protection Licensing Basis for the Prairie Island Nuclear Generating Plant (PINGP) to National Fire Protection Association Standard 805 (NFPA 805).

NSPM submitted an NFPA 805 LAR for PINGP in a letter dated September 28, 2012 (ADAMS Accession No. ML12278A405). Supplemental information was submitted in letters dated November 8, and December 18, 2012 (ADAMS Accession Nos. ML12314A144 and ML12354A464, respectively). In a letter dated April 30, 2014, NSPM submitted a revised Fire Probabilistic Risk Assessment (PRA) in a supplement to the subject LAR (ADAMS Accession Nos. ML14125A106 and ML14125A149). This 2014 Supplement included the entire LAR and was designated "Revision 1;" this is the version referred to in discussions involving "the LAR."

After an onsite audit conducted during the week of March 23, 2015, the NRC staff provided final requests for additional information (RAIs) and a response timeline in an email dated March 30, 2015 (ADAMS Accession No. ML15089A157). The timeline provided due dates for 60, 90, and 120-day RAI responses. NSPM letter dated May 28, 2015 (ADAMS Accession No. ML15153A018) provided responses to the 60-day RAIs and one of the 90-day RAIs (Fire Protection Engineering RAI 03).

The Enclosure to this letter provides NSPM's responses to the remaining 90-day RAIs which are due by June 26, 2015, as follows:

- Safe Shutdown Analysis (SSA) RAI 07
- Fire Modeling (FM) RAIs 01, 02, 03
- Probabilistic Risk Assessment (PRA) RAIs 01.e, 01.g, 02.a, 07, 08, 12, 16, 17, 18

Each of the RAI questions is quoted in italics and each question is then followed by the NSPM response in normal font. Referenced documents are identified at the end of each RAI response.

RAI Responses – Safe Shutdown Analysis (SSA)

SSA RAI 07

NFPA 805, Section 2.4.3.3, states that the PSA (Fire Risk Evaluation) approach, methods, and data shall be acceptable to the AHJ (NRC). NFPA 805, Section 2.4.3.2, states that the PSA evaluation shall address the risk contribution associated with all potentially risk-significant fire scenarios.

In Attachment C of the LAR, the fire risk evaluation for Fire Areas 13 and 18 credited various recovery actions and modifications to resolve VFDR [Variances from Deterministic Requirements]-013-1-02 and VFDR-018-1-02 for Unit 1, and VFDR-013-2-02 and VFDR-018-2-02 for Unit 2.

Please provide the following clarifications related to these VFDRs:

[This RAI includes Subparts a - d as shown below along with NSPM responses.]

NRC Request (SSA RAI 07.a):

a. *For VFDR-18-2-02 in Attachment C, the licensee discusses its evaluation of recovery actions to remove power and manually close MV-32178 and MV-32179. Attachment G of the LAR includes credited recovery actions to de-energize Sump B motor-operated valves (MV-32075, MV-32076, MV-32077, MV-32078, MV-32178, MV-32179, MV-32180 and MV-32181) at their respective motor control centers (MCC). However, Attachment G does not include any specific action(s) to verify the valve position locally or to realign these valves locally if needed.*

   Please discuss the consequences of circuit failure due to open circuits, hot shorts and shorts-to-ground, and describe how the credited recovery actions to only de-energize the valves address the consequences of potential spurious operation to meet the risk evaluation criteria.

NSPM Response (SSA RAI 07.a):

a. NSPM has re-evaluated the Refueling Water Storage Tank (RWST) to containment Sump B drain down scenario and has determined that the following Recovery Actions are no longer needed:

   - De-energize Sump B motor-operated valves (MV-32075, MV-32076, MV-32077, MV-32078, MV-32178, MV-32179, MV-32180 and MV-32181) at their respective motor control centers (MCC)
   - De-energize and manually operate RWST to Residual Heat Removal (RHR) pump isolation valves (MV-32084, MV-32085, MV-32187, MV-32188) upstream of the containment Sump B isolation valves

   The revised delta-risk values were calculated in a sensitivity study, meet the acceptance criteria defined in Regulatory Guide 1.174, and will be included in the response to PRA RAI 03. The Fire Risk Evaluations (FREs) for Fire Areas 13 and 18 will also be revised

to reflect these changes and to support the response to PRA RAI 03, and these revised FREs will be made available on the PINGP NFPA 805 web portal.

LAR Attachments C and G should be revised as follows:

1. LAR Attachment C revision

Revise Variance From Deterministic Requirements (VFDR) dispositions for Fire Areas 13 and 18 as follows:

VFDR-013-1-02 Disposition:

"Evaluate Recovery Actions performed in F5 Appendix B [Reference 15] (Attachments A, B, E and F) to isolate Letdown, Excess Letdown, Head vents, Pressurizer vents, ~~de-energize Sump B valves,~~ de-energize the Containment Spray Pump, locally trip the Reactor Coolant Pumps at the Bus, and actions to re-align 12 Charging Pump suction to the RWST and restart a charging pump. ~~Evaluate Recovery Actions to de-energize and manually close MV-32084 and MV-32085.~~

Modification identified in Table S-2, Item #15 will provide suction protection to the charging pumps so the charging pump can be restarted after suction from the RWST is restored to inject borated water into the RCS.

This VFDR has been evaluated and it was determined that the risk, safety margin and defense-in-depth meet the acceptance criteria of NFPA 805 Section 4.2.4 with recovery actions and plant modifications credited."

VFDR-013-2-02 Disposition:

"Evaluate Recovery Actions performed in F5 Appendix B [Reference 15] (Attachments A, B, D and G) to isolate Letdown, Excess Letdown, Head vents, ~~de-energize Sump B valves,~~ de-energize the Containment Spray Pumps, locally trip the Reactor Coolant Pumps, and actions to re-align 22 Charging Pump suction to the RWST and restart a charging pump. ~~Evaluate Recovery Actions to de-energize and manually close MV-32178 and MV-32179.~~

Modification identified in Table S-2, Item #15 will provide suction protection to the charging pumps so the charging pump can be restarted after suction from the RWST is restored to inject borated water into the RCS.

This VFDR has been evaluated and it was determined that the risk, safety margin and defense-in-depth meet the acceptance criteria of NFPA 805 Section 4.2.4 with recovery actions and plant modifications credited."

VFDR-018-1-02 Disposition:

"Evaluate Recovery Actions performed in F5 Appendix B (Attachments A, B, E, and F) to isolate Letdown, ~~de-energize Sump B valves,~~ de-energize the Containment Spray Pump, locally trip the Reactor Coolant and actions to re-align

12 Charging Pump suction to the RWST and restart a charging pump. ~~Evaluate Recovery Actions to de-energize and manually close MV-32084 and MV-32085.~~

Modification identified in Table S-2, Item #15 will provide suction protection to the charging pumps so the charging pump can be restarted after suction from the RWST is restored to inject borated water into the RCS.

Modification identified in Table S-2, Item #27 will provide a means to isolate Pressurizer PORVs, Excess Letdown, Head Vents, Pressurizer Vents, and Pressurizer Heaters prior to room evacuation.

This VFDR has been evaluated and it was determined that the risk, safety margin and defense-in-depth meet the acceptance criteria of NFPA 805 Section 4.2.4 with recovery actions and plant modifications credited."

<u>VFDR-018-2-02 Disposition:</u>

"Evaluate Recovery Actions performed in F5 Appendix B (Attachments A, B, D, and G) to isolate Letdown, ~~de-energize Sump B Valves,~~ de-energize Containment Spray Pump locally trip the Reactor Coolant Pumps and actions to re-align 22 Charging Pump suction to the RWST and restart a charging pump. ~~Evaluate Recovery Actions to de-energize and manually close MV-32178 and MV-32179.~~

Modification identified in Table S-2, Item #15 will provide suction protection to the charging pumps so the charging pump can be restarted after suction from the RWST is restored to inject borated water into the RCS.

Modification identified in Table S-2, Item #27 will provide a means to isolate Pressurizer PORVs, Excess Letdown, Head Vents, Pressurizer Vents, and Pressurizer Heaters prior to room evacuation.

This VFDR has been evaluated and it was determined that the risk, safety margin and defense-in-depth meet the acceptance criteria of NFPA 805 Section 4.2.4 with recovery actions and plant modifications credited."

2. <u>LAR Attachment G revision</u>

Revise Table G-1 to delete the following Recovery Actions for Fire Areas 13 and 18:

- De-energize Sump B motor-operated valves MV-32075, MV-32076, MV-32077, MV-32078, MV-32178, MV-32179, MV-32180, and MV-32181.
- De-energize and manually close RWST to RHR pump isolation valves MV-32084 and MV-32085 (Unit 1), and MV-32187 and MV-32188 (Unit 2).

NRC Request (SSA RAI 07.b):

b. Attachment C of the LAR did not discuss the modifications listed in Attachment S of the LAR to address IN 92-18 related to the above VFDRs (e.g., modification to MV-32085 and MV-32188).

Please provide justification for not including these modifications in Attachment C, or revise Attachment C accordingly.

NSPM Response (SSA RAI 07.b):

b. Modifications to address IN 92-18 related to the VFDRs listed in the RAI should have been included in Attachment C. However, NSPM has performed additional sensitivity analyses and has determined that the modifications to MV-32085 and MV-32188 that are described in Attachment S of the LAR, Table S-2, Item 36, are no longer needed. Attachment S will be revised and included with the response to the 120-day RAIs, and Table S-2 Item 36 will be deleted at that time. The Fire Risk Evaluations (FREs) for Fire Areas 13 and 18 will also be revised to support the response to the 120-day RAIs, and these revised FREs will be made available on the PINGP NFPA 805 web portal. Revisions to Attachments C and G to reflect the deletion of these modifications are described in the response to Subpart a above.

NRC Request (SSA RAI 07.c):

c. *The recovery actions and modifications to address IN 92-18 only appear to address one of the redundant supplies from the RWST to the Residual Heat Removal (RHR) pumps (MV-32085 for Unit 1 and MV-32188 for Unit 2), and do not address MV-32084 for Unit 1 or MV-32187 for Unit 2.*

Please provide a justification for only needing to address the recovery actions and modifications for valves MV-32085 and MV-32188, and not for their redundant counterparts MV-32084 and MV-32187.

NSPM Response (SSA RAI 07.c):

c. As described in the response to Subpart a above, the recovery actions and modifications for valves MV-32085 and MV-32188, and their counterparts MV-32084 and MV-32187, have been determined to no longer be needed and should be removed from Attachments C and G.

NRC Request (SSA RAI 07.d):

d. *Attachment G of the LAR includes a recovery action to de-energize MV-32085 from two different power supplies: MCC 1K2 (VFDR-013-1-02 and VFDR-018-1-02) and MCC 2K2 (VFDR-013-2-02 and VFDR-018-2-02). It appears that the entry for MCC 2K2 has a typographical error – it refers to MV-32085 as the valve number for "RWST TO 22 RHR PUMP ISOL VLV MV-32085," but the next recovery action identifies the RWST valve to 22 RHR PUMP as MV-32188.*

Please revise Attachment G, as needed, to resolve this conflict.

NSPM Response (SSA RAI 07.d):

d. The entry for MCC 2K2 in Attachment G does have a typographical error in referring to MV-32085 instead of MV-32188. However, this recovery action should be deleted, as described in the response to Subpart a above.

Response to RAIs – Fire Modeling

FM RAI 01

NFPA 805, Section 2.4.3.3, states that the PRA approach, methods, and data shall be acceptable to the NRC. The NRC staff noted that FM comprised the following:

- *The algebraic equations implemented in FDTs [Fire Dynamics Tools] and Fire-Induced Vulnerability Evaluation, Revision 1 (FIVE), were used to characterize flame height, plume temperature, ceiling jet temperature, flame radiation (heat flux), and hot gas layer (HGL) temperature.*
- *The Consolidated Model of Fire and Smoke Transport (CFAST) was used in the multi-compartment analysis (MCA) and the Relay Room analysis.*
- *Fire Dynamics Simulator (FDS) was used to assess MCR habitability.*
- *The FLASH-CAT model was used to calculate the fire propagation in a vertical stack of horizontal cable trays.*

Section 4.5.1.2 of the LAR, "Fire PRA," states that FM was performed as part of Fire PRA development (NFPA 805 Section 4.2.4.2). Reference is made to Attachment J, "Fire Modeling V&V [Verification and Validation]," of the LAR for a discussion of the acceptability of the fire models that were used.

Regarding the acceptability of the PRA approach, methods, and data:

[This section of the RAI includes Subparts a-e, as shown below with NSPM responses]

NRC Request (FM RAI 01.a):

a. *Please identify whether any fire modeling tools and methods have been used in the development of the LAR that are not discussed in Attachment J, and describe their application.*

NSPM Response (FM RAI 01.a):

a. Attachment J of the NFPA 805 LAR currently lists all the fire models used in support of the transition process. No other analytical fire models have been used in support of the transition process.

NRC Request (FM RAI 01.b):

b. *Please provide information on how non-cable secondary combustibles were identified and accounted for in the fire modeling analyses.*

NSPM Response (FM RAI 01.b):

b. Plant walkdowns were conducted in the fire compartments analyzed with detailed fire modeling in the PINGP Fire PRA with the purpose of identifying non-cable secondary

combustibles that could affect the fire scenario progression. With a single exception, no exposed non-cable combustibles such as HVAC insulation, piping insulation, and plastic (HDPE, PVC, etc.) piping were identified during the walkdowns. Rubber insulation for cold piping was identified in some fire compartments. However, this insulation is covered by non-combustible (i.e., calcium silicate or fiberglass) thermal insulation material. Therefore, fire propagation due to non-cable intervening combustibles was not postulated.

NRC Request (FM RAI 01.c):

c. Please describe how cable trays with covers, fire-resistive wraps and FR coated cables were treated in the fire modeling calculations in terms of ignition and fire propagation, and how the presence of holes in cable tray covers was accounted for.

NSPM Response (FM RAI 01.c):

c. Fire wraps (Electrical Raceway Fire Barrier Systems - ERFBS) that are able to meet a one hour minimum fire endurance rating are credited in the Prairie Island Fire PRA to prevent cable failure, ignition, and fire propagation. Fire wraps are not credited for preventing cable damage in High Energy Arcing Fault (HEAF) scenarios or in the high hazard scenarios postulated in the Structural Steel Analysis consistent with NUREG/CR-6850. Cable Tray covers and fire retardants used as cable coatings are not credited in the PINGP Fire PRA. Since cable tray covers were not credited to prevent fire spread, holes in cable tray covers have no impact on the Prairie Island Fire PRA.

NRC Request (FM RAI 01.d):

d. The heat release rate (HRR) of electrical cabinets throughout the plant appears to be based on the assumption that they are Case 2 (closed doors and fire involving multiple bundles of qualified cable) as described in Table E-1 of NUREG/CR-6850, Volume 2, even though some cabinets may contain a mix of qualified and non-qualified cables. The NRC staff notes that typically, during maintenance or measurement activities in the plant, electrical cabinet doors are opened for a certain period of time.

Please explain what administrative controls are in place to minimize the likelihood of fires involving such a cabinet, and describe how cabinets with temporary open doors containing non-qualified cables were treated in the fire modeling analysis.

NSPM Response (FM RAI 01.d):

d. The majority of the HRR assigned are conservatively assigned a Case 5, 98th percentile HRR of 1002 kW. Case 5 identifies vertical cabinets with unqualified cable with more than one cable bundle and open doors. This is the largest HRR assigned to electrical cabinets (Bin 15) in NUREG/CR-6850. Only a small number of electrical cabinets are assigned a HRR smaller than Case 5. Specifically, only the cabinets located in the Relay Room (Fire Compartment 18) are assigned a Case 2, 98th percentile HRR of 702 kW. Case 2 identifies vertical cabinets with qualified cable, fire in more than one cable bundle. This assignment for cabinets in the Relay Room is justified in the response to PRA RAI 01.d, where the majority of the cables at PINGP are of thermoset material. In

summary, the assigned heat release rate probability distributions are based on the highest 98th percentile values (i.e., those assuming fires propagating to more than one cable bundle) for both thermoset and thermoplastic cables. By selecting the most conservative distributions, the fire modeling analysis supporting the PINGP Fire PRA does not rely on the assumption of closed electrical cabinet doors in most areas. The Foreign Material Exclusion and Control procedure (FP-MA-FME-01) includes a statement "Never leave open electrical enclosures, cabinets, boxes, or conduits unattended unless specifically instructed to do so by procedure, operations, or the work task supervisor."

NRC Request (FM RAI 01.e):

e. *Please provide justification for the assumed fire areas and elevations that were used in the transient fire modeling analyses. Explain how the model assumptions in terms of location and HRR of transient combustibles in a fire area or zone will not be violated during and post-transition.*

NSPM Response (FM RAI 01.e):

e. The fire elevation for transient fires is 0.61 m (i.e., approximately 2 ft). Since the transient fires are due to items brought temporarily into the fire compartment, there is uncertainty associated with the fire elevation. The 2' elevation is a necessary practical assumption to account for combustibles that may not be located at floor level, and is representative of typical equipment carts, for example, that are brought into fire compartments. All of the open floor areas in the fire compartment are included in the transient zone areas. This ensures that all possible locations of transient combustibles are considered in the Fire PRA. The size of a defined transient zone is larger than the size of a "zone of influence" as calculated using fire modeling tools (i.e., as described in Appendix F of NUREG/CR-6850). Transient zones extend from the floor slab to the ceiling slab in the transient zone. By covering the complete zone volume, it is expected that these critical portions of the fire compartments are identified. In summary,

- Transient fires are assumed to occur in all open floor areas within the fire compartment (i.e., floor areas that are not currently occupied by fixed plant equipment).
- The fire elevation is assumed to be 0.6 m (i.e., approximately 2 ft above the floor). The practical implication of this assumption is reflected in the determination of severity factors.
- The vertical zone of influence extends from the floor to the ceiling. Therefore, all targets within the defined transient zone are mapped to the transient scenario regardless of the fire elevation.

Transient combustibles during and post transition will be controlled by plant procedure FP-PE-CC-01 (Combustible Control procedure). FP-PE-CC-01 includes requirements and guidance for:

- Performing periodic inspections to verify compliance with the combustible control procedure,
- Specifying approved containers for storage, transfer, and use of combustible material,

- Identifying combustible exclusion areas in accordance with NFPA 805 risk-based evaluations,
- Ensuring all areas containing safety-related cables or equipment are surveyed for fire hazards, including combustible materials, once each Operations shift, and
- Identifying requirements for requesting a combustible control permit.

The 98th percentile HRR (317 kW) for transient fires listed in NUREG/CR-6850, Table G-1, are based on tested fuel package configurations identified in NUREG/CR-6850, Table G-7. The configurations tested are various solid fuel packages such as cardboard, paper, plastics, cotton rags, and acetone. The model assumptions regarding location and HRR of transient combustibles in a fire area will not be violated because Prairie Island plant procedures require that paper, cardboard, scrap wood, rags, and other trash combustibles shall not be allowed to accumulate in any critical building/location except in metal containers with metal covers. Notice that combustible exclusion areas may be defined based on risk associated with the postulated transient fire scenarios. Since transients are assumed within all open floor areas in the fire compartment, the requirements and guidance in the above listed procedure will appropriately control the amount, type and location of combustibles such that the model assumptions will be maintained during and post-transition.

Specifically regarding the detailed FM conducted in single compartments at PINGP:

[This section of the RAI includes Subparts f through k, as shown below with NSPM responses]

NRC Request (FM RAI 01.f):

f. Please describe how Transient Zones (including those in the Relay Room and selected areas in the Turbine Building) were created and analyzed. In addition, explain how it was ensured that targets on the border of a Transient Zone were not missed in the analysis.

NSPM Response (FM RAI 01.f):

f. Transient zones represent the transient fire zones postulated in the PINGP Fire PRA. Transient zones are considered to be an "expanded" zone of influence intended to capture all of the targets within the scope of the Fire PRA in the location where the transient fire scenario is postulated. The identification of fire scenarios and the mapping of targets to ignition sources within a transient zone rely on inspection and analysis of plant-layout, cable tray, conduit, and electrical arrangement drawings. The following elements ensure that targets on the border of a transient zone are not missed in the analysis:

- Transient zones extend from the floor slab to the ceiling slab in the transient zone.
- All of the open floor areas in the fire compartment are included in the transient zone areas.
- A thorough mapping of targets is conducted for each transient zone. Targets include conduits, cable trays and cable end points as listed in the cable routing database.

- Targets located nearby the boundaries between transient zones have been mapped to all transient zones adjacent to that boundary. This ensures that transient fires that may occur along the borders of a defined transient zone capture the appropriate targets.
- "Pinch points" is the term usually used to refer to sections of a fire compartment where two divisions are nearby or, alternatively, where a number of risk significant cables are close together. The size of a defined transient zone is larger than the size of a "zone of influence" as calculated using fire modeling tools (i.e., as described in Appendix F of NUREG/CR-6850). By covering the complete zone volume, it is expected that these critical portions of the fire compartments are identified.
- The scenarios involving the development of a damaging hot gas layer (full zone damage) are also evaluated. For cases where the combination of the transient heat release rate and the heat release rate associated with secondary combustibles (i.e., cable trays) capable of generating a hot gas layer scenario, a damage state is included in the scenario progression, consisting of damaging the full fire compartment.

In response to the Staff's RAIs, walkdowns were performed to inspect the boundaries of the different postulated transient zones and to determine if there were intervening combustibles that could provide a fire propagation path between fire scenarios. Additionally, cable tray drawings were inspected for the same purposes. For those fire scenarios where fire propagation outside the transient zone is possible, additional damage states have been added to the Fire PRA capturing the risk associated with such conditions. The target set associated with these propagating damage states includes the failure of the targets mapped to the adjacent zone of influence. The fire ignition frequency associated with these propagating damage states includes credit for the non-suppression probability at the time of fire propagation. Finally, the risk contribution of these propagating damage states will be included in the Fire PRA quantification described in the response to PRA RAI 03.

NRC Request (FM RAI 01.g):

g. Target mapping is based on the conservative assumption that the zone of influence (ZOI) for each ignition source is 10-foot by 10-foot, regardless of the HRR of the ignition source.

Please explain why this assumption is conservative for fires that involve secondary combustibles or liquid pool fires.

NSPM Response (FM RAI 01.g):

g. The selection of the 10 foot by 10 foot zone of influence is used for selected fixed ignition sources. This zone of influence ensures a bounding initial target selection process for fixed ignition sources. The 98th percentile heat release rate is assigned according to Table G-1 in NUREG/CR-6850. The use of the point source flame radiation model with different 98th percentile HRR values from Table G-1 in NUREG/CR-6850 for assessing the horizontal component of the zone of influence, suggests that a distance of

10 feet is bounding. The following clarifications are made regarding the use of the 10-foot by 10-foot zone of influence:

1. As a bounding zone of influence, the target assignment inherently includes the consideration for fire propagation outside the a more restrictive zone that would be calculated using the 98^{th} percentile heat release rate values in Table G-1 of NUREG/CR-6850.
2. The vertical component of the zone of influence extends up to the ceiling of the fire compartment.
3. It only applies to fixed ignition sources listed in Table G-1 of NUREG/CR-6850. That is, it does not apply to "complex" sources such as propagating fires, oil fires, hydrogen fires, etc.
4. Because the conservative 10 foot by 10 foot zone of influence bounds the zone of influence calculated using the 98^{th} percentile heat release rates in Table G-1 of NUREG/CR-6850, this approach inherently accounts for fire propagation. For example, consider the largest fixed ignition source with a 98^{th} percentile heat release rate of 1002 kW and assuming a radiative fraction of 0.4. For this source, the critical radial distance is approximately 7.5 ft. Therefore, because all targets within the 10 ft by 10 ft ZOI are damaged, fire propagation of at least 2 feet is considered (10 – 7.5 = 2.5).
5. Oil fires are treated as follows: For small oil fires, the full zone of influence (10 foot by 10 foot) was failed with detailed fire modeling credited. For large oil fires, the analysis conservatively fails the entire fire compartment if the oil content of the ignition source is relatively large.

NRC Request (FM RAI 01.h):

h. According to Table J-1 in Attachment J to the LAR three methods were used for the HGL calculations: MQH, Beyler, and FPA.

Please describe the basis for selecting the method that was used in each individual compartment. Provide technical justification for the vent area of 1 m^2 [square meter] that was assumed in the HGL calculations using the MQH method.

NSPM Response (FM RAI 01.h):

h. The PINGP Fire PRA uses the MQH and the FPA models for calculating hot gas layer temperatures. The Beyler method is no longer used for calculating hot gas layer temperatures and it does not need to be included in Attachment J to the LAR. Specifically,

- The FPA method is used for scenarios with forced ventilation (i.e., mechanical ventilation and closed doors).
- The MQH method is used for scenarios with natural ventilation, with the vent area assumed to be 1 m x 1 m.

The selection of a vent area of size 1 m x 1 m is conservative as this area is smaller than the size of a typical fire door opening (i.e., which is approximately 2 m x 1 m). At the

same time, it allows enough air for the fire to be well ventilated and is unlikely to generate extinction due to low oxygen concentration.

From a verification and validation perspective, the fire scenarios using MQH are compared against the experiments used in the validation of MQH in NUREG-1824. The calculations of the equivalence ratio, in some cases, are lower than the validation range of the experiments documented in NUREG-1824, indicating lower oxygen availability. All the fire compartments where the equivalence ratio due to natural ventilation fall outside the validation range are modeled with an opening area of 1 m^2 (i.e., A_0 = 1 m^2). For this parameter to fall within the valid range, the area of this opening was increased to 1.2 m^2 (i.e., A_0 = 1.2 m^2). The effect of increasing this area on the maximum HGL temperature reached by the fire scenario is shown in the table below. For those compartments where a hot gas layer temperature above the damage criteria (i.e., 205°C) is predicted, the sensitivity model predicts a slight increase in time to damage, which is non-conservative. As expected, the maximum hot gas layer temperatures predicted by the sensitivity model decrease when compared to the original model due to the change in the area of the opening, which suggests conservatism in the selection of vent size even if the results are outside of the validation range for ventilation conditions. Therefore, it is concluded that because the sensitivity results are slightly less conservative than the original results for the HGL temperatures predicted for each compartment, the use of the MQH and FPA for these fire scenarios is justified and the validation results for these models presented in NUREG-1824 are applicable.

Sensitivity Results for the Equivalence Ratio in the MQH and FPA HGL Model

Compart-ment ID	Original HGL Model			Sensitivity HGL Model		
	Equivalence Ratio for a 1 m^2 Opening	Time at HGL Temperature of 205°C (min)	Maximum HGL Temperature (°C)	Equivalence Ratio for a 1.2 m^2 Opening	Time at HGL Temperature of 205°C (min)	Maximum HGL Temperature (°C)
20	0.67	6.8	527	0.55	7.3	498
21	0.67	9.5	319	0.55	9.5	301
31	0.67	9.2	312	0.55	9.7	295
32	0.67	10	288	0.55	10.5	272
37	0.67	7.8	444	0.55	8.3	419
38	0.67	9.0	316	0.55	9.0	299
80	0.67	8.0	384	0.55	8.5	363
81	0.67	7.0	416	0.55	7.5	393
2GRP	0.67	NA	153	0.55	NA	146
41GRP	0.67	NA	181	0.55	NA	171
41B-1	0.67	5.0	767	0.55	5.5	725

NA: Not applicable. Cases where the HGL did not reach the damage criteria temperature of 205°C.

Finally, NUREG-1934 lists a bias for the MQH model of 1.44. That is, the room temperatures are over predicted by approximately 40%. A comparison was developed between hot gas layer results assuming vent sizes reduced down to 0.25 m^2 corrected for the model over prediction and the hot gas layer temperature results in the PINGP Fire PRA (i.e., those assuming a vent size of 1.0 m^2). The comparison suggests that the model bias resulting in the over prediction accounts for smaller vent sizes.

In summary, the verification and validation process suggests that the use of the 1.0 m^2 vent size is conservative when compared to ventilation conditions within the validation range, and a sensitivity analysis suggests that the model bias (i.e., over predictions) accounts for smaller vent sizes.

NRC Request (FM RAI 01.i):

i. The licensee assumed that, if no automatic detection or fire watch is present, a challenging fire will generally be detected within 10 minutes due to either personnel in the plant and/or indications of failed components or alarm conditions in the control room.

Please provide additional technical justification for this assumption.

NSPM Response (FM RAI 01.i):

i. The 10 minute detection assumption is no longer used in the Fire PRA model. Alternatively, a delayed detection time of 15 minutes is assumed for the solution of the detection suppression event tree (i.e., event tree described in Appendix P of NUREG/CR-6850) supporting the calculation of non-suppression probabilities. The value of 15 minutes is based on the example solution of the detection suppression event tree in Appendix P of NUREG/CR-6850, and will be used in the analyses to support the response to PRA RAI 03.

NRC Request (FM RAI 01.j):

j. The cable tray fire growth model assumes that the burning region of cable trays is confined within the fire diameter of the ignition source plus any horizontal expansion beyond the fire diameter created by the 35° fire propagation up through the tray stack.

Provide technical justification for not considering horizontal flame spread beyond the 35° expansion cone.

NSPM Response (FM RAI 01.j):

j. The PINGP Fire PRA considers horizontal flame spread beyond the 35° angle expansion zone characterizing the first stage of fire propagation in a cable tray stack (i.e., the expansion cone). Specifically:

1. With respect to the fire modeling analysis supporting the relay room evaluation (Fire Compartment 18), the FLASH-CAT model documented in NUREG/CR-7010 is used for determining the heat release rate contribution from cable trays above fixed or transient ignition sources. The implementation of the FLASH-CAT model is not limited to fire propagation within the 35° angle expansion zone characterizing the first stage of fire propagation in a cable tray stack. This is the case because the input parameters are specified so that flame spread is modeled throughout the length of the cable trays, which extend farther than the 35° angle expansion zone.

2. The fire modeling analysis supporting the evaluation of the Turbine Building hot gas layer scenarios also uses the model FLASH-CAT for determining the heat release rate contribution of cable trays. It should be noted that regardless of the consideration of flame spread and fire propagation beyond the 35° angle expansion zone, no hot gas layer scenarios are postulated in the Fire PRA for fires postulated in electrical cabinets or small transient fires propagating to cable trays due to the relatively large size of the turbine building. Hot gas layer scenarios and the

corresponding failure of the turbine building are postulated in the Fire PRA for large/complex ignition sources such as turbine generator fires.

3. The fire modeling analysis supporting the multi-compartment analysis also uses the FLASH-CAT model for determining the heat release rates entered in CFAST to compute temperature and timing associated with the hot gas layer formation. Similar to the analysis supporting the Relay Room described earlier in Item 1 of this response, the implementation of the FLASH-CAT model is not limited to fire propagation within the 35° angle expansion zone characterizing the first stage of fire propagation in a cable tray stack.

4. The horizontal flame spread beyond the 35° expansion cone is not included for the Single Compartment Fire Modeling Analysis for fire compartments other than the ones listed earlier in the response. However, the Fire PRA implementation is conservative from both a fire size and target selection perspective due to the following reasons:

   a) The heat release rate per unit area assumed for the cable trays. The assumed value of 328 kW/m^2 is the average bench scale heat release rate for thermoset insulation types given in Appendix R to NUREG/CR-6850. This is higher than the value of 250 kW/m^2 for thermoplastic cable trays or 150 kW/m^2 for thermoset cable trays recommended by NUREG/CR-7010. Since the majority of cable is qualified (thermoset) or Kerite (Engineering Change 20695), the use of 328 kW/m^2 conservatively estimates the contribution to the total fire heat release rate from cable trays.

   b) As described in the responses to FM RAI 01 parts "f" and "g," the zone of influence associated with fixed and transient ignition sources have been conservatively selected to be larger than the one defined by a 35° angle expansion zone. The practical implication of this selection is that targets within this expanded zone of influence are included as impacts in the fire scenario at the time the zone of influence is damaged by fire.

NRC Request (FM RAI 01.k):

k. *Please describe the criteria that were used to decide whether a cable tray in the vicinity of an electrical cabinet will ignite following a high energy arcing fault (HEAF) event in the cabinet.*

   Explain how the ignited area was determined and subsequent fire propagation was calculated.

   Describe the effect of cable tray covers, fire-resistant wraps and FR cable coatings on HEAF-induced cable tray ignition and subsequent fire propagation.

NSPM Response (FM RAI 01.k):

k. Consistent with the guidance in Appendix M of NUREG/CR-6850 and the response to PRA RAI 10, the process for determining heat release rates in HEAF scenarios is as follows:

1. A peak heat release rate value is assigned to the switchgear or load center where the high energy arcing fault is postulated following the guidance in Appendix G of NUREG/CR-6850. This peak heat release rate is the 98th percentile of the probability distribution assigned to the ignition source. It is assumed that the peak heat release rate is achieved at the time of the explosion (i.e., no fire growth phase is credited).

2. Once the fault occurs, the combustibles that are present in the zone of influence (ZOI) of the fault are assigned a heat release rate. In most cases, these combustibles are cables routed in cable trays. Therefore, the guidance for determining cable tray heat release rates in Volume 1 of NUREG/CR-7010 or in Appendix R of NUREG/CR-6850 is used.

3. Fire propagation through secondary combustibles above the switchgear or load center is modeled following the guidance described in Appendix M of NUREG/CR-6850.

It should be noted that in practice, the ZOI identified for the HEAF scenarios is the same ZOI identified for the peak HRR of the electrical cabinet (i.e., switchgear or load center). This approach is considered conservative as Appendix M in NUREG/CR-6850 identifies a ZOI of 5 ft vertically and 1 ft horizontally from the cabinet's front or rear panel (versus the 10 ft by 10 ft horizontal ZOI assigned to fixed ignition sources in the PINGP Fire PRA). Any exposed cables in the first cable tray above the cabinet are ignited at the time of the HEAF. The cable tray fire will propagate to additional trays consistent with the non-HEAF scenarios. ERFBS are not credited for preventing cable damage in HEAF scenarios. In addition, cable tray covers and fire retardant (FR) coated cables are not credited in the Fire PRA.

Specifically regarding the detailed fire modeling conducted in the Relay Room at PINGP:

[This section of the RAI includes Subparts l-q, as shown below with NSPM responses]

NRC Request (FM RAI 01.l):

l. Wall and corner fires seem to be treated differently in the Relay Room fire modeling analysis, as compared to the Turbine Building or Single Compartment analysis.

Please describe in more detail how wall and corner fires were accounted for in the different parts of the Relay Room analysis (e.g., plume temperature, HGL, and detector actuation calculations).

NSPM Response (FM RAI 01.l):

l. The treatment of wall and corner effects in the PINGP Fire PRA is as follows:
   - Relay Room Analysis: Wall and corner effects are accounted for in the zone of influence analysis for determining the critical heat release rate used for calculating severity factors. Similarly, the hot gas layer calculations were performed considering wall configurations as numerous panels in the room are located along the perimeters of the wall. No fixed ignition sources are located in the corners of the room. For the case of smoke detection actuation, the smallest

fire identified for the relay room is electrical panel 112, which consists of a single panel fire with no overhead cable trays. This fire is used for determining the activation time that is applied in all the scenarios. This is considered the bounding case as this scenario would yield the longest times to the optical density and smoke layer height threshold.

- Turbine Building Analysis: Wall and corner effects are accounted for in the hot gas layer calculations performed for the Turbine Building.
- Single Compartment Analysis: Wall and corner effects are accounted for in the zone of influence analysis for determining the critical heat release rate used for calculating severity factors. Similarly, the hot gas layer calculations were performed considering wall or corner configurations depending on the ignition source configuration.

For the three cases described above, the peak HRR associated with the ignition source wall and corner is multiplied by 2 and 4, respectively, to account for wall and corner effects, respectively, and is applied consistent with the "image" method.

NRC Request (FM RAI 01.m.i):

m. Regarding fire propagation in cable trays in the Relay Room:

(i) The flame spread in cable trays with a mixture of thermoset and thermoplastic cables is calculated using a mass-weighted average approach.

Please provide technical justification for this approach.

NSPM Response (FM RAI 01.m.i):

(i) Guidance for the specification of flame spread rate in cable trays in Volume 1 of NUREG/CR-7010 recommends the use of the rate characterizing the majority of the cables within the tray. The flame spread rates for thermoset and thermoplastic cables are identified in NUREG/CR-7010 as 1.1 m/h and 3.2 m/h, respectively. As discussed in the response to PRA RAI 01.d, the majority of the cables at PINGP are of thermoset material. Therefore, the flame spread rate recommended in NUREG/CR-7010 is 1.1 m/h. As a conservative practice, PINGP instead used the flame spread rate resulting from a weighted average of the amount of thermoset and thermoplastic cable in each transient zone. Furthermore, after calculating the weighted average, the fastest spread rate was selected as representative for all the transient zones. For example, the mass-weighted flame spread average for TRA-14, which contains 65% thermoset and 35% thermoplastic cable trays, is calculated as:

Flame Spread = (0.65 x 1.1) + (0.35 x 3.2) = 1.84 m/h

This represents the worst-case (i.e., fastest spread rate) value for all the transient zones in the Relay and Computer Rooms. Therefore, a flame spread value of 1.84 m/h was used for all FLASH-CAT scenarios in the Relay Room. Since the majority of the cable jacket/insulation material in the Relay Room is thermoset, using a value of 1.84 m/h is conservative compared to the thermoset flame spread value of 1.1 m/h given in NUREG/CR-7010. Kerite insulated cable is

considered as thermoset for flame spread rate based on IEEE-383 test reports for PINGP Kerite insulated cable.

NRC Request (FM RAI 01.m.ii):

(ii) The percentage split assumed for the entire compartment is 65 percent thermoset and 35 percent thermoplastic, which is said to represent TRA-14 (transient zone 14).

Since there are 18 transient zones in this fire area, please provide additional information concerning the thermoset/thermoplastic percentage split in the remainder of this fire area and confirm that the values used in the analysis are representative or bounding.

NSPM Response (FM RAI 01.m.ii):

(ii) As stated in the response to Subpart m.i above, the percentage split of 65% thermoset and 35% thermoplastic for transient zone TRA-14 results in the fastest flame spread rate for all of the transient zones in the Relay and Computer Rooms. Calculated flame spread rates for other transient zones in the Relay Room varied from 1.1 m/h to 1.84 m/h. Use of a flame spread rate of 1.84 m/h for all FLASH-CAT scenarios in the Relay and Computer Rooms is conservative and bounding for all transient zones in this area.

NRC Request (FM RAI 01.n):

n. Please provide the technical basis for the material properties that were specified in CFAST for the combustibles in the Relay Room. Provide confirmation that the assumed soot yield and heat of combustion values lead to conservative estimates of the soot generation rate with respect to smoke detection. Explain how the CFAST smoke concentration bias reported in Table 4-1 of NUREG-1934 was accounted for in the smoke detector actuation calculations, or provide technical justification for ignoring this bias.

NSPM Response (FM RAI 01.n):

n. For the relay room analysis, smoke detection is predicted within 2.5 minutes and CO_2 delivery at 3.5 minutes. This value is applied to all the fire scenarios postulated in the relay room. Conservatively, this value was calculated using the scenario associated with TB1226, which is a single electrical cabinet with no overhead cable trays. That is, the detection results are based on the lowest heat release rate associated with fire scenarios in the relay room. In the specific case of scenario TB1226, the time to detection is limited by the time required to fill the beam pockets. At 2.5 minutes, the actual smoke optical density (OD) is 0.27 OD/m (nearly twice the specified detection limit 0.14 OD/m), which accounts for the bias in CFAST for smoke OD reported in NUREG-1934. In addition, by 3.3 minutes, the OD is 0.44 OD/m. In summary, the results suggest that the smoke layer height threshold is reached after the optical density threshold limit is reached, which makes the prediction not dependent on the model bias for smoke concentration.

The fuel properties selected are described in Appendix D, Section D.3 of the Relay Room Damage State Analysis report (FPRA-PI-RRA). Specifically, the specified material properties and other factors influencing the conservatisms in the analysis are as follows:

1. The material fuel properties are selected based on data provided in the Society of Fire Protection Engineering (SFPE) Handbook, Generation of Heat and Chemical Compounds in Fires chapter by Tewarson (Reference F-1).

2. The timing analysis is based on electrical cabinet fires. The fuel properties for cables/panels are defined by Polyethylene/Polyvinylchloride (sample number 5) in Table 3-4.14 of Tewarson (Reference F-1). These values are the highest soot yield and lowest heat of combustion for the specified material.

3. However, additional conservative assumptions and application of the detector timing are applied which are anticipated to bound the effects of the fuel properties. These include:

   a) Selection of the longest detection time of 2.5 minutes and a maximum delay in automatic suppression of 1 minute, resulting in 3.5 minutes until automatic suppression may be activated in the event tree.
   b) Selection of the lowest heat release rate fire in the Relay Room or Computer room as the basis for the detector timing. This is an electrical cabinet. Note that a transient ignition source has a lower HRR, but a faster growth rate than electrical cabinets, and the result is conservative.
   c) The detector performance is conservatively selected as 0.14 OD/m (9.4%/ft), based on experimental test program reported by Geiman and Gottuk (Reference F-2), which is sufficient for confidence that 91% of ionization detectors would alarm prior to this level of obscuration. Selection of a 50th percentile detector would result in faster detector timing. The smoke detectors installed in the Relay Room have an alarm sensitivity of 1.0%/ft. Therefore, the selection of 0.14 OD/m (9.4%/ft) for detector performance is conservative.
   d) The detector performance is based on the hot gas layer optical density. This approach is considered to be bounding and conservative because most smoke detectors have been observed to activate according to the arrival of plume or ceiling jet gases, which are typically very optically dense smoke. The smoke layer in comparison is considerably diluted and requires additional time to reach the detection threshold.
   e) The smoke is also required to fill at least two beam pockets prior to activation of the two required devices to trigger the suppression system. Since the smoke detectors are located at the ceiling, the smoke does not have to completely fill the second and third beam pockets in order to activate the detector. The sequence of events required to achieve detection is defined by the time required to fill the first beam pocket, and the time the overall smoke optical density is sufficient to activate the detectors. If the first 2 ft beam pocket has been completely filled with smoke with a small amount left to spill into adjacent pockets, and the smoke is optically dense, then at least two smoke detectors will activate. This approach ensures that sufficient smoke has been produced to expose two or more smoke detectors to the smoke

layer, and it is conservative in comparison to simply evaluating the time for the smoke layer to achieve the detection limit.

NRC Request (FM RAI 01.o):

o. *Please provide technical justification for consolidating the cable tray and ignition source fires in the CFAST analysis.*

NSPM Response (FM RAI 01.o):

o. The CFAST analysis is used for determining the time to the hot gas layer scenario in the Relay Room. Therefore, a heat release rate profile that includes both the ignition source and intervening combustibles is necessary to determine the room temperature increase in time. The ignition source is characterized by the heat release rate profile described in Appendix G of NUREG/CR-6850, where the growth phase of the fire lasted approximately 12 minutes, followed by a steady burning period of an additional 8 minutes. The heat release rate from cable tray fires is determined using the model FLASHCAT, which is described in NUREG/CR-7010, Volume 1. In summary, in order to determine the time at which the hot gas layer is postulated in the risk analysis, the contribution of the ignition source and the cable tray fires is used to develop a heat release rate profile that serves as an input to CFAST. The contributions of both the ignition source and secondary combustibles are consolidated in one heat release rate curve. The heat release rate profile is assumed to occur at the location of the ignition source. The consolidation is appropriate because all the predicted times for the generation of hot gas layer scenarios occur before 20 minutes, which is the time at which the heat release rate contribution from the fixed or transient ignition source ends. That is, time to hot gas layer is always predicted to occur before the ignition source extinguishes and only cable trays remain on fire. In addition, in most cases the time to hot gas layer is predicted to be within the time of ignition of the first few trays immediately above the ignition source and before significant fire propagation and flame spread through cable trays occur.

NRC Request (FM RAI 01.p):

p. *The results of the analysis show that in several cases, the oxygen is depleted in the Relay Room, such that the HRR and HGL temperature plateaus or decreases. The licensee stated that this room has re-circulating ventilation.*

Please provide additional information concerning the ventilation in the Relay Room and justify the prescribed ventilation input parameters used in the CFAST analysis.

NSPM Response (FM RAI 01.p):

p. The ventilation conditions in the Computer and Relay Room (i.e., Fire Compartment 18) are characterized for fire modeling purposes in terms of natural and mechanical characteristics:

   1. Natural Ventilation: The Relay room and Computer Room each have two standard size fire doors connected to the exterior of each compartment, which

governs the natural ventilation conditions for each compartment. The leakage area is based on a ½ -in opening assumed in each of the doors in both the Relay and Computer Room. NUREG/CR-6850 (Section F.2) recommends a ½-in opening. Doors to the Computer Room are 3'8" wide and 7' tall. Doors on the north wall of the Relay Room are 4' wide and 8' tall. The leakage is implemented in the CFAST model by assigning an opening fraction of 0.006 for each door, where (0.5 in × (1 ft/12 in) × 3 ft)/ (7 ft × 3 ft) = 0.00595 = 0.006.

2. Mechanical Ventilation: Fire Compartment 18 has no forced ventilation (i.e., no supply or exhaust) in or out of the room. It is cooled by a localized system, which re-circulates air inside the room. Therefore, no forced ventilation is modeled in the Relay Room in CFAST as the localized system does not add or extract air mass in or from the upper or lower layers in the two zone model formulation. Any smoke cooling effect the localized HVAC system may have is conservatively excluded.

NRC Request (FM RAI 01.q):

q. The Relay Room has very complex geometry, which includes beam pockets as well as a significant amount of obstructions in the form of cable raceways.

Please provide technical justification for the use of CFAST in this fire area.

NSPM Response (FM RAI 01.q):

q. The CFAST analysis is used for determining primarily the time to the hot gas layer and smoke detector activation in the Relay Room. For these applications, the room is characterized in CFAST as an equivalent volume that meets the requirements of the verification and validation study described in NUREG-1824. In addition, the CFAST model for the relay room is consistent with the guidance and examples in NUREG-1934 where hot gas layer temperatures are calculated.

In terms of hot gas layer temperature predictions, obstructions in the room will absorb some of the heat generated by the fire, and therefore produce lower gas temperatures relative to a room without obstructions. At the same time, reducing the room volume to account for obstructions is expected to produce slightly higher hot gas layer temperatures. To account for this impact, heat release rates for the different fire scenarios are conservatively specified so that: 1) the 98^{th} percentile values from the probability distributions for fixed and transient sources are used, and 2) the contribution for cable tray fires (i.e., secondary combustibles) is based on the assumption of no fuel extinction, and bounding flammability parameters.

CFAST is also utilized in the Relay Room analysis for determining smoke detection activation times. For this purpose, beam pockets in the room become relevant. The activation times are determined considering these beam pockets as the criteria for activation are based on both: 1) the obscuration within the beam pockets and 2) the volume of smoke required to fill at least two beam pockets as suggested by the hot gas layer development. In the application of detector timing, the obstructions will occupy volume in the upper elevations of the room, resulting in more rapid filling and dispersion of the smoke and increased likelihood that the fire will be detected. Therefore, no

consideration for the obstructions results in a conservative detection activation prediction.

In summary, the Relay Room evaluation was developed following the guidance of NUREG-1934 and meeting the validation requirements in NUREG-1824. Based on the influencing factors in the determination of hot gas layer temperatures and smoke detection activation, the CFAST modeling for the Relay Room provides bounding predictions.

Specifically regarding the detailed fire modeling conducted in the Turbine Building at PINGP:

[This section of the RAI includes Subparts r and s, as shown below with NSPM responses]

NRC Request (FM RAI 01.r):

r. Please describe how flame spread to secondary combustibles was performed in these fire areas. Explain whether the same approach was used as in the Relay Room, or if the approach described in the single compartment analysis was used.

NSPM Response (FM RAI 01.r):

r. As described also in the response to part "j" of FM RAI 01, the fire modeling analysis supporting the evaluation of the Turbine Building hot gas layer scenarios also used the model FLASH-CAT for determining the heat release rate contribution of cable trays. Therefore the approach used for flame spread to secondary combustibles in the Relay Room is identical to the approach used for the Turbine Building analysis. It should be noted that regardless of the consideration of flame spread and fire propagation beyond the 35° angle expansion zone, no hot gas layer scenarios are postulated in the Fire PRA for fires postulated in electrical cabinets or small transient fires propagating to cable trays due to the relatively large size of the turbine building. Hot gas layer scenarios and the corresponding failure of the turbine building is postulated in the Fire PRA for large/complex ignition sources such as turbine generator fires.

NRC Request (FM RAI 01.s):

s. Please explain how the HGL damage state was screened based on the sensitivity analysis.

NSPM Response (FM RAI 01.s):

s. The hot gas layer damage state was not screened based on a sensitivity analysis in the PINGP Fire PRA. Instead, a comprehensive fire modeling evaluation was performed for determining if hot gas layer scenarios are required to be postulated. This evaluation determined the hot gas layer temperature and timing using the worst case, or largest heat release rate, fire scenario for the corresponding Fire Compartment. This selected heat release rate for each individual evaluation included the contribution of the ignition source and secondary combustibles. Compartments identified as screened do not result in a full compartment burnout fire progression in the single compartment analysis. This information was also used when appropriate to screen multi compartment combinations.

For areas that do not screen (i.e., a hot gas layer scenario is predicted), individual fire scenarios are evaluated for progression to full room burnout. In some cases, automatic suppression is credited to lower the frequency of full room burnout. In the specific case of the Turbine Building (8GRP), while the fire modeling analysis identifies fire compartments as screened from hot gas layer for fire scenarios associated with relatively small ignition sources, full failure of the Turbine Building is considered in the Fire PRA for large/complex sources such as turbine generator fires.

Specifically regarding facts and observations (F&O) FSS-D6-01 in Attachment V of the LAR:

NRC Request (FM RAI 01.t):

t. This F&O requested that the licensee provide justification for the underlying assumptions used in the HGL calculations, and states that additional work should be undertaken to address bias in the results of the HGL calculations due to the assumed input parameters. In addition, a possible resolution is provided which involves sensitivity calculations with varying size vent openings in the FDTs. The disposition provided a discussion of the revised analysis, but, did not specifically address the issue of vent size or any sensitivity calculations.

Please provide further justification for the underlying assumptions used in the HGL calculations in the context of this F&O and the provided possible resolution.

NSPM Response (FM RAI 01.t):

t. The PINGP Fire PRA uses the MQH and the FPA models for calculating hot gas layer temperatures. The Beyler method is no longer used for calculating hot gas layer temperatures and it does not need to be included in Attachment J to the LAR. Specifically,

- The FPA method is used for scenarios with forced ventilation (i.e., mechanical ventilation and closed doors).
- The MQH method is used for scenarios with natural ventilation, with the vent area assumed to be 1 m x 1 m.

The selection of a vent area of size 1 m x 1 m is conservative as this area is smaller than the size of a typical fire door opening (i.e., which is approximately 2 m x 1 m). At the same time, it allows enough air for the fire to be well ventilated and is unlikely to generate extinction due to low oxygen concentration.

From a verification and validation perspective, the fire scenarios using MQH are compared against the experiments used in the validation of MQH in NUREG-1824. The calculations of the equivalence ratio, in some cases, are lower than the validation range of the experiments documented in NUREG-1824, indicating lower oxygen availability. All the fire compartments where the equivalence ratio due to natural ventilation fall outside the validation range are modeled with an opening area of 1 m^2 (i.e., A_0 = 1 m^2). For this parameter to fall within the valid range, the area of this opening was increased to 1.2 m^2 (i.e., A_0 = 1.2 m^2). The effect of increasing this area on the maximum HGL temperature reached by the fire scenario is shown in the table below. For those compartments where a hot gas layer temperature above the damage criteria (i.e.,

205°C) is predicted, the sensitivity model predicts a slight increase in time to damage, which is non-conservative. As expected, the maximum hot gas layer temperatures predicted by the sensitivity model decrease when compared to the original model due to the change in the area of the opening, which suggests conservatism in the selection of vent size even if the results are outside of the validation range for ventilation conditions. Therefore, it is concluded that because the sensitivity results are slightly less conservative than the original results for the HGL temperatures predicted for each compartment, the use of the MQH and FPA for these fire scenarios is justified and the validation results for these models presented in NUREG-1824 are applicable.

Sensitivity Results for the Equivalence Ratio in the MQH and FPA HGL Model

Compartment ID	Original HGL Model			Sensitivity HGL Model		
	Equivalence Ratio for a 1 m^2 Opening	Time at HGL Temperature of 205°C (min)	Maximum HGL Temperature (°C)	Equivalence Ratio for a 1.2 m^2 Opening	Time at HGL Temperature of 205°C (min)	Maximum HGL Temperature (°C)
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NA: Not applicable. Cases where the HGL did not reach the damage criteria temperature of 205°C.

Finally, NUREG-1934 lists a bias for the MQH model of 1.44. That is, the room temperatures are over predicted by approximately 40%. A comparison was developed between hot gas layer results assuming vent sizes reduced down to 0.25 m^2 corrected for the model over prediction and the hot gas layer temperature results in the PINGP Fire PRA (i.e., those assuming a vent size of 1.0 m^2). The comparison suggests that the model bias resulting in the over prediction accounts for smaller vent sizes.

In summary, the verification and validation process suggests that the use of the 1.0 m^2 vent size is conservative when compared to ventilation conditions within the validation range, and a sensitivity analysis suggests that the model bias (i.e., over predictions) accounts for smaller vent sizes.

With regard to the use of FDS in the MCR abandonment calculations:

[This section of the RAI includes Subparts u-x, as shown below with NSPM responses]

NRC Request (FM RAI 01.u):

u. *The HVAC [heating, ventilation and air conditioning] system in the MCR operates in one of two modes. In normal mode flow rates are 10,000 cubic feet per minute (cfm) in recirculation mode and 2,000 cfm in fresh air mode. In emergency mode, the control room goes to 100 percent recirculation.*

Please explain what assumptions were made concerning the HVAC status in the MCR abandonment calculations.

NSPM Response (FM RAI 01.u):

u. The Main Control Room (MCR) abandonment fire simulations created in the Fire Dynamics Simulator (FDS) are performed assuming the following:

1. The MCR abandonment simulations assume that there is no mechanical ventilation and that the ventilation dampers are closed. This decision was made based on the control room not having a mechanical smoke purge mode, and that the primary flow of air is recirculation.

2. The MCR was modeled as a closed envelope with no openings to adjacent rooms. This is a conservative assumption as the generated smoke will be contained within the MCR which leads to a quicker abandonment. This assumption was validated with a sensitivity study where room leakage was assumed. The sensitivity showed that there was less than 1% difference in MCR abandonment time.

NRC Request (FM RAI 01.v):

v. *Please explain what value was used for the soot yield and heat of combustion of cables in the MCR (the latter either explicitly or implicitly through the specified fuel composition), and discuss the results of using this value in terms of conservatism of the calculated soot generation rate.*

NSPM Response (FM RAI 01.v):

v. A Soot Yield of 0.12 was conservatively selected. Subsequently, a review of control room cabling was performed and determined that approximately 40% of the cabling by length is Fluorinated Ethylene Propylene, Teflon, which has a soot yield of 0.003 (Reference: Society of Fire Protection Engineering (SFPE) Handbook, 4th Edition, Table 3-4.16). Calculating the cable length weighted average soot yield of all of the cabling types in the control room resulted in a soot yield of 0.096 by selecting the most conservative soot yield values from the SFPE table. The value selected is conservative in comparison to all values reported for cable materials in NUREG/CR-7010, Section 5.2, and page 28. Therefore, the selection of a bounding soot yield has the effect of producing faster room obscuration in the accumulated smoke, which directly influences the abandonment time. The shorter abandonment time produces a higher probability of non-suppression which results in Core Damage Frequency (CDF)/Large Early Release Frequency (LERF) values that are bounding.

In the case of the heat of combustion, the chemical formula for PVC was taken as C_2H_3Cl, and the heat of combustion was determined using the default method in FDS by stoichiometry to be 13.8 MJ/kg. This value is lower than the value reported for PVC in the Fourth Edition of the Society of Fire Protection Engineering (SFPE) Handbook, Table 3-4.16. The lower heat of combustion value also has the effect of producing faster room obscuration by producing a greater mass of smoke per unit heat release, which directly influences the abandonment time. The room obscuration, which governs the

abandonment criteria based on an operator's visibility through smoke, triggers MCR abandonment in many of the simulations. Therefore, the selection of a bounding soot yield directly affects the abandonment results implemented in the Fire PRA.

NRC Request (FM RAI 01.w):

w. Fires were placed based on "their ability to create an uninhabitable condition within the MCR".

Please describe the approach that was used to assess the ability of an ignition source to create an uninhabitable condition in the MCR.

NSPM Response (FM RAI 01.w):

w. Contrary to the original documentation, ignition sources were not assessed for their ability to create uninhabitable conditions in the MCR. The ignition sources (fixed and transient) in the MCR were used as inputs to determine the time for operators to abandon the MCR per the abandonment criteria provided in NUREG/CR-6850. The phrase "their ability to create an uninhabitable condition within the MCR" is misleading and has been removed from the supporting documentation.

The four simulated (i.e. selected) fire locations were spread out to reasonably depict a fire scenario anywhere in the MCR. These four different fire locations, which are evaluated with both transient and electrical cabinet heat release rate profiles, were placed inside and outside the MCR horseshoe in the Fire Dynamics Simulator (FDS) analysis to simulate potential fires in the MCR. Transients were placed on the floor spaced evenly between adjacent electrical cabinets to ensure that combustion products migrate unobstructed into the hot gas layer. One electrical cabinet fire was placed along the wall in order to capture "wall effects" in the fire generated conditions since a number of panels in the MCR have wall configurations.

Figure F-1 illustrates the simulated fire locations (transient inside, transient outside, electrical cabinet inside and electrical cabinet outside) in the MCR:

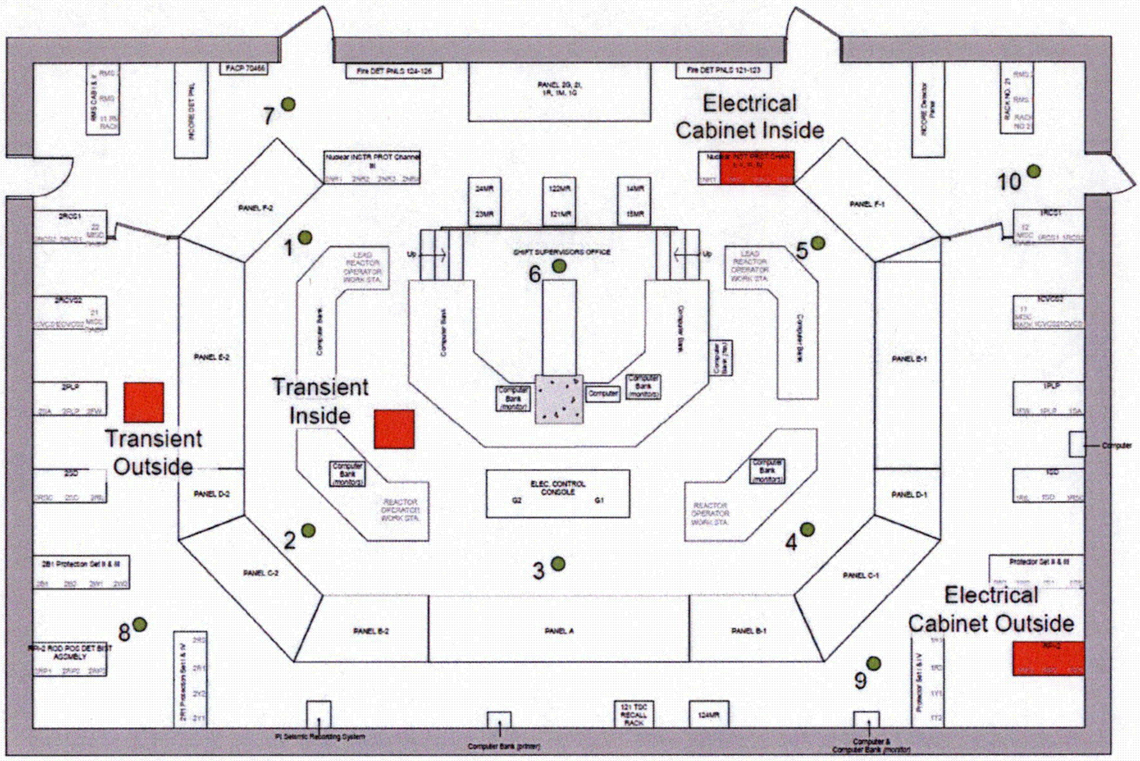

Figure F-1 PINGP Main Control Room

NRC Request (FM RAI 01.x):

x. FDS "devices" (heat flux and optical density) were placed at different locations around the MCR.

Please describe the basis for choosing these locations. Explain how the output from the devices was used to assess control room habitability.

NSPM Response (FM RAI 01.x):

x. The locations of the FDS devices in the MCR abandonment simulations were selected so that:

1. Heat flux and visibility conditions were continuously measured 6 ft above the floor, consistent with the guidance in Section 11.5.2.11 of NUREG/CR-6850, EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities, Volume 2: Detailed Methodology. Section 11.5.2.11 states that the final decision to abandon the MCR should be made if radiative heat flux at 6 ft above the floor exceeds 1 kW/m^2 due to fire conditions or optical density due to smoke at 6 ft above the floor is greater than 3.0 m^{-1}. Radiative heat flux and smoke obscuration measurements were continuously monitored in parallel with FDS and the first measurement to reach the specified habitability conditions was conservatively chosen for the abandonment time.

2. Devices are located throughout the open areas of the MCR to ensure that habitability measurements are obtained and evaluated to reasonably depict locations anywhere a Control Room operator may be located at a given time.

Figure F-1 above illustrates the simulated operator/FDS device locations (numbers 1-10) in the MCR:

References

F-1 Tewarson, A., "Generation of Heat and Chemical Compounds in Fires," Section 3-4, The Society of Fire Protection Engineers (SFPE) Handbook of Fire Protection Engineering, 4th Edition, SFPE, Bethesda, MD, 2008.

F-2 Geiman, J. and D.T. Gottuk, "Alarm Thresholds for Smoke Detector Modeling," Fire Safety Science – Proceedings of the Seventh International Symposium, International Association for Fire Safety Science, Worcester, MA, pp. 197-208, 2003.

FM RAI 02

In the LAR, Section 4.5.1, Fire PRA Development and Assessment, the licensee states that the PINGP Fire PRA was developed in compliance with the requirements of Part 4 of ASME/ANS Standard RA-Sa-2009, "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessments for Nuclear Power Plant Applications."

Part 4 of ASME/ANS Standard RA-Sa-2009, requires damage thresholds be established to support the Fire PRA. Thermal impact(s) must be considered in determining the potential for thermal damage of SSCs and appropriate temperature and critical heat flux criteria must be used in the analysis.

[This RAI includes Subparts a-d, as shown below with NSPM responses]

NRC Request (FM RAI 02.a):

a) *Please describe how the installed cabling in the power block was characterized, specifically with regard to the critical damage threshold temperatures and critical heat fluxes for thermoset and thermoplastic cables as described in NUREG/CR-6850.*

NSPM Response (FM RAI 02.a):

a) The damage criteria used throughout the Fire PRA analysis is for thermoplastic cable as specified in Appendix H of NUREG/CR-6850 (i.e., 6 kW/m^2 and 205 °C). Engineering Evaluation EC 20695 documents that the majority of cabling at PINGP is thermoset and that the thermoplastic cabling is either in conduit or low voltage (low energy) cabling. The damage criteria for thermoplastic cable are conservatively used per Assumption 1 in Section 3.0 of FPRA-PI-SCA. The use of these damage criteria is necessary to characterize the fire impacts expected for raceways containing a mixture of cables with varying insulation types, including Kerite cable.

NRC Request (FM RAI 02.b):

b) Please describe how cable trays with covers, fire-resistive wraps and FR coated cables were treated in the fire modeling calculations in terms of damage, and how the presence of holes in cable tray covers was accounted for.

NSPM Response (FM RAI 02.b):

b) Fire wraps (Electrical Raceway Fire Barrier Systems - ERFBS) that are able to meet a one hour minimum fire endurance rating are credited in the Prairie Island Fire PRA to prevent cable failure, ignition, and fire propagation. Fire wraps are not credited for preventing cable damage in High Energy Arcing Fault (HEAF) scenarios or in the high hazard scenarios postulated in the Structural Steel Analysis consistent with NUREG/CR-6850. Cable Tray covers and fire retardants used as cable coatings are not credited in the PINGP Fire PRA. Since cable tray covers were not credited to prevent fire spread, holes in cable tray covers have no impact on the Prairie Island Fire PRA.

NRC Request (FM RAI 02.c):

c) Please explain how the damage thresholds for non-cable components (i.e., pumps, valves, electrical cabinets, etc.) were determined. Identify any non-cable components that were assigned damage thresholds different from those for thermoset and thermoplastic cables, and provide a technical justification for these damage thresholds.

NSPM Response (FM RAI 02.c):

c) The Fire PRA treatment of non-cable targets is as follows:

1. For major components such as motors, valves, etc., the fire vulnerability should be assumed to be limited to the vulnerability of the power, control, or instrument cables connected to the components and subjected to fire-generated conditions in a postulated fire scenario.

2. Equipment constructed of ferrous metal with no cable connections such as pipes and water tanks should be considered invulnerable to fire.

3. Passive components such as flow check valves should be considered invulnerable to fire.

This treatment is consistent with the guidance in Appendix H of NUREG/CR-6850. In addition, there is no "non-cable" target in the Fire PRA that has been assigned a plant specific damage threshold.

NRC Request (FM RAI 02.d):

d) Please describe the damage criteria that were used for exposed temperature-sensitive electronic equipment. Explain how temperature-sensitive equipment inside an enclosure was treated, and provide a technical justification for the assumed damage criteria.

NSPM Response (FM RAI 02.d):

d) Sensitive electronics are conservatively treated in the model as discussed below. The analysis is based primarily on Fire PRA FAQ 13-0004 as follows:

1. Sensitive electronics are located in the relay room/cable spreading room (Fire Compartment 18), and the MCR (Fire Compartment 13).

2. In Fire Compartment 18, all the cabinets are closed. Therefore, the guidance in Fire PRA FAQ 13-0004 is applicable. That is, the fire generated conditions associated with damaging thermoset cables are necessary to damage sensitive electronics inside a closed cabinet. Specific to this fire compartment: 1) Electrical cabinets that are both ignition sources and targets are failed at ignition time, failing all the sensitive electronics inside the panel, 2) The adjacent cabinets in the same bank as the ignition source are failed at the time of the first cable tray failure above the ignition source, which fails sensitive electronics in the adjacent panel (i.e., fails any cables mapped to basic events in these cabinets), 3) the hot gas layer scenario for the room fails all the targets in the fire compartment at the thermoplastic damage temperature of approximately 200°C, which fails all sensitive electronics in the room.

3. Fire PRA FAQ 13-0004 applies to any sensitive electronics in the closed cabinets in the MCR. For the specific case of the closed cabinets behind the Main Control Board, as well as for the Main Control Board panels, the MCR is abandoned at or before temperatures reach 95°C, at which point no equipment is credited, regardless of whether the panels are open or closed. Currently, the model does not credit any suppression where the MCR is the exposed compartment. Therefore, targets in the MCR are assumed to fail at ignition.

FM RAI 03

NFPA 805, Section 2.7.3.2, states that each calculational model or numerical method used shall be verified and validated through comparison to test results or comparison to other acceptable models.

In the LAR, Section 4.5.1.2 states that fire modeling was performed as part of the Fire PRA development (NFPA 805, Section 4.2.4.2). Reference is made to Attachment J of the LAR for a discussion of the verification and validation (V&V) of the fire models that were used. Furthermore, Section 4.7.3 of the LAR states that "Calculational models and numerical methods used in support of compliance with10 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:

[This RAI includes Subparts a-c, as shown below with NSPM responses]

NRC Request (FM RAI 03.a):

a. For any tool or method identified in the response to FM RAI 01(a) above, please provide the V&V basis if not already explicitly provided in the LAR (e.g., in LAR Attachment J).

NSPM Response (FM RAI 03.a):

a. Attachment J of the NFPA 805 LAR lists all the fire models used in support of the transition process. No other analytical fire models have been used in support of the transition process. It should be noted that the 60-day response to part b of FM RAI 04, transmitted by letter dated May 28, 2015, clarified the use of the Alpert ceiling jet correlation in the PINGP Fire PRA. Specifically, the response indicates that the Alpert ceiling jet correlation is not used in the PINGP Fire PRA.

NRC Request (FM RAI 03.b):

b. Please explain how the cable tray fire propagation calculations based on the models described in Appendix R of NUREG/CR-6850 and Chapter 9 of NUREG/CR-7010 were verified.

NSPM Response (FM RAI 03.b):

b. Verification of the use of the FLASH-CAT model is documented in FPRA-PI-RRA. The verification is based on comparison of the FLASH-CAT results as programmed in support of the NFPA 805 application with the results presented in NUREG/CR-7010 Volume 1. Specifically, the numerical results produced by the spreadsheet programmed to solve the FLASHCAT model in the PINGP Fire PRA were compared with the FLASH-CAT results documented in NUREG/CR-7010, Volume 1, for the same input parameters to ensure that the implementation of the model was verified.

NRC Request (FM RAI 03.c):

c. Please provide the validation basis for the optical density threshold (0.14 OD/m) used in the Relay Room CFAST analysis to estimate smoke detector actuation.

NSPM Response (FM RAI 03.c):

c. The article "Alarm Thresholds for Smoke Detector Modeling" by Geiman and Gottuk (Reference F-2) provides guidance on selecting optical density (OD) at alarm thresholds. This guidance was developed from data collected from full-scale tests conducted by the U.S. Navy, the Fire Research Station, and the Indiana Dunes Tests, using a wide variety of ion and photoelectric smoke detectors with smoldering and flaming fires. Geiman and Gottuk state that the use of an alarm threshold of 0.14 OD/m (9.4 %/ft) is a reasonable estimate when a majority of smoke detectors will alarm. The smoke detectors installed in the Relay Room have an alarm sensitivity of 1.0%/ft. Therefore, the use of an alarm threshold of 0.14 OD/m (9.4%/ft) is conservative.

References

F-2 Geiman, J. and D.T. Gottuk, "Alarm Thresholds for Smoke Detector Modeling," Fire Safety Science—Proceedings of the Seventh International Symposium, International Association for Fire Safety Science, Worcester, MA, pp. 197-208 (2003).

FM RAI 04

Response to FM RAI 04 was provided with the 60-day RAIs.

FM RAI 05

Response to FM RAI 05 was provided with the 60-day RAIs.

FM RAI 06

Response to FM RAI 06 was provided with the 60-day RAIs.

RAI Responses – Probabilistic Risk Assessment (PRA)

PRA RAI 01 – Fire Event Facts and Observations

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 authority having jurisdiction (AHJ), which is the NRC. The RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a fire PRA (FPRA) 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. The 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 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 and the subsequent resolution of these F&Os.

Please clarify the following dispositions to fire F&Os and Supporting Requirement (SR) assessments identified in Attachment V of the LAR that have the potential to impact the FPRA results and do not appear to be fully resolved:

[This RAI includes Subparts a - h; responses to Subparts a - d and f were provided with the 60-day responses and Subpart h will be included with the 120-day responses; Subparts e and g are shown below with NSPM responses]

NRC Request (PRA RAI 01.e)

e. <u>FSS-B2-01</u>: As discussed in the licensee's analysis (FPRA-PI-MCR), the approach used to develop and quantify scenarios associated with Main Control Board (MCB) fires appears to deviate from accepted methods and approaches in NUREG/CR-6850, Appendix L.

Please provide justification that the overall PINGP approach for evaluating MCB fires bounds the results (i.e., CDF, LERF, ΔCDF and ΔLERF) that would be obtained had the guidance in Appendix L of NUREG/CR-6850 been applied using a set of scenarios representative of MCB risk. Note that Appendix L applies the full MCB ignition frequency to each postulated MCB scenario, and may be bounding for the PINGP approach depending on the number and target sets of scenarios modeled.

NSPM Response (PRA RAI 01.e):

e. The PINGP analysis of Main Control Board panels does not use the method described in Appendix L of NUREG/CR-6850. The guidance described in Appendix L of NUREG/CR-6850 includes credit for non-suppression probabilities in the selection of the frequency apportioning factor. Some of the damage states of Main Control Board fire scenarios include MCR abandonment due to habitability conditions. Therefore, avoiding the use of the values recommended in Appendix L allows for a comprehensive credit to MCR abandonment probability considering the dependencies in non-suppression probabilities among the different damage states in a scenario frequency.

Specifically, propagation between panels in the Main Control Board is part of a comprehensive event tree model including sequences for small fires that are promptly

suppressed, and fires that do not propagate outside of the panel of fire origin. The justification for the assumed values for characterizing the different sequences is based on a comparison with values obtained from the approach described in Appendix L of NUREG/CR-6850 for the four general types of fire scenarios that can be postulated in the Main Control Board:

Ignition

The initiating event is the ignition frequency for the fixed ignition source (electrical cabinet or Main Control Board section) with a transient combustible contribution. In the case of the Main Control Board, the frequency of ignition for the entire Main Control Board is apportioned to each panel as a ratio of the number of cables mapped to the panel divided by the total number of cables mapped to the Main Control Board. The number of cables was determined through a query of the Prairie Island Cable Database which mapped cables to the vertical openings beneath each panel. The vertical openings were mapped to each MCB panel and electrical cabinet through a review of drawing NF-40118-8. In the case of the additional electrical cabinets, the corresponding electrical cabinet frequency is used. The transient frequency for each scenario is added to the panel ignition frequency so that its contribution is included in the apportioning process through the event tree model. The following discussion describes each sequence in the event tree model.

Prompt Suppression (Sequence 1)

This event accounts for manual suppression by operators before the fire ignition source develops and spreads. This sequence therefore captures events associated with very small fires that are promptly suppressed. It should be noted that although a fire may be promptly suppressed, the fire may still result in a plant trip (Sequence 1) if the panel itself or the raceways routed directly to that panel are mapped as plant trip initiators in the Fire PRA model.

Since the MCR is constantly occupied, it is assumed that detection of a fire occurs near to the ignition time. From Chapter 14 of Supplement 1 to NUREG/CR-6850 (see Table 14-2), the suppression curve constant, λ, for MCR Fires is 0.33/min. Therefore, an average time of 3 minutes is needed to suppress a fire in the MCR (1/0.33 minutes = 3 minutes). The probability of prompt suppression success is Pr (t<tp-supp) = 1 - EXP(-0.33 x 1/0.33) = 0.63. If the fire is promptly suppressed, propagation to other panels and MCR abandonment are not postulated.

The non-suppression probability at three minutes is then = EXP(-λ x 3) = 0.37. This non-suppression probability is considered conservative because it is associated with a very small fire damaging only a single component in the control board panel. Appendix L of NUREG/CR-6850 suggests values (see Figure L-1) on the order of 5.5E-3 to 8.5E-3 for representing the multiplication of non-suppression probability and severity factor for small fires propagating distances 0 to 0.5 m. In contrast, the Prairie Island Fire PRA conservatively represents these fires with a probability of 0.37 and impacts to all Fire PRA cables mapped to each MCB panel. Further, if prompt suppression fails, propagation to other panels and MCR abandonment are considered.

Plant Trip (Sequence 2)

Sequence 2 of the event tree accounts for the ignition sources that will not directly cause an initiating event. In Sequence 2, the ignition source is immediately extinguished with the initiating-event-inducing component not acting as the source of the fire. This is essentially a non-event in which the plant continues to operate. No scenario is postulated in Fire PRA on this branch.

Propagation Outside Panel (Sequences 3 and 4)

Sequences 3 and 4 consider scenarios involving fire propagation from one panel to one or more adjacent panels. Specifically, Sequence 3 captures propagating MCB fires that result in Control Room Abandonment and Sequence 4 captures propagating MCB fires that do not result in Control Room Abandonment. The logic allows these scenarios to occur only when prompt suppression fails. The branch probabilities for these sequences are based on the manual suppression probability constant of 0.33/min evaluated 10 minutes after ignition. A propagation time from panel to panel of 10 minutes is used in the analysis based on the guidance available in Appendix S of NUREG/CR-6850. Per Appendix S of NUREG/CR-6850, no significant heat release occurs from the adjacent cabinet for 10 minutes if the cables in the adjacent cabinet are in direct contact with the separating wall. Therefore, it is postulated that a fire not suppressed in 10 minutes will propagate to the adjacent panel. The probability for this branch is calculated as PR(t>tprop) = EXP(-0.33 x 10) = 0.037. Therefore, the probability of 0.037 is the value used to characterize the event tree sequence associated with a MCB panel fire propagating to one or more additional panels 10 minutes after ignition. The practical implication of the use of ten minutes for propagation time between panels is as follows: 1) the panel where the fire starts is assumed failed completely (i.e., all Fire PRA cables within the panel are assumed failed) at the time of ignition, and 2) full failure of the adjacent panels is assumed at ten minutes. Appendix L of NUREG/CR-6850 suggests values on the order of 3.5E-03 to 8.5E-03 for representing the multiplication of the non-suppression probability and severity factor for small fires propagating distances of between 0 m and 1.0 m.

No Propagation Outside Panel (Sequences 5 and 6)

Sequences 5 and 6 consider scenarios involving the fire remaining within one (1) Main Control Board Panel. Specifically, Sequence 5 captures non-propagating MCB fires that result in Control Room Abandonment and Sequence 6 captures non-propagating MCB fires that do not result in Control Room Abandonment. The logic allows these scenarios to occur only when prompt suppression fails and the fire propagates beyond the panel of origin. The branch probabilities for these sequences are based on the manual suppression probability constant of 0.33/min evaluated 10 minutes after ignition. A propagation time from panel to panel of 10 minutes is used in the analysis based on the guidance available in Appendix S of NUREG/CR-6850, page S-2. Per Appendix S of NUREG/CR-6850, no significant heat release occurs from the adjacent cabinet for 10 minutes if the cables in the adjacent cabinet are in direct contact with the separating wall. Therefore, it is postulated that if a fire is suppressed within 10 minutes of ignition it will not propagate to the adjacent panel. The conditional probability of this branch is calculated as Pr(tp-supp < t < tprop) = Pr(Prompt Suppression Fails) – Pr(Suppression Prior to 10 minutes) = EXP(-0.33 x 1/0.33) – EXP(-0.33 x 10) = 3.31E-01. In other

words, conditional probability for branches 5 and 6 is the probability that suppression is successful sometime between prompt suppression and time to propagation.

Control Room Abandonment (Sequences 3 and 5)

Sequences 3 and 5 reflect the probability that the fire results in MCR abandonment due to fire generated conditions. For MCR abandonment (Branches 3 and 5), the target set is based on failing the basic events associated with the ignited panel or panels. In Branches 4 and 6, fire growth is assumed to affect critical equipment and one or more panels, but MCR abandonment is not required. The target set is based on failing the basic events associated with the ignited panel or panels.

The split fraction for Sequences 3 and 4 is the conditional probability that a propagating fire (i.e., a fire lasting longer than 10 minutes) generates abandonment conditions. The split fraction for Sequences 5 and 6 is the conditional probability that a non-propagating fire (i.e., a fire that is not promptly suppressed but is suppressed in less than 10 minutes) generates abandonment conditions.

Because fire suppression is already included in the analysis in the propagation likelihood, the probability of abandonment (i.e., the MCR abandonment split fraction) is taken to be the conditional probability given the failure to suppress a fire that is large enough to generate abandonment conditions.

In summary, as the fire grows, different consequences (i.e. damage states resulting from the scenario) can develop. The intent of the PINGP approach is to quantify the risk contribution of each damage state. To do so, the generic fire ignition frequency for the Main Control Board needs to be apportioned to each panel as this is the initiating event frequency for the scenario progression. This is accomplished using the ratio of the number of cables mapped to the panel divided by the total number of cables mapped to the Main Control Board. The number of cables mapped to each panel is used as a surrogate of the number of potential ignition sources (e.g., cable termination points, switches, etc.) within the panel. The resulting initiating event frequencies for the different Main Control Board panels result from the multiplication of the generic Main Control Board frequency listed in Chapter 10 of Supplement 1 to NUREG/CR-6850 times the apportioning factor and the location weighting factor accounting for the two units.

Further apportioning of the frequencies for the different damage states is based on the MCR non suppression probability and the abandonment probability due to fire generated conditions. The use of these probabilities accounts for the conditional elements associated with the scenario progression. If for example fire propagation from panel to panel occurs before control abandonment in the scenario frequency, the calculation of the abandonment probability considers the failure to suppress at the time of the fire propagation. A summary of the frequency apportioning results is listed in the following table:

Consequence	Frequency (per yr)	Frequency Contribution
Prompt suppression	1.0E-03	62.8%
Control Room Abandonment	7.4E-06	0.4%
No abandonment	6.1E-04	36.8%

The results listed above indicate the following:

1. 62.8% of the postulated fires in the PINGP Fire PRA Main Control Board remain small and are promptly suppressed. This percentage conservatively bounds the fire events experienced in the US nuclear industry where all the fires associated with Main Control Boards have remained small and have not propagated far from the point of ignition.

2. 36.8% of the fires are postulated to damage at least one full cabinet in the Main Control Board. This percentage also bounds the fire events experience in the US nuclear industry as no fire of such consequence has been observed.

3. 0.4% of the fires are postulated to lead to MCR abandonment. This percentage also bounds the fire events experience in the US nuclear industry as no fire starting in the MCR has led to abandoning the room.

It should be also noted that the targets associated with the above listed conditions are conservative as they include either a bounding localized impact within the panel for those scenarios that are promptly suppressed or the full mapping of cables/basic events to the corresponding panel for the scenarios that are not promptly suppressed. This target mapping approach, together with the frequency apportioning process described earlier, ensures that the resulting risk values (i.e., CDF and LERF) are bounding in the PINGP Fire PRA.

NRC Request (PRA RAI 01.g):

g. <u>FSS-D7-02</u>: The disposition to this F&O indicates that the total failure probability of credited detection and suppression systems is the sum of the generic unreliability values given in NUREG/CR-6850 and an unavailability estimate developed through a plant-specific data review. However, Section 7.6 of FPRA-PI-TBA appears to indicate that this approach was not used for all analyses supporting the FPRA, e.g., the turbine building analysis.

Please clarify this discrepancy.

NSPM Response (PRA RAI 01.g):

g. The discrepancy regarding the inconsistent determination of total failure probabilities of credited detection and suppression systems will be corrected in the aggregate PRA analyses for NSPM's response to PRA RAI 03. The non-suppression probability has been calculated as the sum of the unreliability and the unavailability values corresponding to each credited automatic detection and suppression system. This approach has been implemented in all the scenarios analyzed with detailed fire modeling crediting automatic suppression in the Fire PRA. The results of the updated analysis will be reflected in the final quantification described in the response to PRA RAI 03.

PRA RAI 02 – Internal Event F&Os

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. The 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, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA 805. The 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 provide clarification to the following dispositions to Internal Events F&Os and SR assessments identified in Attachment U of the LAR that have the potential to impact the FPRA results and do not appear to be fully resolved:

[This RAI includes Subparts a, b, and c; responses to Subparts b and c were included with the 60-day responses; Subpart a is shown below with NSPM's response]

NRC Request (PRA RAI 02.a):

a. *<u>QU-C2</u>: This F&O indicates that a minimum for joint human error probabilities (HEPs) was not originally specified for the internal events PRA (IEPRA). NUREG-1921 indicates and NUREG-1792 (Table 2-1) states that joint HEP values should not be below 1.0E-05.*

   Please confirm that each joint HEP value used in the FPRA below 1.0E-05 includes its own justification that demonstrates the inapplicability of the NUREG-1792 lower value guideline. Provide an estimate of the number of these joint HEPs below 1.0E-05 and at least two different types of justification.

NSPM Response (PRA RAI 02.a):

a. NSPM has applied the 1E-05 minimum value for joint HEPs to the model used for the re-quantification that will be completed to support the response to PRA RAI-03. If a lower joint HEP value is used in the future, the basis for its use will be incorporated into the associated Human Reliability Analysis (HRA) documentation.

PRA RAI 03 – Integrated Analysis

Response to PRA RAI 03 will be submitted in separate correspondence by July 24, 2015, pending resolution of outstanding RAIs.

PRA RAI 04 – Transient Fire Placement at Pinch Points

Response to PRA RAI 04 was provided with the 60-day RAIs.

PRA RAI 05 – Cable Fires Caused by Welding and Cutting

Response to PRA RAI 05 was provided with the 60-day RAIs.

PRA RAI 06 – Junction Boxes

Response to PRA RAI 06 was provided with the 60-day RAIs.

PRA RAI 07 – Sensitive Electronics

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. The 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, as providing methods acceptable to the NRC staff for adopting a fire protection program consistent with NFPA 805. 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.

Appendix H of the LAR does not cite FAQ 13-0004, "Clarifications on Treatment of Sensitive Electronics," dated December 3, 2013 (ADAMS Accession No. ML13322A085), as one of the FAQ guidance documents used to support the FPRA.

Please describe the treatment of sensitive electronics for the FPRA, and explain whether it is consistent with the guidance in FAQ 13-0004, including the caveats about configurations that can invalidate the approach (i.e., sensitive electronic mounted on the surface of cabinets and the presence of louvers or vents). If the approach is not consistent with FAQ 13-0004, justify the approach, or replace the current approach with an acceptable approach in the integrated analysis performed in response to PRA RAI 03.

NSPM Response (PRA RAI 07):

Sensitive electronics are conservatively treated in the model as discussed below. The analysis is based primarily on Fire PRA FAQ 13-0004 as follows:

1. Sensitive electronics are located in the relay room/cable spreading room (Fire Compartment 18), and the MCR (Fire Compartment 13).

2. In Fire Compartment 18, all the cabinets are closed. Therefore, the guidance in Fire PRA FAQ 13-0004 is applicable. That is, the fire generated conditions associated with damaging thermoset cables are necessary to damage sensitive electronics inside a closed cabinet. Specific to this fire compartment: 1) Electrical cabinets that are both ignition sources and targets are failed at ignition time, failing all the sensitive electronics inside the panel, 2) The adjacent cabinets in the same bank as the ignition source are failed at the time of the first cable tray failure above the ignition source, which fails sensitive electronics in the adjacent panel (i.e., fails any cables mapped to basic events in these cabinets), 3) the hot gas layer scenario for the room fails all the targets in the

fire compartment at the thermoplastic damage temperature of approximately 200°C, which fails all sensitive electronics in the room.

3. Fire PRA FAQ 13-0004 applies to any sensitive electronics in the closed cabinets in the MCR. For the specific case of the closed cabinets behind the Main Control Board, as well as for the Main Control Board panels, the MCR is abandoned at or before temperatures reach 95°C, at which point no equipment is credited, regardless of whether the panels are open or closed. Currently, the model does not credit any suppression where the MCR is the exposed compartment. Therefore, targets in the MCR are assumed to fail at ignition.

PRA RAI 08 – Conditional Probabilities of Spurious Operations

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 fire protection program to an NFPA 805 based program, and all future plant changes to the program, shall be acceptable to the NRC. The RG 1.174 provides quantitative guidelines on CDF, 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's review of the information in the LAR has identified additional information that is required to fully characterize the risk estimates.

New guidance on using conditional probabilities of spurious operation for control circuits was issued in a letter from the NRC to NEI, "Supplemental Interim Technical Guidance on Fire-induced Circuit Failure Mode Likelihood Analysis" (ADAMS Accession Nos. ML14086A165 and ML14017A135) and in NUREG/CR-7150, Volume 2. This guidance included: a) replacement of the conditional hot short probability tables in NUREG/CR-6850 for Option #1 (including removal of credit for Control Power Transformers (CPTs) and conduit) with new circuit failure probabilities for single break and double break control circuits; b) Option #2 in NUREG/CR-6850 is no longer an adequate method and should not be used; c) replacement of the probability of spurious operation duration figure in FAQ 08-0051 (NUREG/CR-6850 Supplement 1) for AC control circuits and additional guidance to address duration for DC control circuits; d) aggregate-values for circuit failure probabilities should be used unless it is demonstrated that a cable is only susceptible to a single failure mode; e) incorporation of the uncertainty values for the circuit failure probabilities and spurious operation duration in the state-of-knowledge correlation (SOKC) for developing the mean CDF/LERF; and f) recommendations on the hot short probabilities to use for other cable configurations, including panel wiring, trunk cables, and instrument cables.

Please provide an assessment of the assumptions used in the FPRA relative to the updated guidance specifically addressing each of these items. If the FPRA assumptions are not bounded by the new guidance, provide justification for each difference or provide updated risk results as part of the integrated analysis requested in PRA RAI 03, utilizing the guidance in NUREG/CR-7150, Volume 2.

NSPM Response (PRA RAI 08):

The assumptions used in the PINGP Fire PRA relative to the updated guidance in the cited NRC letter, "Supplemental Interim Technical Guidance on Fire-induced Circuit Failure Mode Likelihood Analysis" (ADAMS Accession Nos. ML14086A165 and ML 14017A135), and NUREG/CR-7150, Volume 2, were addressed as follows:

a) The replacement hot short-induced spurious operation probabilities from ML14017A135 and NUREG/CR-7150 Volume 2 were used in the PINGP Fire PRA Circuit Failure Mode Likelihood Analysis (CFMLA) for Option 1.

b) Option 2 of NUREG/CR-6850, Task 10, Circuit Failure Mode Likelihood Analysis, was not used in the PINGP Fire PRA.

c) NUREG/CR-7150 spurious operation duration probabilities were used for both AC and DC control circuits.

d) The aggregate best estimate probability of failure was used unless it was demonstrated that a cable was only susceptible to a single failure mode.

e) NUREG/CR-7150 Volume 2 data for hot short probabilities has been incorporated. The results of incorporation of uncertainty values will be included in the response to PRA RAI 03, aggregate impact.

f) The aggregate hot short probabilities were used for panel wiring and trunk cables based on guidance in ML14017A135 and NUREG/CR-7150 Volume 2. Instrument cables (shielded twisted pair cables) did not use the aggregate probabilities, but assumed a failure probability of 1.0 as recommended in NUREG/CR-7150.

The aggregate impact will be evaluated in the response to PRA RAI 03.

PRA RAI 09 – Counting and Treatment of Bin 15 Electrical Cabinets

Response to PRA RAI 09 was provided with the 60-day RAIs.

PRA RAI 10 – High Energy Arcing Faults (HEAF)

Response to PRA RAI 10 was provided with the 60-day RAIs.

PRA RAI 11 – Time to Delayed Detection

Response to PRA RAI 11 was provided with the 60-day RAIs.

PRA RAI 12 – MCR Abandonment

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 fire protection program to an NFPA 805 based program, and all future plant changes to the program, shall be acceptable to the NRC. The RG 1.174 provides quantitative guidelines on CDF, 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's review of the information in the LAR has identified additional information that is required to fully characterize the risk estimates.

Although it appears from the scenario insights presented in Attachment W of the LAR that MCR abandonment is credited for scenarios in the MCR and Relay Room, the NRC staff could not identify in the LAR or licensee's analysis a description of how MCR abandonment was modeled for either loss of habitability or loss of control. In light of this observation, provide the following:

[This RAI includes Subparts a - e as shown below along with NSPM responses.]

NRC Request (PRA RAI 12.a):

a. *Please describe how MCR abandonment was modeled for loss of habitability. Include identification of the actions required to execute safe alternate shutdown and how they are modeled in the FPRA, including actions that must be performed before leaving the MCR.*

NSPM Response (PRA RAI 12.a):

a. Analysis of MCR Abandonment for MCR Fires:

The abandonment analysis determines whether fires of multiple strengths and varying locations will result in abandonment of the MCR, and if abandonment is necessary, the time available before operators are forced to exit for both electrical cabinet fires and transient fires. Consistent with NUREG/CR-6850, the following criteria are used to determine whether individual fire scenarios will require MCR abandonment due to habitability concerns:

- The heat flux at 6 feet above the floor exceeds 1 kW/m^2 (relatively short exposure). This can be considered the minimum heat flux for pain to skin. Approximating radiation from the smoke layer as $q_r'' = \sigma \cdot T_{sl}^4$, a smoke layer of around 95°C (200°F) could generate such heat flux.
- The smoke layer descends below 6 feet from the floor, and optical density of the smoke is greater than 3.0 m^{-1}. With such optical density, a light-reflecting object would not be seen if it's more than 0.4 m (1.31 feet) away. A light-emitting object will not be seen if it's more than 1 m (3.28 feet) away.

The Fire Dynamics Simulator (FDS) code was used to test these habitability criteria and to determine time to abandonment through fire simulation. The time to abandonment is determined as the time that any one of the abandonment criteria is first met or exceeded.

Appropriate non-suppression probabilities were then applied based on the calculated time to abandonment for each initiator type. The total abandonment frequency for a given MCR fire scenario includes the fire ignition frequency, severity factors and non-suppression probability.

The Fire PRA then developed the Conditional Core Damage Probability (CCDP)/ Conditional Large Early Release Probability (CLERP) for each MCR abandonment scenario by applying the inputs from FRANX fire scenario information and operator failure probabilities to the CAFTA models built for Alternate Shutdown (ASD). If the scenario does not require abandonment due to fire generated environmental conditions, the corresponding CCDP captures loss of controls due to fire damage and any ex-MCR activity due to loss of operability. If the scenario requires abandonment due to fire generated environmental conditions, the corresponding CCDP captures the loss of all MCR functions related to the inability to stay in the room and the appropriate ex-MCR activities.

Analysis of MCR Abandonment for Relay Room Fires:

The decision to credit ASD for fires occurring in the Relay Room is determined based on damage criteria identified through detailed fire modeling analysis. These fires initiate in the cable spreading room (the "Relay Room") located directly below the MCR; therefore, abandonment due to MCR habitability issues are unlikely, but may occur due to loss of control concerns experienced by the MCR operators. As with the MCR fire scenarios, the Fire PRA models the abandonment scenario CCDP with the ASD logic models, and non-abandonment scenario CCDP with the non-ASD logic models (that are used for all non-MCR abandonment fire sequences).

The detailed fire modeling analysis for the Relay Room addresses several damage states. The first damage state postulates a fire that is limited to the ignition source and localized target damage (i.e., the first cable tray and nearby conduits). A second damage state postulates the localized targets damaged in the first damage state and all targets within the zone of influence (ZOI) of the 98th percentile HRR of the specific ignition source. A third damage state is postulated as a full compartment burn of the Relay Room. All fire scenarios capable of a hot gas layer that meet the damage criteria contribute to the full compartment burn scenario. In FRANX, the damage states are denoted at the end of the scenario name. For example, scenario "18-07-TB1216-EC-2" is a fire in the Relay Room (18), in transient area 07. The equipment ID is TB1216, which is an electrical cabinet (EC) and this is the second damage state, denoted by "-2" at the end of the scenario name. ASD credit is assumed for all damage states greater than one. A very localized fire is not anticipated to postulate enough damage to require alternate shutdown activities. It is anticipated that a fire damaging a larger set of targets will require alternate shutdown activities due to the large quantity of risk significant cables that route through the Relay Room, resulting in a significant loss of plant control from the MCR. The Relay Room full compartment burn scenario (18-ALL-FA-18-FCB) credits ASD as well.

Fire PRA Modeling of Alternate Shutdown Actions:

Procedure F5 Appendix B (Control Room Evacuation) identifies the actions taken by the plant staff that are required to execute safe alternate shutdown for any fire requiring

MCR abandonment. The decision to abandon is made by the Unit 1 Shift Supervisor based on an assessment of the continued habitability of the MCR, or loss of control, for a fire occurring in the MCR or Relay Room. Steps 2.3.1 and 2.3.2 of the procedure provide two symptoms that are expected to lead to MCR evacuation. These are:

2.3.1 A catastrophic fire as evidenced by flames or smoke in the Control Room (Zone 57) and/or Relay Room (Zone 12) that requires evacuation due to either of the following:

- Environmental conditions (smoke/heat).

OR

- A loss of Control Room control of critical plant functions which cannot be adequately addressed by Alarm Response Procedure (ARP), Abnormal Operating Procedure (AOP), Instrument Failure Guide (IFG) or Emergency Operating Procedure (EOP) response actions.

2.3.2 Actuation of fire detection and suppression in other fire areas which indicates conditions i.e., (smoke, fumes) that require Control Room evacuation.

Note that the second symptom listed in Section 2.3.1 defines the considerations that would force abandonment due to loss of control.

Once the decision to abandon the MCR has been made by the Shift Supervisor, procedure F5 Appendix B, Attachments A – I and T specify the necessary actions to achieve hot standby. Each operator has a pre-planned list of actions provided in a dedicated attachment.

A number of actions are taken by the Unit 1 and Unit 2 Reactor Operators prior to leaving the MCR. These include:

- Trip the reactor
- Verify turbine trip
- Trip RCPs and Main Feedwater Pumps and place switches in PULL-TO-LOCK
- Close MSIVs and Power Operated Relief Valve (PORV) block valves
- Place control switches for the Containment Spray pumps in PULL-TO-LOCK
- Position the pressurizer spray valve switches to "MANUAL" and "CLOSED"
- Verify all Charging Pump speed controls in "MANUAL"
- Open the RWST SUPPLY TO CHARGING PUMP SUCTION MOV via the associated control switch

These actions, which are primarily designed to prevent or limit the impact of fire-induced spurious operation of equipment, are detailed in F5 Appendix B Attachments C and D. Note that the procedure is designed to verify the actions taken from the MCR were successful in the field (and if not, make it so through local, manual action). The Fire PRA does not model these actions explicitly, however, the time expended by the operators in performing these actions factors into the human reliability analysis (HRA) for the post-abandonment actions modeled in the Fire PRA (see response to item c. below).

This is because the potential for fire-induced failure or spurious actuation of equipment is assumed to be present in every scenario in which the cables associated with spurious equipment operation can be impacted.

The operator actions that are modeled as Human Failure Events (HFE) in the ASD analysis are listed below:

ASD HFE	Description
0ASDAVLTXXY	Operators fails to cross tie bus 15 and bus 25
0ASDCHLOCAY	Operators fail to stop charging LOCAs during ASD
0ASDCOGNIFY*	Failure to make decision to leave MCR due to fire that causes loss of control
0ASDLETDNFY	Operator Fails to Manually Isolate Letdown to Prevent Letdown LOCA
0ASDLOCACRY	Operators Fail to De-energize Source of Fire-induced LOCA using MCR Switch
0ASDVSLOCAY	Operators fail to isolate RCS vent or Excess Letdown LOCAs during ASD
0CTISASDXXY	Operators Fail to Verify Containment Isolation on ASD
0ECRABSGPVY	Failure to provide AFW decay heat removal for Spurious SG PORV Opening related ASD Scenarios
1ACRABXXXXY	Failure to Locally Start and Load D1 Diesel Generator During Alternate Shutdown Scenarios
1ECRABXXXXY	Failure to Provide Unit 1 AFW Decay Heat Removal During Alternate Shutdown Scenarios
1LCRABXXXXY	Failure to Establish Charging Flow to Unit 1 for Alternate Shutdown Scenarios
2ACRABXXXXY	Failure to Locally Start and Load D5 Diesel Generator During Alternate Shutdown Scenarios
2ECRABXXXXY	Failure to Provide Unit 2 AFW Decay Heat Removal During Alternate Shutdown Scenarios
2LCRABXXXXY	Failure to Establish Charging Flow to Unit 2 for Alternate Shutdown Scenarios

*Applies to Loss of Control scenarios.

The resources available to the operators to safely shut down the plant following MCR abandonment are only a subset of those available from the MCR; equipment controls, indications and communications capabilities are more limited and some actions must be performed away from the Hot Shutdown Panels. A minimum set of equipment that will remain available post-fire to support the key safety functions necessary to safely shut down the plant has been developed and evaluated to meet NFPA 805 requirements. Therefore, the operator guidance for safely shutting down the plant given any fire

involving abandonment credits the potential for this equipment to remain available. The Fire PRA credits only this procedural guidance in the event of MCR abandonment, and assumes that the operators follow the guidance as written despite the fact that additional equipment supporting a given safety function may have remained unaffected by the fire. However, some equipment relevant to the plant safety functions maintained during MCR abandonment that may have remained available (and in service, or available for automatic actuation) without operator action is credited in the Fire PRA. As with the non-abandonment scenario quantification, the set of available equipment for performing ASD is determined through the mapping of fire-related failures by fire scenario in the FRANX database.

NRC Request (PRA RAI 12.b.i):

b. Please explain how the CCDPs/CLERPs are estimated for fires that lead to abandonment due to loss of habitability and how they address various possible fire-induced failures. Specifically include in this explanation, a discussion of how the following scenarios are addressed:

(i) Scenarios where fire fails only a few functions aside from forcing MCR abandonment and successful alternate shutdown is straightforward;

NSPM Response (PRA RAI 12.b.i):

(i) Overview of ASD CCDP/CLERP Evaluation:

The CCDP/CLERP for each MCR abandonment (i.e., Alternate Shutdown or ASD) scenario is not based on pre-determined probability values; the Fire PRA develops the CCDP/CLERP for each MCR abandonment scenario by applying the inputs from FRANX fire scenario information and operator failure probabilities to the CAFTA models built for ASD. The logic reflects the fact that the F5 Appendix B procedure is constructed to support the decay heat removal (Auxiliary Feedwater), RCS inventory (CVCS charging), essential power safety functions, and other functions (primary/secondary pressure control, etc.) available from the Hot Shutdown Panels and local control. It does not credit the availability of other safety functions or means of providing inventory or cool-down (for example, Emergency Core Cooling System (ECCS) pumps and heat exchangers, or bleed and feed) that are not monitored or assumed to be available by the F5 Appendix B procedure. However, the Fire PRA does credit the potential availability of other AFW pumps or AC power buses if they remained free of fire damage in a given fire scenario and can operate or function with the controls and indications available to the operators outside of the MCR and without explicit guidance in F5 Appendix B. The operator recovery actions credited are only those called out by the F5 Appendix B procedure (without credit for any such additional equipment), except for the actions that credit plant modifications, procedural enhancements and other changes to be implemented as identified in LAR Attachment S.

Note that after the initial implementation of F5 Appendix B Attachments A – I and T, the operators begin the process of initiating plant recovery. At this point it is expected that an account of the availability of any additional equipment supporting a given function may be determined. However, no additional procedural guidance is

credited in the analysis. While controls to operate the equipment may be available locally it is expected that the operators will not take additional actions to stop equipment that has remained available and is contributing to the successful maintenance of plant safety functions (for example, additional AFW pumps, or AC buses that have remained energized).

The Fire PRA assumes that core damage occurs for ASD scenarios that involve an un-isolated Loss of Cooling Accident (LOCA) (larger than can be mitigated with a charging pump), or steam line break-like scenarios. These scenarios would generally require the availability of the ECCS for mitigation. For fire initiators, these are typically multiple spurious operations (MSOs) that involve spurious operation of pressurizer PORVs (with failure of operator action to block them) or steam generator PORVs, or other spurious equipment operation that would result in the continuous opening of these valves if unmitigated (i.e., spurious charging pump operation, spurious pressurizer heaters energized, etc.). In addition, the Fire PRA assumes that core damage occurs for ASD scenarios involving ATWS.

CAFTA Modeling of ASD for CCDP/CLERP Evaluation:

The alternate shutdown model was developed to be applied directly into the Fire PRA model. By turning on the "F-ASD" flag, the logic associated with Alternate Shutdown is activated when the model is solved. Fault tree gates from the balance of the Fire PRA model were also used in the fire alternate shutdown model to include hardware failures which could contribute to failure to complete alternate shutdown procedures.

The Alternate Shutdown top logic fault tree is shown in Figure P12-1, below. Although the figure shows the F-ASDTOP as a top gate, this was done for ease of use. Each of the second tier gates, F-ASDTOPLOGIC1 and F-ASDTOPLOGIC, are also inputs into the CDF gates for quantification.

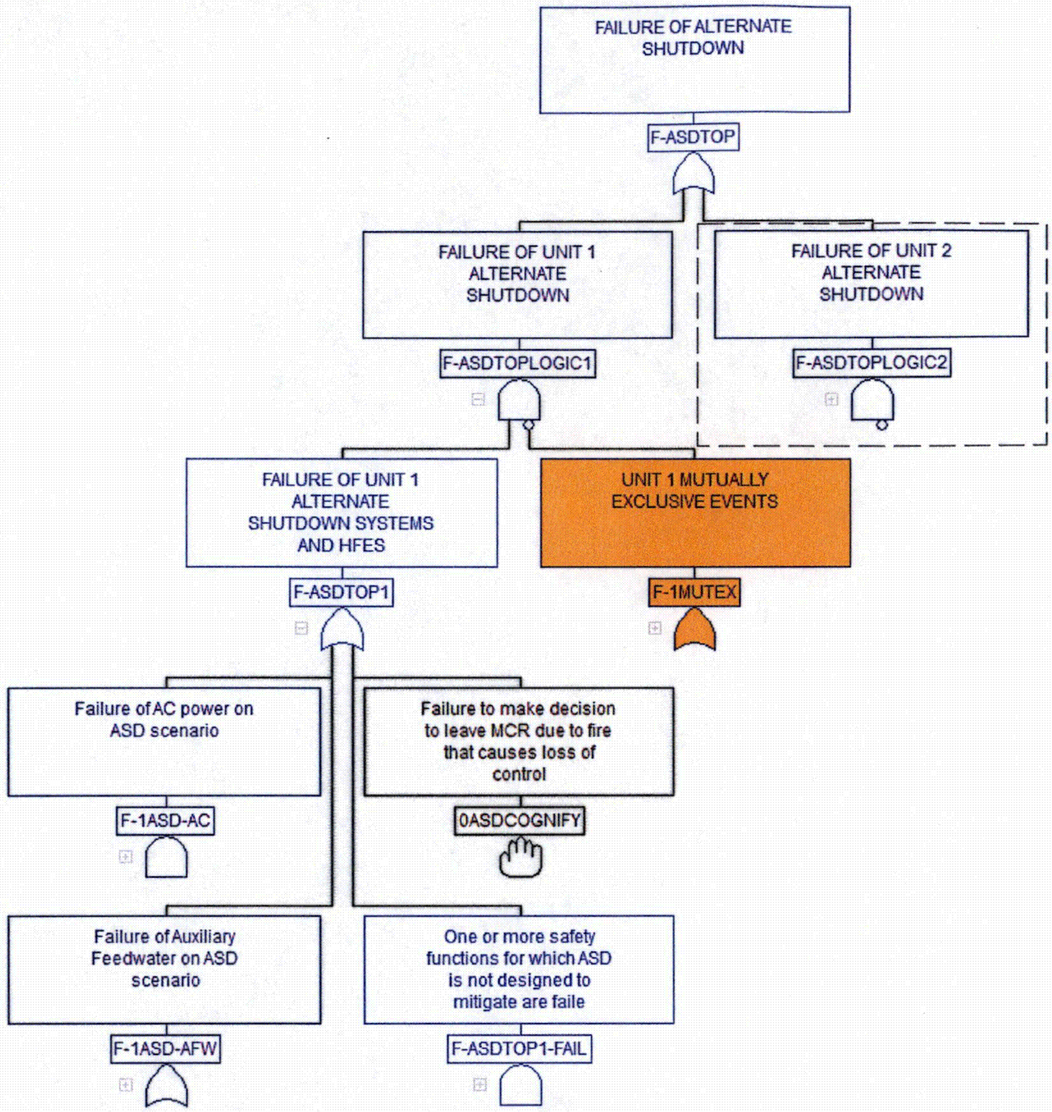

Figure P12-1 – Alternate Shutdown Top Logic

The logic for Alternate Shutdown for each Unit consists of three gates and a basic event, 0ASDCOGNIFY. [Note: 0ASDCOGNIFY is the HFE modeled for the Shift Supervisor failing to make the decision to abandon the MCR for fires that could cause a loss of control; this is discussed further under the response to item d (ii)]. The gates for Unit 1 are detailed below; however, the equivalent gates are also present for Unit 2:

- F-1ASD-AC: Failure of AC power on ASD scenario
- F-1ASD-AFW: Failure of Auxiliary Feedwater on ASD scenario
- F-ASDTOP1-FAIL: One or more safety functions for which ASD is not designed to mitigate are failed.

Gates F-1ASD-AC and F-1ASD-AFW contain the hardware failures and the "macro" HFEs taken to achieve alternate shutdown. These gates contain the first of two subsets of ASD HFEs, the so-called "CRAB" events. These events are given in Table P12-1, along with the rationale for use of the subtree in the model. The "Subtree Top Gate Name" column shows the fault tree gate associated with the hardware failures related to the HFE.

Table P12-1 – FPRA Subtrees in the ASD Model

Subtree Top Gate Name	Gate Description	Related HRA Event	Rationale For Incorporation Into Model
F-1#MSFLB1 F-2#MSFLB1	Unit 1/Unit 2 Fire-Induced Main Steam Line Break Upstream of the MSIV	0ECRABSGPVY	SG PORV(s) spuriously open and AFW needs to be initiated to provide decay heat removal
F-1ASD-AC-15[1]	Random equipment failures fail the restoration of power to Bus 15 during ASD	1ACRABXXXXY	Alternate onsite power must be provided to operate pumps, to move cooling water to cool the Unit 1 reactor core
F-1AFW	Insufficient AF flow to both SGs	1ECRABXXXXY	AFW pumps must be functional to provide Unit 1 decay heat removal
F-1CHGCLBRCS	Charging to cold leg loop B RCS flowpath failures	1LCRABXXXXY	The charging pumps must be functional to provide water flow for Unit 1 RCS inventory control, and to maintain RCS subcooling margin
F-1ASD-AC-25[2]	Random equipment failures fail the restoration of power to Bus 25 during ASD	2ACRABXXXXY	Alternate onsite power must be provided to operate pumps, to move cooling water to cool the Unit 2 reactor core
F-2AFW	Insufficient AF flow to both SGs	2ECRABXXXXY	AFW pumps must be functional to provide Unit 2 decay heat removal
F-2CHGCLBRCS	Charging to cold leg loop B RCS flowpath failures	2LCRABXXXXY	The charging pumps must be functional to provide water flow for Unit 2 RCS inventory control, and to maintain RCS subcooling margin

Notes for Table P12-1:
[1] Primary subtree that was used to model hardware failures. Additional ASD logic was modeled under gate F-1ASD-AC-15-1.
[2] Primary subtree that was used to model hardware failures. Additional ASD logic was modeled under gate F-2ASD-AC-25-1.

The gate, F-ASDTOP1-FAIL, contains the hardware failures and operator actions associated with the safety functions for which Alternate Shutdown was not designed to mitigate. This second subset of HFEs models the "micro" actions taken by operators during Alternate Shutdown, such as the operator actions taken in F5 Appendix B to mitigate or prevent fire-induced spurious actuation of equipment. Although the model contains hardware failures representing plant conditions that cannot be addressed with the available equipment and controls for ASD, credit for

the operator response during ASD to stop these sequences from progressing to core damage have been applied. These actions typically include operator actions credited for mitigating spurious operation of equipment. The hardware failures and associated HFEs are summarized in Table P12-2. The "Subtree Top Gate Name" column shows the fault tree gate associated with the hardware failures related to the HFE.

Table P12-2 – Additional Recovery Actions and FPRA Subtrees in the ASD Model

Subtree Top Gate Name	Gate Description	Related HRA Event	Rationale For Incorporation Into Model
F-1RAC-BUS-15-N9 F-2RAC-BUS-25-N9	Unrecoverable failures of Bus 15/25	0ASDAVLTXXY	This HFE credits local operator action to close the bus-tie breakers between Bus 15 and Bus 25 to repower a dead bus from the opposite unit 4kV source. For example, if the D1 source is not available to Bus 15 but Bus 25 is available, the operator will locally close the bus-tie breakers to allow Bus 15 to be re-energized from Bus 25. The same action is used to repower Bus 25 from Bus 15 should the D5 EDG be unavailable.
F-1RAC1020-N9 F-2RAC1021-N9-ASD	FAILURE OF BUS 15/25 MANUAL VOLTAGE RESTORATION HARDWARE		
F-1ASD-AC F-2ASD-AC	Failure of AC power on ASD scenario	0ASDCOGNIFY	The cognitive decision to abandon the MCR is developed in this HFE.
F-1ASD-AFW F-2ASD-AFW	Failure of Auxiliary Feedwater on ASD scenario		
F-ASDTOP1-FAIL F-ASDTOP2-FAIL	One or more safety functions for which ASD is not designed to mitigate are failed		
F-1-CHG-LOCA1 F-2-CHG-LOCA1	Spurious start of 21, 22, or 23 charging pumps	0ASDCHLOCAY	Fire-induced spurious charging pump starts could result in an open pressurizer PORV, a condition that is not recoverable with ASD. This HFE credits an operator action to trip a charging pump that has spuriously started.
F-1LETDWN-LOCA0 F-2LETDWN-LOCA0	Unit 1/ Unit 2 Letdown LOCA	0ASDLETDNFY	This action ensures that letdown is isolated.

(Table P12-2 continued next page)

Table P12-2 (Continued)

Subtree Top Gate Name	Gate Description	Related HRA Event	Rationale For Incorporation Into Model
F-I-1-VSLOCA-IES-1 F-I-2-VSLOCA-IES-1	Unit 1/Unit 2 Fire-Induced very small LOCA		
F-ASDTOP1-FAIL-5-1 F-ASDTOP2-FAIL-5-1	ASD sequence with PORV LOCA	0ASDLOCACRY	This HFE is credited to preclude LOCAs due to spurious operation of pressurizer PORVs.
F-1MSO-HI-PZRP-ASD F-2MSO-HI-PZRP-ASD	High pressurizer pressure (challenge to PZR relief valves) – ASD		
F-I-1-VSLOCA-IES-1 F-I-2-VSLOCA-IES-1	Unit 1/Unit 2 Fire-Induced Very-Small LOCA	0ASDVSLOCAY	Very small LOCA events (pressurizer vent/RCS head vent valve spurious operation, excess letdown spurious operation) result in loss of inventory at a low rate that can be mitigated by the operation of a single charging pump. This action ensures that an otherwise available charging pump is available to mitigate this loss of inventory.
F-1CIF-ASD-1 F-2CIF-ASD-1	ASD scenarios where failure of containment isolation is assumed not recoverable	0CTISASDXXY	This operator action ensures that isolation of containment penetrations was successful.
F-ASDTOP1-FAIL-4-2 F-ASDTOP2-FAIL-4-2	Loss of RCP seal cooling and RCPs not tripped	0RCPN900LFY	This HFE credits a local operator action to trip the RCPs at the 4kV bus should remote trip fail or be disabled by the fire.

NRC Request (PRA RAI 12.b.ii):

(ii) Scenarios where fire could cause some recoverable functional failures or spurious operations that complicate the shutdown, but successful alternate shutdown is likely; and,

NSPM Response (PRA RAI 12.b.ii):

(ii) The Fire PRA develops the CCDP/CLERP for each MCR abandonment scenario by applying the inputs from FRANX fire scenario information and operator failure probabilities to the CAFTA models built for ASD. Although other equipment may remain available to the operator depending on the fire scenario, only the actions called out in the procedural guidance of F5 Appendix B are credited. These actions and their failure probabilities are not altered or adjusted according to the status of equipment following a given fire.

NRC Request (PRA RAI 12.b.iii):

(iii) Scenarios where the fire-induced failures cause great difficulty for shutdown by failing multiple functions and/or complex spurious operations that make successful shutdown unlikely.

NSPM Response (PRA RAI 12.b.iii):

(iii) The Fire PRA develops the CCDP/CLERP for each MCR abandonment scenario using the application of FRANX fire-related failures and operator failure probabilities to the CAFTA models built for ASD. Although other equipment may remain available to the operator depending on the fire scenario, only the actions called out in the procedural guidance of F5 Appendix B are credited. These actions and their failure probabilities are not altered or adjusted according to the status of equipment following a given fire.

Although the same HFEs/HEPs were used, they were considered to be bounding for all scenarios based on the timing from thermal-hydraulics analysis used to evaluate them.

Table P12-3 summarizes the system time window used for each of the execution ASD HFEs. The basis for selection of the Tsw is a thermal-hydraulic MAAP case.

Table P12-3 - T_{sw} Summary for Execution ASD HFEs

Basic Event	Description	Tsw	Basis
0ASDAVLTXXY	Operators fails to cross tie bus 15 and bus 25	2.75 hrs	MAAP case PI-09b
0ASDCHLOCAY	Operators fail to stop charging LOCAs during ASD	28 min	MAAP sequence 0ASDCHLOCAY_2CP
0ASDLETDNFY	Operator Fails to Manually Isolate Letdown to Prevent Letdown LOCA (ASD Scenarios)	30 min	MAAP sequence 0ASDLOCACRY-IsoPORV
0ASDLOCACRY	Operators Fail to De-energize Source of Fire-induced LOCA using MCR Switch	30 min	MAAP sequence 0ASDLOCACRY-IsoPORV
0ASDVSLOCAY	Operators fail to isolate RCS vent or Excess Letdown LOCAs during ASD	24 hrs	MAAP case PI-09b
0CTISASDXXY	Operators Fail to Verify Containment Isolation on ASD	78 min	MAAP case PI-07a
0ECRABSGPVY	Failure to provide AFW decay heat removal for Spurious SG PORV Opening related ASD Scenarios	55 min	MAAP sequence 0ASDPVMSLBY-1-IsoRV
1ACRABXXXXY	Failure to locally start and load D1 Diesel Generator during alternate shutdown scenarios	2.75 hrs	MAAP case PI-09b

In addition, no credit is given for operator response actions if equipment failures occur that were assumed to fail ASD altogether (fire-induced failure of all AC power, AFW failure, scenarios that would require recovery using ECCS equipment, etc.); core damage is simply assumed to occur in these scenarios.

NRC Request (PRA RAI 12.c):

c. *Please explain the timing considerations (i.e., total time available, time until cues are reached, manipulation time, and time for decision-making) made to characterize scenarios in Part (b). Include in the explanation the basis for any assumptions made about timing.*

NSPM Response (PRA RAI 12.c):

c. In general, the fire itself will most likely be the initial cue an operator has for a fire in the MCR. For a fire in the Relay Room, an alarm will sound in the MCR. There are fire detection panels near the doors of the shared MCR which alarm to an annunciator on the Main Control Boards. The fire alarms and indications are applicable to both Unit 1 and Unit 2. The fire zone in which the fire is located will be illuminated on the applicable detection panel.

The cues used for cognitive HFE ASDCOGNIFY for the decision to abandon the MCR are based on Section 2.3 of the Control Room Evacuation (Fire) procedure F5 Appendix B:

2.3.1 A catastrophic fire as evidenced by flames or smoke in the Control Room (Zone 57) and/or Relay Room (Zone 12) that requires evacuation due to either of the following:

- Environmental conditions (smoke/heat).

OR

- A loss of Control Room control of critical plant functions which cannot be adequately addressed by Alarm Response Procedure (ARP), AOP, Instrument Failure Guide (IFG) or EOP response actions.

2.3.2 Actuation of fire detection and suppression in other fire areas which indicates conditions i.e., (smoke, fumes) that require Control Room evacuation.

Other cues and indications, which are also symptoms or entry conditions into F5 Appendix B, would include:

- Spurious cycling of plant equipment due to fire damage in the MCR or Relay Room.
- A loss of control of plant equipment from the MCR due to fire damage in the MCR or Relay Room.
- Unreliable or loss of MCR instrumentation due to fire damage in the MCR or Relay Room.

The total time available (system time window, or Tsw) for each ASD HFE was determined using bounding MAAP thermal hydraulic analysis. Timing consistent with the overall fire HRA was used to assess how long it takes from receipt of a fire alarm to perform the visual confirmation; this is taken as the delay time (T_{delay}). The median response time ($T_{1/2}$) considers time for detection, diagnosis and decision-making, including travel time to the location where the actions are taken, and time for performance of intervening procedure steps prior to the performance of the actions associated with the HFE in question. If the cues and indications are impacted by the fire, it will take the operators longer to make the correct diagnosis; this is reflected in the $T_{1/2}$ values chosen. For those ASD HFEs that involve the reactor operators, $T_{1/2}$ also includes the time required to perform the F5 Appendix B required actions prior to leaving the MCR. The manipulation time (now called execution time or T_{exe} in the latest version of the EPRI HRA Calculator) includes the time to complete the actions associated with the specific HFE in question, as required in F5 Appendix B.

NRC Request (PRA RAI 12.d.i):

d. If MCR abandonment is credited for loss of control (i.e., non-habitability cases), then

(i) Please describe when MCR abandonment on loss of control is credited and how it was modeled. Include justification of the criteria used by the FPRA to govern whether a scenario results in MCR abandonment on loss of control, including how these criteria are representative of the cues used by operators in making the determination to abandon the MCR. Explain how the cognitive component associated with the decision to abandon the MCR is assessed.

NSPM Response (PRA RAI 12.d.i):

(i) Procedure F5 Appendix B allows for Shift Supervisor determination to abandon the MCR on loss of control. The Fire PRA also calculates the probability of abandonment of the MCR from environmental conditions due to a fire occurring within MCR. Such fires may also be large enough to also result in loss of safe shutdown functional control (e.g., both trains and alternate means of providing the function from the MCR), such that it may be reasonable to assume the Shift Supervisor would issue the order to abandon the MCR on "loss of control" grounds. Abandonment due to loss of control in these cases is not credited. However, there are cases where the fire is small such that habitability is not threatened, but the operators may need to abandon the MCR and shut down using the F5 Appendix B guidance due to a significant loss of control of plant equipment. Three MCR fire scenarios were determined to be in this category. These scenarios involve fires located in the G-panel in the MCR which contains the controls for both offsite power and for the emergency diesel generators. These three scenarios are:

- FA13-MCR-1P-PANEL-G1 (G-Panel fire with Prompt Suppression, plant trip only)
- FA13-MCR-4NA-PANEL-G1 (G-Panel fire, no Prompt Suppression, propagation outside panel)
- FA13-MCR-6NA-PANEL-G1 (G-Panel fire, no Prompt Suppression, no propagation outside panel)

The set of targets developed in the analysis of these scenarios was such that, without additional random or non-fire-related failures, a station blackout (SBO) scenario can develop. Initial quantification of these scenarios using the non-ASD logic showed a very high CCDP for these scenarios. Procedure F5 Appendix B provides guidance for local operator action to restore a train of power to the plant. Therefore, while the operators may not be experiencing significant habitability concerns, it was determined that in these situations the operators would elect to abandon the MCR on the grounds of a significant loss of control of plant functions. These scenarios were then included in the list of scenarios evaluated using the MCR abandonment models.

The CCDPs for loss of control were calculated in a similar manner to those for loss of habitability.

NRC Request (PRA RAI 12.d.ii):

(ii) Please discuss the bases for the timing assumed in the HRA performed for MCR abandonment scenarios on loss of control, including the results of thermal-hydraulics analyses. Include discussion of the cues to abandon the MCR, the timing associated with those cues, and the basis for time available to complete required actions. Include explanation of how fire-induced impacts including spurious operations are accounted for in determining the timing associated with the cue to abandon and the time available to perform operator actions.

NSPM Response (PRA RAI 12.d.ii):

(ii) The cues used for cognitive HFE ASDCOGNIFY for the decision to abandon the MCR are based on Section 2.3 of the Control Room Evacuation (Fire) procedure F5 Appendix B:

2.3.1 A catastrophic fire as evidenced by flames or smoke in the Control Room (Zone 57) and/or Relay Room (Zone 12) that requires evacuation due to either of the following:

- Environmental conditions (smoke/heat).

OR

- A loss of Control Room control of critical plant functions which cannot be adequately addressed by ARP, AOP, Instrument Failure Guide (IFG) or EOP response actions.

2.3.2 Actuation of fire detection and suppression in other fire areas which indicates conditions i.e., (smoke, fumes) that require Control Room evacuation.

Other cues and indications, which are also symptoms or entry conditions into F5 Appendix B, would include:

- Spurious cycling of plant equipment due to fire damage in the MCR or Relay Room.
- A loss of control of plant equipment from the MCR due to fire damage in the

MCR or Relay Room.

- Unreliable or loss of MCR instrumentation due to fire damage in the MCR or Relay Room.

A detailed human reliability analysis (HRA) was conducted using NUREG-1921 accepted methods to evaluate MCR abandonment, including the decision to abandon, modeled by the ASD HFE ASDCOGNIFY.

Since the issue is not whether the MCR is ever abandoned, but whether it is abandoned in time, a timeline was established to assess the following key timing elements that provide input to the calculation of the human error probability (HEP) for the cognitive HFE:

- Thermal hydraulics and PRA evaluation were used to determine how long the operators have to evacuate the MCR.

  The MAAP sequence for HFE 0ASDPVMSLBY models the spurious opening of one and two SG PORVs along with a loss of main feedwater and reactor trip. With the SG PORV blocked immediately, bleed and feed criteria is reached by approximately 59 minutes. (MAAP sequence 0ASDPVMSLBY-1-IsoRV). Using 55 minutes gives about 4 minutes of margin.

  The longest execution time of all the ASD actions is from 1LCRABXXXXY and is 33 minutes. Since 33 minutes is required for execution, and 55 minutes is assumed to be available, 22 minutes is considered to be a plausible time window for exiting the MCR and initiating the abandonment procedure attachments.

- Timing consistent with the overall fire HRA was used to assess how long it takes from receipt of a fire alarm to perform the visual confirmation; this is taken as the delay time (T_{delay}).

  Given that the fire in the MCR or Relay Room is large enough to require an evacuation due to habitability or control issues, it is assumed that the fire would either initiate as a large fire or become large very quickly as small fires would be noticed and extinguished. An exception is a smaller fire in a critical panel that would not create habitability issues, but would create operability problems sufficient to warrant MCR abandonment. For this analysis, a 5 minute delay time is retained in the MCR abandonment scenarios, similar to other fire HEPs elsewhere in the plant, to account for the time between either the start of a large unmanageable fire or an obvious loss of control in the MCR and the crew acknowledgment (cue) of a fire to account for the smaller fires that may not be obvious within critical panels. By this time the Shift Supervisor will have all the information needed to make the decision to abandon (that is, the Shift Supervisor will have a report on the fire location, its severity, and the fire induced failures (e.g., spurious actuations) that will have manifested themselves in the MCR.

- Timing consistent with the overall fire HRA was used to estimate the Cognition portion of the HFE (T_{cog}), which is the decision to abandon.

  This decision is made by the Shift Supervisor on the basis of confirmation of the severity of the fire. As discussed in Part (a) above, Procedure F5 Appendix B,

section 2.3.1 specifies the loss of control abandonment criteria as "A loss of Control Room control of critical plant functions which cannot be adequately addressed by ARP, AOP, Instrument Failure Guide (IFG) or EOP response actions."

Given that the fire is assumed to be large and obvious within a very short time frame or damages a significant number of MCR indicators, and there is procedural guidance plus training, this Tcog time was estimated as 1 minute.

- The time between the decision to abandon and the actual start of the execution actions was included in this cognitive HFE as well, represented by the "manipulation time" or execution time (T_{exe}).

  The calculation GEN-PI-055, Rev.1, 10 CFR 50 Appendix R Manual Action Feasibility Study provides estimated timing (including transit times) for performing the Unit 1 Shift Supervisor Actions specified in the abandonment procedure F5 Appendix B Attachment A. An estimate of 14 minutes was used for T_{exe} based on calculation GEN-PI-055.

  GEN-PI-055, 10 CFR 50 Appendix R, Manual Action Feasibility Study, is being revised to update the timing for the Unit 1 Shift Supervisor (U1 SS) actions (listed in Appendix D, Attachments A and I) performed in the abandonment procedure F5 Appendix B. The timing will be verified during the implementation phase as part of Attachment S, Table S-3 item 53, prior to self-approval.

  Regarding the execution actions that take place after the MCR is evacuated, rather than modeling human actions by each individual plant operator, the modeling approach was organized by function, which did not always account for the fact that the sequence of tasks involved more than one operator. This simplification introduces minimal error because timing of the individual actions was still properly accounted for in the analysis, and because in executing their individual attachments steps from F5 Appendix B, the operators do not need to stop and wait for actions by others to be completed before they proceed.

Table P12-3 above summarizes the system time window (T_{sw}) used for each of the execution HFEs. The basis for selection of the T_{sw} is a thermal-hydraulic MAAP case.

The T_{delay} for the ASD execution actions is based on the $T_{delay} + T_{cog} + T_{exe}$ from ASDCOGNIFY, since the cognitive decision to abandon and initial abandonment preparation steps must occur before the execution at the remote shutdown panels or other local actions take place.

T_{cog} for the ASD execution actions is assumed to be zero, since the procedures are direct and clear regarding the execution steps that must be taken. Timing for the operators to perform procedurally directed local actions, including travel time, is addressed in the individual execution HFE T_{exe} values, which are based on the GEN-PI-055 Appendix D Manual Action Feasibility Study timeline that breaks down timed actions of procedure steps in F5 Appendix B.

NRC Request (PRA RAI 12.d.iii):

(iii) If the timing of the cues to abandon the MCR and the available time for performing operator actions does not take into account fire-induced impacts, then justify the current approach or replace this approach with an acceptable approach in the integrated analysis provided in response to RAI 03.

NSPM Response (PRA RAI 12.d.iii):

(iii) Timing of the cues to abandon the MCR are based on how long it takes from receipt of a fire alarm to perform the visual confirmation of the fire severity; this is taken as the delay time (Tdelay) of the cognitive HFE 0ASDCOGNIFY. This time – estimated as 5 minutes - is consistent with other fire HEPs and reflects the time between either the start of a large unmanageable fire or an obvious loss of control in the MCR and the crew acknowledgment (cue) of a fire to account for the smaller fires that may not be obvious within critical panels.

The PINGP calculation GEN-PI-055, Rev.1, 10 CFR 50 Appendix R Manual Action Feasibility Study provides estimated timing (based on walk downs in the plant including transit times) for performing the operator actions specified in the abandonment procedure F5 Appendix B and its attachments. These times take into account fire-related impacts and are factored into the detailed timing analysis for each of the ASD HFEs.

NRC Request (PRA RAI 12.e):

e. Please explain how the abandonment scenario frequencies due to loss of habitability and/or loss of control were determined. Include explanation of how the fire ignition frequencies contributing to these scenarios and non-suppression probabilities were determined.

NSPM Response (PRA RAI 12.e):

e. <u>Loss of Habitability Scenarios:</u>

The sequence of events depicted in the event tree in Figure P12-2 summarizes the evaluation of the MCR panel fire scenario frequencies. Each of the top events in Figure P12-2 is described in the text that follows the figure. Note that while the discussion focuses on Main Control Board (MCB) panel fires, there are additional electrical cabinets within the MCR for which fire scenarios must be considered. Except for the ignition frequency (see below), the modeling of the fire scenarios due to these panels is the same as the treatment of the MCB panels and includes the possibility of abandonment due to fire.

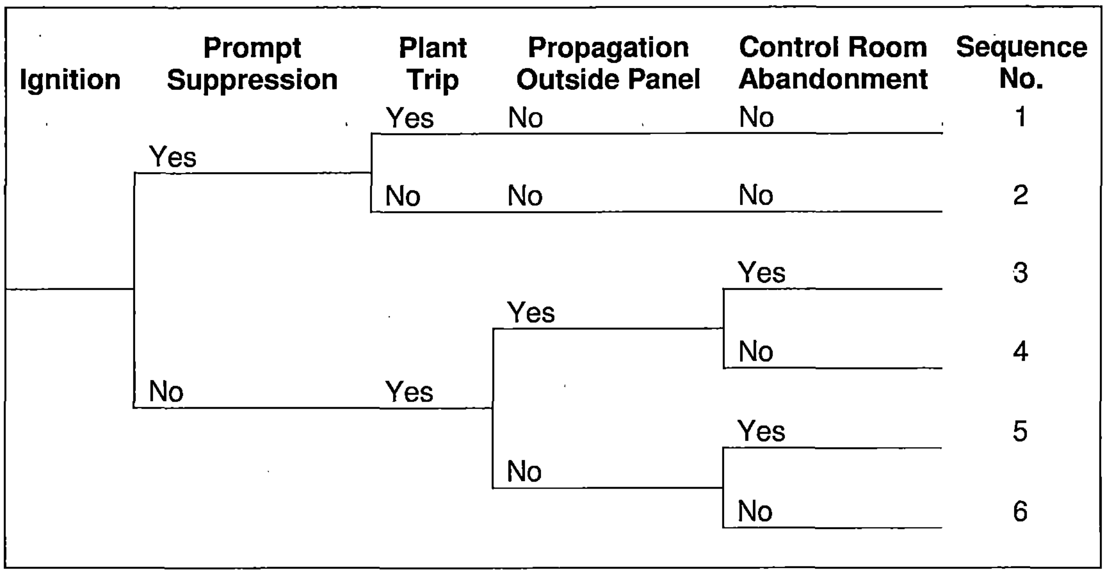

Figure P12-2 – Evaluation Logic for Main Control Room Panel Fires

A detailed discussion of each sequence in the Figure P12-2 event tree model is provided in the response to PRA RAI 01.e above.

Because fire suppression is already included in the analysis in the propagation likelihood, the probability of abandonment (i.e., the MCR abandonment split fraction) is taken to be the conditional probability given the failure to suppress a fire that is large enough to generate abandonment conditions. The probabilities are obtained using the output of FDS code simulations to calculate conditional probabilities for different heat release rates. Therefore, the cumulative probability of observing a heat release rate that generates abandonment is the sum of the non-suppression probabilities and severity factors for all the fire sizes generating abandonment.

Loss of Control Scenarios:

The Prairie Island Fire PRA assumes MCR abandonment scenarios on a loss of control basis for certain fire scenarios in the MCR and in the Relay Room.

MCR Scenarios:

As described in the response to sub-part d(i) above, there were three MCR scenarios that were assumed to force abandonment due to loss of control rather than loss of habitability. These scenarios were:

- FA13-MCR-1P-PANEL-G1 (G-Panel fire with Prompt Suppression, plant trip only)
- FA13-MCR-4NA-PANEL-G1 (G-Panel fire, no Prompt Suppression, propagation outside panel)
- FA13-MCR-6NA-PANEL-G1 (G-Panel fire, no Prompt Suppression, no propagation outside panel)

The sequence probabilities for these scenarios were developed using the same process described above for the MCR loss of habitability evaluation. Although these scenarios

did not require abandonment from a habitability standpoint (they involved sequences 1, 4 and 6 from Figure P12-2, respectively), the target sets involved in these scenarios were determined to require abandonment due to loss of control.

Relay Room Scenarios:

As described in the response to sub-part a. above, the decision to credit ASD for fires occurring in the Relay Room is determined based on damage criteria identified through detailed fire modeling analysis. These fires initiate in the cable spreading room located directly below the MCR (the "Relay Room"); therefore, abandonment due to MCR habitability issues are unlikely, but may occur due to loss of control concerns experienced by the MCR operators. As with the MCR fire scenarios, the Fire PRA models the abandonment scenario CCDP with the ASD logic models, and non-abandonment scenario CCDP with the non-ASD logic models (that are used for all non-MCR abandonment fire sequences). The scenario frequencies are determined following guidance from NUREG/CR-6850.

Damage States for Relay Room Analysis:

The detailed fire modeling analysis for the Relay Room used the general process described above but addressed three potential damage states. The first damage state postulates a fire that is limited to the ignition source and localized target damage (i.e. the first cable tray and nearby conduits). A second damage state postulates the localized targets damaged in the first damage state and all targets within the zone of influence (ZOI) of the 98^{th} percentile HRR of the specific ignition source. A third damage state is postulated as a full compartment burn of the Relay Room. All fire scenarios capable of a hot gas layer that meets the damage criteria contributes to the full compartment burn scenario. ASD credit is assumed for all damage states greater than one (i.e., damage states "2" and "3").

PRA RAI 13 – Calculation of ΔCDF, ΔLERF and Additional Risk of Recovery Actions

Response to PRA RAI 13 was provided with the 60-day RAIs.

PRA RAI 14 – Attachment W Inconsistencies

Response to PRA RAI 14 was provided with the 60-day RAIs.

PRA RAI 15 – Implementation Item Impact on Risk Estimates

Response to PRA RAI 15 was provided with the 60-day RAIs.

PRA RAI 16 – Use of Incipient Detection

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. In letter dated July 12, 2006, to NEI (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.

Attachment S, Table S-2, of the LAR indicates that incipient detection systems (i.e., Very Early Warning Fire Detection System) are credited in the Fire PRA and will be installed in Relay Room cabinets. Though LAR Attachment S, Table S-2 provides some comments about how incipient detection was modeled in the FPRA more explanation is needed to fully understand how incipient detection was credited.

Please explain and justify how incipient detection is credited in the FPRA, describing any departures from guidance in FAQ 08-0046. If incipient detection is credited beyond what is allowed by FAQ 08-0046, then remove this credit, and incorporate acceptable credit as part of the integrated analysis performed in response to PRA RAI 03.

NSPM Response (PRA RAI 16):

The Incipient Detection System (Very Early Warning Fire Detection System) is being credited to reduce risk of electrical cabinet fires. The guidance in FAQ 08-0046 is being followed. Credit for incipient fire detection system applies only to ignition sources that are:

- Present in low voltage electrical cabinets/panels (250 V or less) in selected fire areas/zone, and
- Expected to present an incipient fire growth stage.

Credit for the incipient fire detection system in the Fire PRA was modeled as a multiplicative factor to the fire ignition frequency. Following the guidance in NUREG/CR-6850 Supplement 1 for incipient detection credit (FAQ 08-0046), an event tree approach is used to obtain the incipient detection factor, 0.02, to be multiplied times the ignition frequency value.

The logic model has the following events (See Figure P16-1 below):

- FIRE: This is the first event, i.e., the initiating event, in the chronology. The value for this event is kept as 1.0 as the resulting factor is multiplied by the scenario frequency calculated in the quantification module of the fire modeling database.
- INCIP: This is the second event in the chronology. This event represents the probability that the ignition source presents an incipient stage. The value for the top branch in this event is 1.0, indicating that the incipient detection system is credited in electrical cabinets that are expected to always present an incipient state (i.e., low voltage electrical cabinets [mostly control or termination cabinet] with no fast acting components such as chart recorder drives, cooling fan motors, other electric motors, etc.).

- DET: This is the third event in the chronology. The event captures the probability of the incipient detection system failing to detect the fire upon demand, i.e., it captures the reliability and availability of the system. Success for this branch in the event tree means that the incipient detection system has issued an alert. Based on the guidance on Page 13-5 of NUREG/CR-6850 Supplement 1, the failure probability value, β, is set equal to 1E-02.
- FB: This is the fourth event in the chronology. The event captures the operator/brigade response to an alert from the incipient detection system. In general, it is expected that operator/brigade response to an alert will include identification of hot spot(s) where an incipient fire is developing and appropriate disposition of the events. The branch probability of failure of the operator/fire brigade to respond to the alert and find the component, can be conservatively set to 1.0E-2 as recommended in page 13-6 of NUREG/CR-6850 Supplement 1.
- SUPP: This is the last event in the chronology. Success indicates that the "flash watch" stationed at the cabinet in response to an incipient detection alert condition has successfully controlled the fire before it affects the target. 'ε1' (epsilon1) represents the probability that, given success of the event of an alert response, the person staged at the cabinet responsible for the alert fails to promptly suppress the fire (i.e., quickly enough to prevent damage to PRA targets outside the cabinet) once open flaming does break out. This probability is set to 1E-03 per guidance on page 13-8 of NUREG/CR-6850 Supplement 1. This is considered to be reasonable given the nature of the response required by a trained responder who is stationed at the location with the correct equipment.

Branches following failure in the successful operator response or detector unavailability lead to prevention of damage to the targets by the fire brigade. The probability of "normal" non-suppression is calculated using the Detection Suppression Event Tree in NUREG/CR-6850, Appendix P, and the electrical fire suppression curve for manual suppression from Chapter 14 of NUREG/CR-6850 Supplement 1. Credit should be given as described in Appendix P for automatic detection and suppression (normal spot detectors and automatic suppression in the area) as well as delayed manual detection, manual actuation of fixed suppression, and manual suppression via the fire brigade. In this application, a conservative time of 3.5 minutes has been selected for calculating an approximate branch probability of 30% success suppression by the fire brigade. The 3.5 minute value is a representative conservative value applied to all the scenarios. It is the estimated time it takes the flames of a fire postulated outside an electrical cabinet to reach the cable damage temperature of approximately 205°C, assuming a fire growth to a peak of 1 MW in 12 minutes (fire growth rate recommended in Appendix G of NUREG/CR-6850). Recall that the brigade response time is not considered when the suppression curves from Chapter 14 of NUREG/CR-6850 Supplement 1 are used. The value is considered conservative as all the cabinets in the fire compartments where the system is credited are closed.

Results: The multiplicative factor to the ignition frequency is the sum of the resulting branch probabilities with the exception of the top branch (No-Fire). This resulting sum is 9.8E-4 + 2.97E-3 + 6.93E-3 + 3.0E-3 + 7.0E-3 = 0.02088 ≈ 0.02.

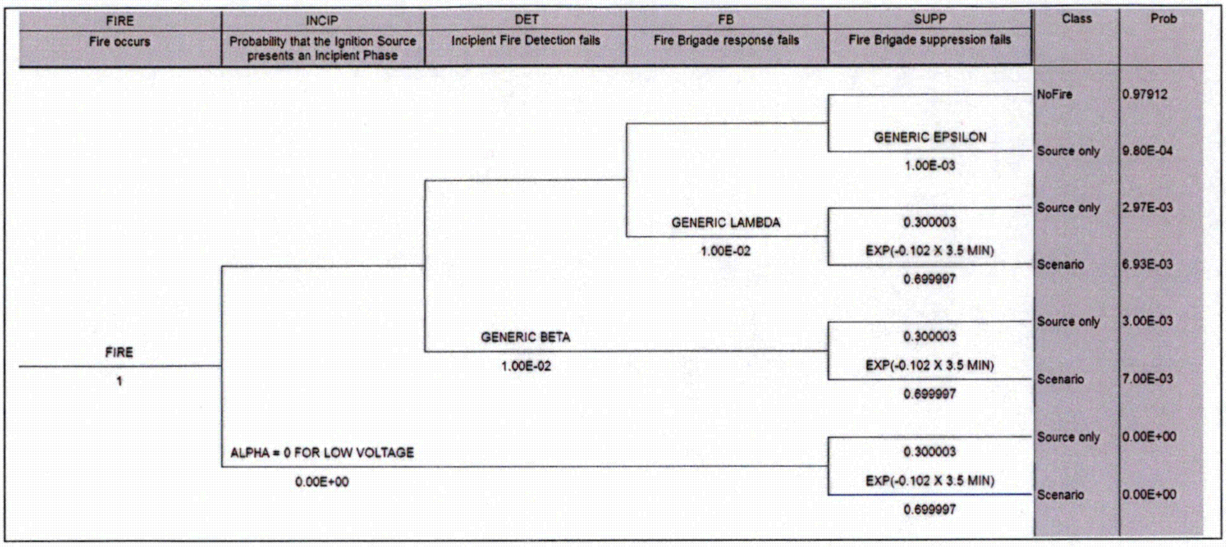

Figure P16-1 Incipient Detection Fault Tree

PRA RAI 17 – RCP Seal PRA Modeling

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. The 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, as providing methods acceptable to the NRC staff for adopting a fire protection program consistent with NFPA 805. The 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.

Attachment S of the LAR indicates that a Flowserve N-9000 abeyance RCP seal package has been installed for Unit 2 and will be installed for Unit 1. Additionally, Attachment U states that a Flowserve RCP seal PRA model has been developed for the package and peer reviewed in May of 2014, i.e., after the LAR was submitted.

[This RAI includes Subparts a and b as shown below along with NSPM responses.]

NRC Request (PRA RAI 17.a):

a. *Please provide a summary of the technical basis and any available test information that supports the PINGP RCP seal PRA modeling.*

NSPM Response (PRA RAI 17.a):

a. The Flowserve Corporation topical report "PRA Model for Flowserve 3 Stage N-Seals with Abeyance Seal", Revision 0 dated December 20, 2013, was the basis for the PINGP RCP seal modeling. The Flowserve topical report was provided to the NRC in a

letter from Florida Power and Light dated July 18, 2014 (Reference P-1). A copy is available for information purposes on the PINGP NFPA 805 web portal.

The topical report concluded that the seals allow for an operator response time for RCP trips of up to 2 hours. The volume of water inside of the RCP above the cold leg will be purged in conservatively 60 minutes and Flowserve tests show that at least an additional 60 minutes will be available until the seals had measurable changes in leakage. The report also concluded that for Station Blackout (SBO) scenarios a failure probability of 6.83E-07 is appropriate and with no SBO and a time to trip of two hours the failure probability of 2.73E-04 is appropriate for the Fire PRA.

NRC Request (PRA RAI 17.b):

b. *Please clarify whether the F&Os generated from the May 2014 peer review performed on the RCP seal PRA modeling have been adequately addressed and incorporated into the FPRA.*

NSPM Response (PRA RAI 17.b):

b. The focused peer review to evaluate the model changes made to address the incorporation of Flowserve N9000 Reactor Coolant Pump (RCP) seals at Prairie Island Nuclear Generating Plant (PINGP) was performed to ASME/ANS RA-Sa-2009 as clarified by RG 1.200, Revision 2.

The resolution of the findings from this Peer Review were incorporated into the Prairie Island Fire PRA and will be reflected in the integrated analysis to support the response to PRA RAI 03.

References

P-1 Letter from M. Kiley (Florida Power and Light) to Document Control Desk (NRC), "Response to Request for Additional Information Regarding License Amendment Request No. 216 – Transition to 10 CFR 50.48(c) – NFPA 805 Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants (2001 Edition)," July 18, 2014.

PRA RAI 18 – Deviations from Acceptable Methods

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.

Please indicate if any other methods were employed that deviate from other NRC-accepted guidance (e.g., subsequent clarifications documented in FAQs, interim guidance documents, etc.). If so, describe and justify any proposed method that deviates from NRC guidance, or replace the proposed method with an accepted method. Also, include the proposed method as a method "currently under review" as part of the integrated analysis in the response to PRA RAI 03.

NSPM Response (PRA RAI 18):

The PINGP Fire PRA has been developed with accepted methods. One deviation from the guidance in NUREG/CR-6850 has been identified. Technical details associated with this deviation are provided as part of the response to PRA RAI 01.e. The deviation involves the apportioning of the Main Control Board generic frequency to the different fire scenarios defined in the Fire PRA. Specifically, the generic frequency associated with the fire scenarios defined in the PINGP Main Control Board has been apportioned so that the full frequency is accounted as part of different damage states in the fire scenario progression. The following damage states are included in the analysis:

1. Promptly suppressed fire generating a plant trip.
2. Promptly suppressed fire with no consequence to the plant (this damage state is conservatively ignored in the analysis)
3. Fire damaging more than one Main Control Board panel generating MCR abandonment due to worsening habitability conditions (i.e., MCR abandonment scenario)
4. Fire damaging more than one Main Control Board panel not generating MCR abandonment due to worsening habitability conditions (i.e., no MCR abandonment)
5. Fire damage limited to one control board panel generating MCR abandonment due to worsening habitability conditions (i.e., MCR abandonment scenario)
6. Fire damage limited to one control board panel not generating MCR abandonment due to worsening habitability conditions (i.e., no MCR abandonment)

It should be noted that the targets associated with damage states three through six listed above include ALL the cables mapped to basic events in the Fire PRA that are routed in the corresponding cabinets. This target mapping approach ensures that all targets in the Main Control Board were included in the analysis.

Items three through six listed above represent a fire scenario progression that starts with ignition in the Main Control Board. As the fire grows, different consequences (i.e. damage states resulting from the scenario) can develop. Therefore, the intent of this approach is to quantify the risk contribution of each damage state. To do so, the generic fire ignition frequency for the Main Control Board needs to be apportioned to each panel as this is the initiating event frequency for the scenario progression. This is accomplished using the ratio of the number of cables mapped to the panel divided by the total number of cables mapped to the Main Control Board. The number of cables mapped to each panel is used as a surrogate of the number of potential ignition sources (e.g., cable termination points, switches, etc.) within the panel. The resulting initiating event frequencies for the different Main Control Board panels result from the multiplication of the generic Main Control Board frequency listed in Chapter 10 of Supplement 1 to NUREG/CR-6850 times the apportioning factor and the location weighting factor accounting for the two units.

Further apportioning of the frequencies for the different damage states is based on the MCR non-suppression probability and the abandonment probability due to fire generated conditions. The use of these probabilities accounts for the conditional elements associated with the scenario progression. If for example fire propagation from panel to panel occurs before MCR abandonment in the scenario frequency, the calculation of the abandonment probability considers the failure to suppress at the time of the fire propagation. A summary of the frequency apportioning results is listed in the following table:

Consequence	Frequency (per yr)	Frequency Contribution
Prompt suppression	1.0E-03	62.8%
Control Room Abandonment	7.4E-06	0.4%
No abandonment	6.1E-04	36.8%

The results listed above indicate the following:

1. 62.8% of the postulated fires in the PINGP Fire PRA Main Control Board remain small and are promptly suppressed. This percentage conservatively bounds the fire events experience in the US nuclear industry where all the fires associated with Main Control Board have remain small and not propagated far from the point of ignition.
2. 36.8% of the fires are postulated to damage at least one full cabinet in the Main Control Board. This percentage also bounds the fire events experience in the US nuclear industry as no fire of such consequence has been observed.
3. 0.4% of the fires are postulated to lead to MCR abandonment. This percentage also bounds the fire events experience in the US nuclear industry as no fire starting in the MCR has led to abandoning the room.

It should also be noted that the targets associated with the above listed conditions are conservative as they include either a bounding localized impact within the panel for those scenarios that are promptly suppressed or the full mapping of cables/basic events to the corresponding panel for the scenarios that are not promptly suppressed. This target mapping approach, together with the frequency apportioning process described earlier, ensures that the resulting risk values (i.e., CDF and LERF) are bounding in the PINGP Fire PRA.

PRA RAI 19 – Defense-in-Depth and Safety Margin

Response to PRA RAI 19 was provided with the 60-day RAIs.

Enclosure 2

Licensee Identified Changes

This Enclosure identifies changes to LAR sections not directly related to RAI responses, as follows.

Licensee Identified Issue #1: Monitoring Program

The PINGP LAR currently discusses the NFPA 805 Monitoring Program in Section 4.6.2, *Overview of Post-Transition NFPA 805 Monitoring Program.* Development and implementation of the monitoring program is identified in Attachment S, Table S-3 Items 1 and 32, as follows:

> Item 1
> Implement monitoring program required by NFPA 805 Section 2.6 in accordance with NFPA 805 FAQ 10-0059, including a process that reviews the FPP performance and trends in performance.
>
> Item 32
> Revise FP-E-MR-01, "Maintenance Rule Process" to add High Safety Significant SSCs that require monitoring based on the Fire PRA.

The details of the PINGP Monitoring Program are still under development as part of S-3 Implementation Item 1, and NSPM is considering development of a separate program to monitor NFPA 805 items, to avoid potentially complicated changes to the Maintenance Rule program. To support development of a separate monitoring program, the LAR discussions should be revised as follows:

Existing Section 4.6.2 (first full paragraph on page 46):

> The Fire PRA will be used to identify high-safety-significant (HSS) NSCA SSCs that require monitoring. The Maintenance Rule guidelines differentiating HSS from low safety-significant (LSS) SSCs will be used. High-safety-significant NSCA SSCs not currently monitored in Maintenance Rule will be included in the PINGP Maintenance Rule program. Revisions to PINGP Procedure FP-E-MR-01, "Maintenance Rule Process," will be completed as an Implementation Item described in Attachment S, Table S-3. All NSCA SSCs that are not HSS should be considered LSS and need not be included in the monitoring program.

Revised Section 4.6.2:

> The Fire PRA will be used to identify high-safety-significant (HSS) NSCA SSCs that require monitoring. The Maintenance Rule guidelines differentiating HSS from low safety-significant (LSS) SSCs will be used. PINGP will develop an NFPA 805 monitoring program consistent with FAQ 10-0059. Development of the monitoring program will include a review of existing surveillance, inspection, testing, compensatory measures,

and oversight processes for adequacy. The review will examine adequacy of the scope of SSCs within the existing plant programs, performance criteria for availability and reliability of SSCs, and the adequacy of the plant corrective action program. The monitoring program will incorporate phases for scoping, screening using risk criteria, risk target value determination, and monitoring implementation. The scope of the program will include fire protection systems and features, NSCA equipment, SSCs relied upon to meet radioactive release criteria, Fire PRA equipment, and fire protection programmatic elements. The NFPA 805 Monitoring Program will be completed as an Implementation Item described in Attachment S, Table S-3, Item 1. All NSCA SSCs that are not HSS should be considered LSS and need not be included in the monitoring program.

This change will ensure that an NFPA 805 monitoring program is developed and implemented as described in Table S-3, item 1, and that the monitoring program will not necessarily be included within the PINGP Maintenance Rule program.

In addition to the change to Section 4.6.2 as described above, Attachment S, Table S-3, Item 32, which requires a revision to the PINGP Maintenance Rule Process procedure FP-E-MR-01, to reflect the NFPA 805 monitoring program, should be deleted. Attachment S will be revised and submitted with the response to PRA RAI 03, and this update will include the above change.

Licensee Identified Issue #2: Implementation Schedule

The implementation schedule in Section 5.5, Transition Implementation Schedule, should be revised to state that the Implementation Items described in Attachment S, Table S-3, will be completed within 12 months after NRC approval, in lieu of 6 months as currently stated. NSPM requests 12 months to complete these Implementation Items because of the extensive changes to be completed and other staffing demands at the two-unit PINGP site. In addition, 12 months is consistent with implementation periods provided in several recently approved NFPA 805 license amendments, e.g., Fort Calhoun Station, Cooper Nuclear Station, D.C. Cook Nuclear Plant, and Turkey Point Nuclear Generating Unit.

In addition, the introductory statement for Attachment S, Table S-3 should be changed to describe an implementation period of twelve months. Attachment S will be revised and submitted with the response to PRA RAI 03, and this update will include the above change.

Also, the Fire Protection License Condition provided in Attachment M to the LAR will be revised to include the 12 month implementation period for Table S-3 items, and will be included at a future date when other LAR markups are submitted.

Licensee Identified Issue #3: Add S-2 Item 38

During an internal review of Operating Experience items, NSPM identified that fusing should be provided to protect the control circuits for the DC Lube Oil pumps in both units. This item was entered into the PINGP corrective action program, CAP #01442220, and should be added to Attachment S, Table S-2. Attachment S will be revised and submitted with the response to PRA RAI 03, and the update will include this addition to Table S-2.

Licensee Identified Issue #4: Add S-2 Item 39

During an internal review, NSPM identified that a remote alarm should be provided in the Control Room to indicate loss of power to the Motor Driven Firewater Pump. This item was entered into the PINGP corrective action program, CAP #01439443, and should be added to Attachment S, Table S-2. Attachment S will be revised and submitted with the response to PRA RAI 03, and the update will include this addition to Table S-2.